Appendix B

Surface Water and Hydrology Specialist Study

Newcastle Power Station

Surface Water and Hydrology Specialist Study

AGL Energy Limited

Reference: 503269

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2020-03-04

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Bringing ideas to life

Executive summary

Aurecon Australia has been engaged by AGL Energy Limited (AGL) to undertake an Environmental Impact Statement (EIS) for the proposed Newcastle Power Station, located in Tomago, NSW (the proposal). This report provides a review of the current surface water conditions and potential hydrological / surface water quality impacts that may arise during the construction and operational phases of the power station.

The proposal includes the power station site as well as two easement investigation areas, for the gas pipelines linking the power station to the existing Newcastle Gas Storage Facility (NGSF) as well as the electrical transmission lines.

The power station site is located on a topographic high point adjacent to the Hunter River and divided by a topographic ridge approximately central to the site. Current topographical conditions result in runoff from the north-eastern portion of the site flowing towards an off-site seep-away area, overlying the fringe of the Tomago Sandbeds. Whereas runoff from the south-western section also drains to an on-site collection and seep away low-lying area. The proposed surface water management plan would result in a portion of the northern runoff being diverted south and draining to the current low-lying area.

The water for the proposed power station would be sourced from the Port Stephens municipal water supply system. Most of the water would be evaporated and discharged to the atmosphere via the exhaust stack. Any excess process water would be tankered off site. Potable water drains and site sewage shall be collected and discharged to a site sewerage system. Septic tank(s) shall be used and will be pumped out by truck as required.

All runoff from roads, car-park and hardstand areas will be collected in a ‘pit and pipe’ stormwater system. This system will discharge after undergoing treatment through an oil and grease separator and a bioretention system. The expected discharge qualities would potentially be better than the current background local groundwater quality (receiving waterbody).

The flood assessment found that the flooding events modelled (10% annual exceedance probability (AEP), 1% AEP, 1% AEP with climate change, and probable maximum flood (PMF) scenarios) would not reach the proposed power station site. However, for the 1% AEP, 1% with climate change and the PMF events, the flood waters are expected to cover the proposed underground pipelines connecting to the NGSF. The infrastructure is thus unlikely to have any impact on changing flood levels or flow patterns or velocity outside the property area.

Several potential impacts on the receiving environment’s hydrology and water quality have been identified for both the construction and operational phase. These impacts can mostly be mitigated by implementing several specified management plans and operational procedures. By implementing these plans a Neutral or Beneficial Effect (NorBE) on the receiving water quality can be demonstrated.

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1 Introduction

1.1 Background

Aurecon Australia has been engaged by AGL Energy Limited (AGL) to undertake an Environmental Impact Statement (EIS) for the proposed Newcastle Power Station, located in Tomago, NSW (the proposal). This report provides a review of the current surface water conditions, a flooding assessment and the potential hydrological / surface water quality impacts that may arise during the construction and operational phases of the power station. A separate Groundwater Specialist Study has been prepared to examine the groundwater conditions and potential impacts of the proposal on these systems.

The proposal has been declared as Critical State Significant Infrastructure and Secretary's Environmental Assessment Requirements (SEARs) issued. This report addresses those regarding surface water and hydrology.

To support the abating or elimination of potential adverse impacts on the receiving surface and groundwater systems caused by the proposal, the report incorporates proposed mitigation measures, including recommendations for the development of specific construction and operational environmental management plans.

1.2 Proposal Summary

AGL propose to construct and operate a dual fuel (gas or diesel) fired fast-start peaking power station with a nominal operating capacity of approximately 250MW, and associated infrastructure including natural gas supply and electrical connection to the existing TransGrid Tomago 132kV switchyard.

The proposal includes the Newcastle Power Station (NPS), gas pipelines supplying gas to the facility, electricity transmission from the NPS, site access and associated ancillary facilities. The pipeline(s) would supply the proposed NPS with gas from the eastern Australia gas transmission pipelines via the Jemena HPP network. A new electricity transmission line would transfer the electricity produced by the proposed NPS to the national electricity network via connection to the existing 132kV Tomago switchyard.

1.3 Study Objective

An objective of the EIS is to address potential surface water impacts associated with the construction and operational phase of the proposal. It also aims to provide guidance on ways of managing the potential sources of surface water impacts to avoid any environmental degradation.

This assessment has been prepared to fulfil the requirements included in the SEARs, which are outlined in **Table 1-1** below. The assessment also addresses agency comments outlined in **Table 1-2**.

Table 1-1 SEARs Requirements for Surface Water and Hydrology

Secretary's Requirements	Scope of assessment	Report Section
A description of the existing environment likely to be affected by the proposal using sufficient baseline data	Review of recent and historic reports relevant to surface water and hydrological assessment for the study area	Section 4.2
	Site inspection to obtain a valid understanding and conceptualisation of the surface water and hydrological conditions within and around the proposal space	Section 4.1
	Baseline desktop analysis of available information to characterise the surface water and hydrological environment within and around the proposal area	Section 5

Secretary's Requirements	Scope of assessment	Report Section
A detailed site water balance for the project, including water supply and wastewater disposal arrangements	A local climatic water balance. The process water balance will be influenced by the engine technology installed, which has not been confirmed at this time.	Section 5.1
An assessment of the flood impacts of the proposal	Desktop flooding assessment to consider the flood immunity of the proposed infrastructure	Section 5.3.4
An assessment of the potential impacts of the proposal, including any cumulative impacts, and taking into consideration relevant guidelines, policies, plans and industry codes of practice	Identification and assessment of the potential construction, operational and cumulative impacts	Section 6
A description of how the proposal has been designed to avoid and minimise impacts (including selection of gas connection option)	Review of the neutral or beneficial effect on water quality (NorBE) assessment – an appropriate methodology to consider impacts to the Tomago sand beds and associated drinking water catchment land	Section 7
A description of the erosion and sediment control measures that would be implemented to mitigate any impacts during construction	Determination of constraints and opportunities for erosion and sediment control	Section 7
	Conclusions and recommendations for management or mitigation of potential impacts	Section 11

Table 1-2 Agency Comments for Surface Water and Hydrology

Agency	Agency Comments	Report Section
OEH (Baseline Assessment)	▪ The EIS must map the following features relevant to water and soils including:	
	– Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method)	Section 5.3
	– Wetlands as described in s4.2 of the Biodiversity Assessment Method	
	– Proposed intake and discharge locations	Section 7.2
	▪ The EIS must describe background conditions for any water resource likely to be affected by the development, including:	
	– Existing surface and groundwater	Section 5.3.5
	– Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	n/a
	– Water Quality Objectives (as endorsed by the NSW Government that represent the community's uses and values for the receiving waters	Section 5.3.5
	– Indicators and trigger values/criteria for the environmental values in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government	

Agency	Agency Comments	Report Section
EPA (Baseline Assessment)	■ Describe existing surface and groundwater quality.	Section 5.3.5
	■ An assessment needs to be undertaken for any water resource likely to be affected by the proposal.	n/a
	■ Issues to be discussed should include but are not limited to:	
	– A description of any impacts from existing industry or activities on water quality	Section 5.3.5
	– A description of the condition of the local catchment (e.g. erosion, soils, vegetation cover)	Section 4.2
	– Historic river flow data	
	– Water Quality Objectives for receiving waters relevant to the proposal	Section 5.3.5
	– Indicators and associated trigger values or criteria for the identified environmental values	
NSW Department of Industry Lands and Water Division (Impact Assessment)	■ The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.	Section 2.6
	■ A detailed and consolidated site water balance.	Section 2.6
	■ Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts	Section 6
	■ Proposed surface and groundwater monitoring activities and methodologies.	Section 9
	■ Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans	Section 3
EPA (Impact Assessment)	■ Describe the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges	n/a
	■ Demonstrate that all practical options to avoid discharges have been implemented and environmental impact minimised where discharge is necessary	Section 2.6
	■ Where relevant include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	Section 2.6 Section 7.2
	■ Describe the nature and degree of impact that any proposed discharges will have on the receiving environment, both surface water and groundwater	Section 6 Section 8
	■ Detail contractual and other arrangements that will be put in place to prevent pollution from haul roads and unsealed roads per se, particularly rights of carriageways not owned by the proponent	n/a
	■ Assess impacts against the relevant ambient water quality outcomes. Demonstrate how the proposal will be designed and operated to:	Section 5.3.5
	– Protect the Water Quality Objectives for receiving waters where they are currently being achieved	
	– Contribute towards achievement of the Water Quality Objectives over time where they are not currently being achieved	
	■ Where a discharge is proposed that includes a mixing zone, the proposal should demonstrate how wastewater discharged to waterways will ensure the ANZECC (2000) water quality criteria for relevant chemical and non-chemical parameters	n/a

Agency	Agency Comments	Report Section
	are met at the edge of the initial mixing zone of the discharge, and that any impacts in the initial mixing zone are demonstrated to be reversible ■ Propose water quality limits for any discharge(s) that adequately protects the receiving environment ■ Assess impacts on groundwater and groundwater dependent ecosystems ■ Describe how stormwater will be managed both during and after construction ■ Describe how predicted impacts will be monitored and assessed over time	Section 7 GW report Section 7.2 Section 9
OEH (Impact Assessment)	■ The EIS must assess the impacts of the development on water quality, including the nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction. ■ Identification of proposed monitoring of water quality.	Section 7 Section 9
Hunter Water (Impact Assessment)	■ Hunter Water expects that all development in drinking water catchments will demonstrate NorBE. NorBE applies to all releases of water, wastewater and other contaminants from the site that may affect water quality, during both construction and operation. A development is considered to demonstrate NorBE if the development: – Has no identifiable potential impact on water quality, or – Will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or – Will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority ■ Hunter Water has published guidelines for development in drinking water catchments and these can be viewed on Hunter Water's website at Guideline for Development in the Drinking Water catchments.	Section 8 Section 3.2
Port Stephens Council (Impact Assessment)	■ Biodiversity considerations – Assessment of koala habitat on site and offsetting requirements are to be conducted in accordance with Port Stephens Council's Comprehensive Koala Plan of Management. – Any offsetting requirements in accordance with the biodiversity offset scheme should be secured within the local area, where possible. – As the proposal site is located within proximity to a number of wetland environments including the Hunter Estuary Wetlands (Ramsar site) and known habitat for threatened species and migratory birds, an assessment of air and water quality impacts in relation to biodiversity impacts is required to determine potential impacts of emissions (chemical and heat (including plume rise)) and associated acid rainfall events on wetlands environments (including SEPP wetlands, nationally important wetlands and internationally important wetlands). Special consideration should be given to potential impacts on habitat quality, food sources (insects, fish etc.), fight patterns of migratory birds and amphibians. ■ Heritage considerations	n/a n/a n/a n/a

2 Proposal description

2.1 Overview

The proposal would involve the construction and operation of a power station with a nominal capacity of approximately 250MW. The proposal would supply electricity to the grid at short notice during periods of high electricity demand, particularly during low supply periods from intermittent renewable sources or during supply outages.

The proposal would also involve the construction and operation of gas pipeline(s) and an electricity transmission line. The pipeline(s) would supply the proposed power station with gas from the Eastern Gas Pipeline via the Jemena network and from the Newcastle Gas Storage Facility (NGSF). A new electricity transmission line would transfer the electricity produced by the proposed power station to the national electricity network via connection to the existing 132kV Tomago switchyard.

The main elements of the proposal are as follows:

- Power station comprising of either large reciprocating engine generators or gas turbine generators, necessary supporting ancillary equipment and supporting infrastructure. The power station would be capable of operating with diesel fuel, if necessary.
- 132kV electricity transmission line to the existing Tomago switching yard, operated by TransGrid
- Gas transmission/storage pipeline(s) and receiving station, compressor units, and ancillary infrastructure
- Storage tanks and laydown areas
- Water management infrastructure including pond(s), stormwater drainage and a connection to Hunter Water potable infrastructure in line with Hunter Water requirements
- Diesel storage and truck unloading facilities
- Site access road
- Office / administration, amenities, workshop / storage areas and carparking

2.2 Site location

The proposal site is located approximately 15km north-west of Newcastle CBD, NSW as indicated in **Figure 2-1**.

The proposed power station will be located in Lot 3 DP 1043561 at 1940 Pacific Highway, Tomago. Some additional clearing may be required to augment the current cleared areas within Lot 2 DP1043561 for use as laydown area during construction (see **Figure 2-2**). AGL owns both Lot 2 and Lot 3 DP 1043561.

The site has been used previously for agricultural purposes, including grazing, and hosts a single storey residential dwelling which would be demolished if not repurposed during construction and operation. The nearest residential areas off the site are more than two kilometres away. There are some isolated trees on the site as well as stands of native vegetation generally confined to the boundaries. The nearest major water body is the Hunter River, approximately 470 metres north-west, however two minor ponds have also been identified within the site boundary.

Lot 2 and Lot 3 (proposed power station and laydown areas) are zoned IN-1 General Industrial under the current Port Stephens Local Environmental Plan (LEP) as indicated in **Figure 2-2**. Pipeline and electricity easement corridors would extend east into Lot 4 DP 1043561 and Lot 202 DP 1173564. These Lots are owned by the Tomago Aluminium Company (TAC).

Land within the gas pipeline and electrical transmission easement investigation areas is also zoned IN-1 General Industrial under the current Port Stephens LEP. The land is vegetated and contains existing easements for gas pipelines, electrical infrastructure, and roads. There are no dwellings in these investigation areas.

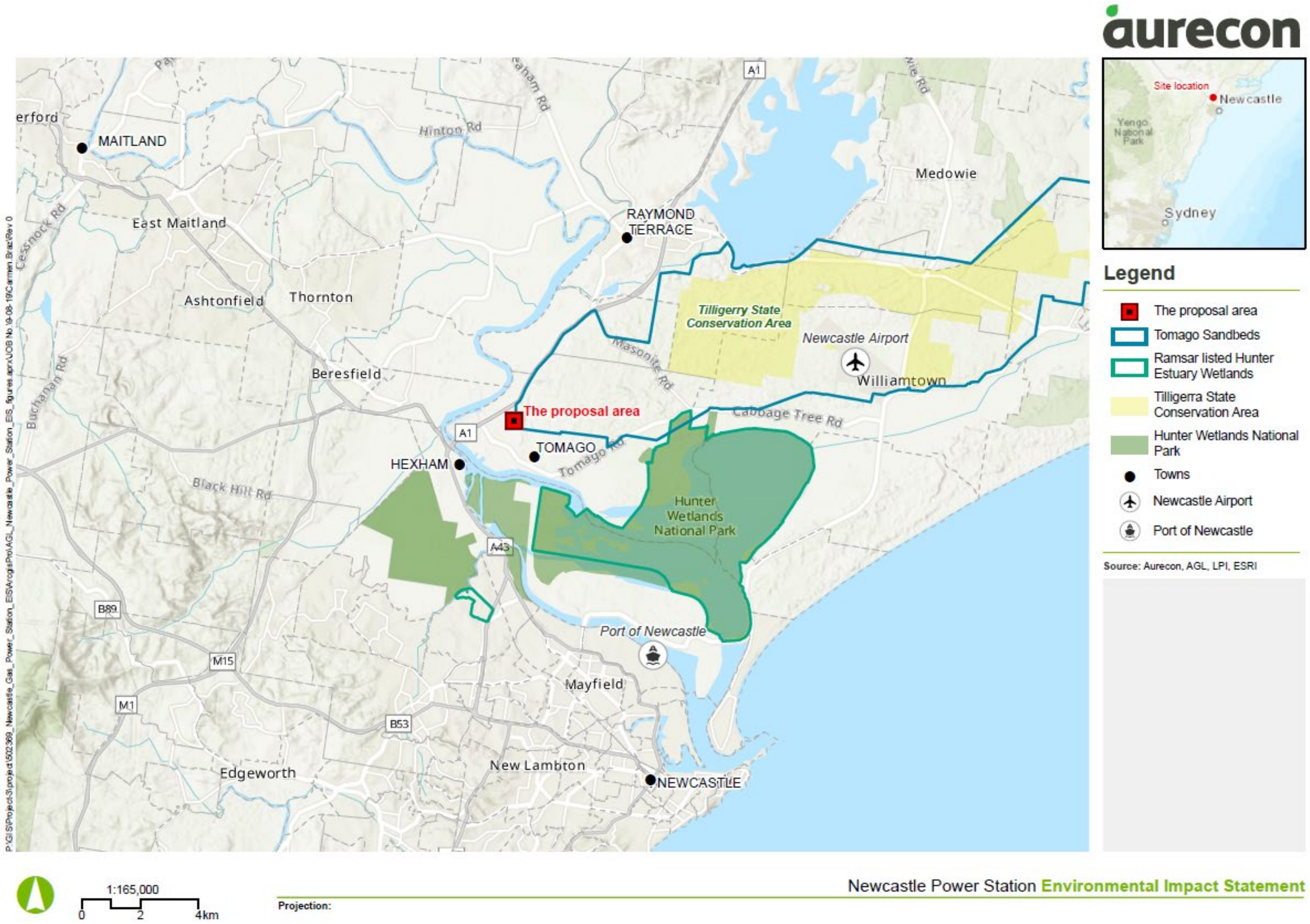

Figure 2-1 Proposal location

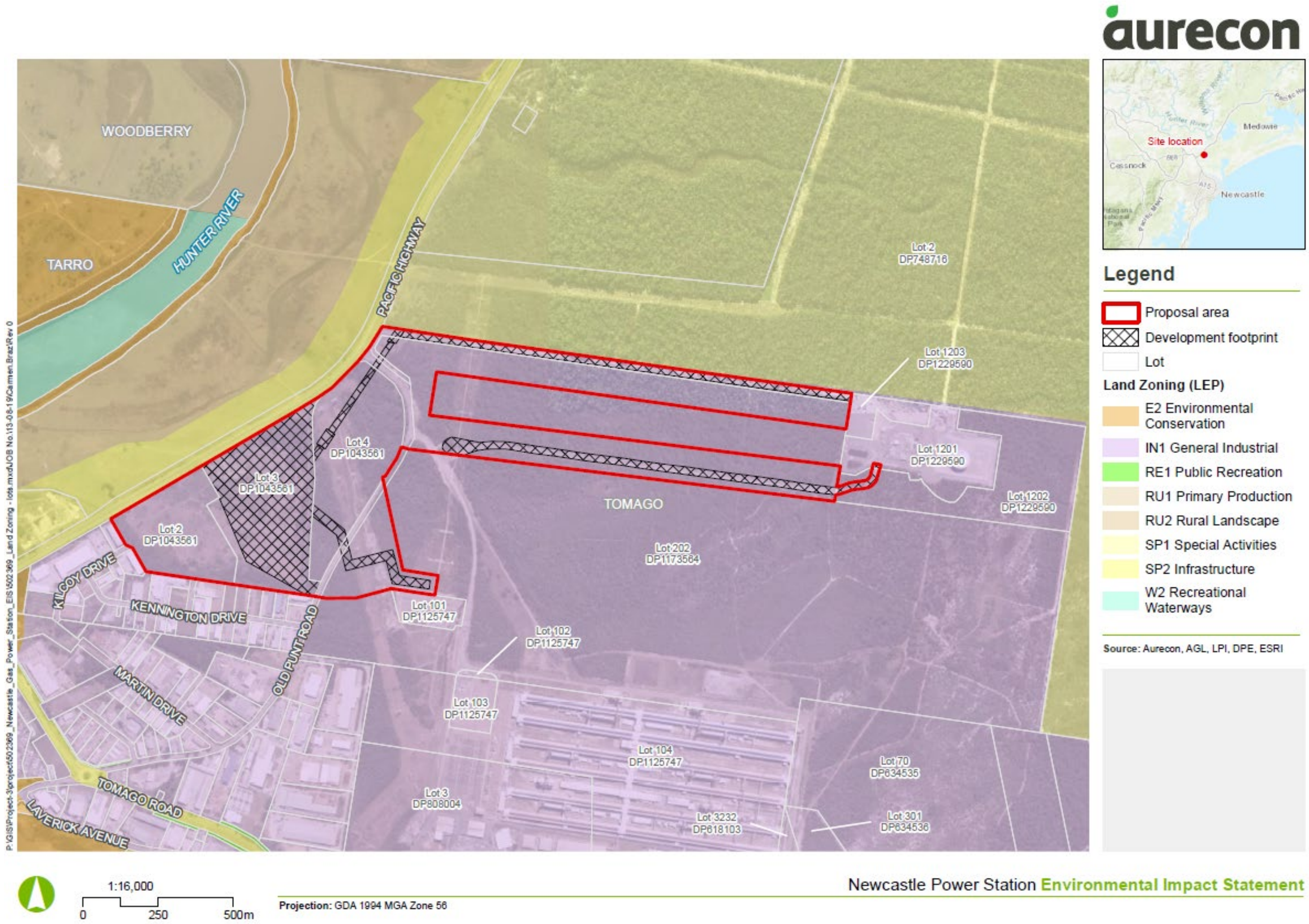

Figure 2-2 Land Zoning

The proposed site layout plan is provided in **Figure 2-3**. The current layout is an indicative one and will only be finalised once the engine technology type has been selected.

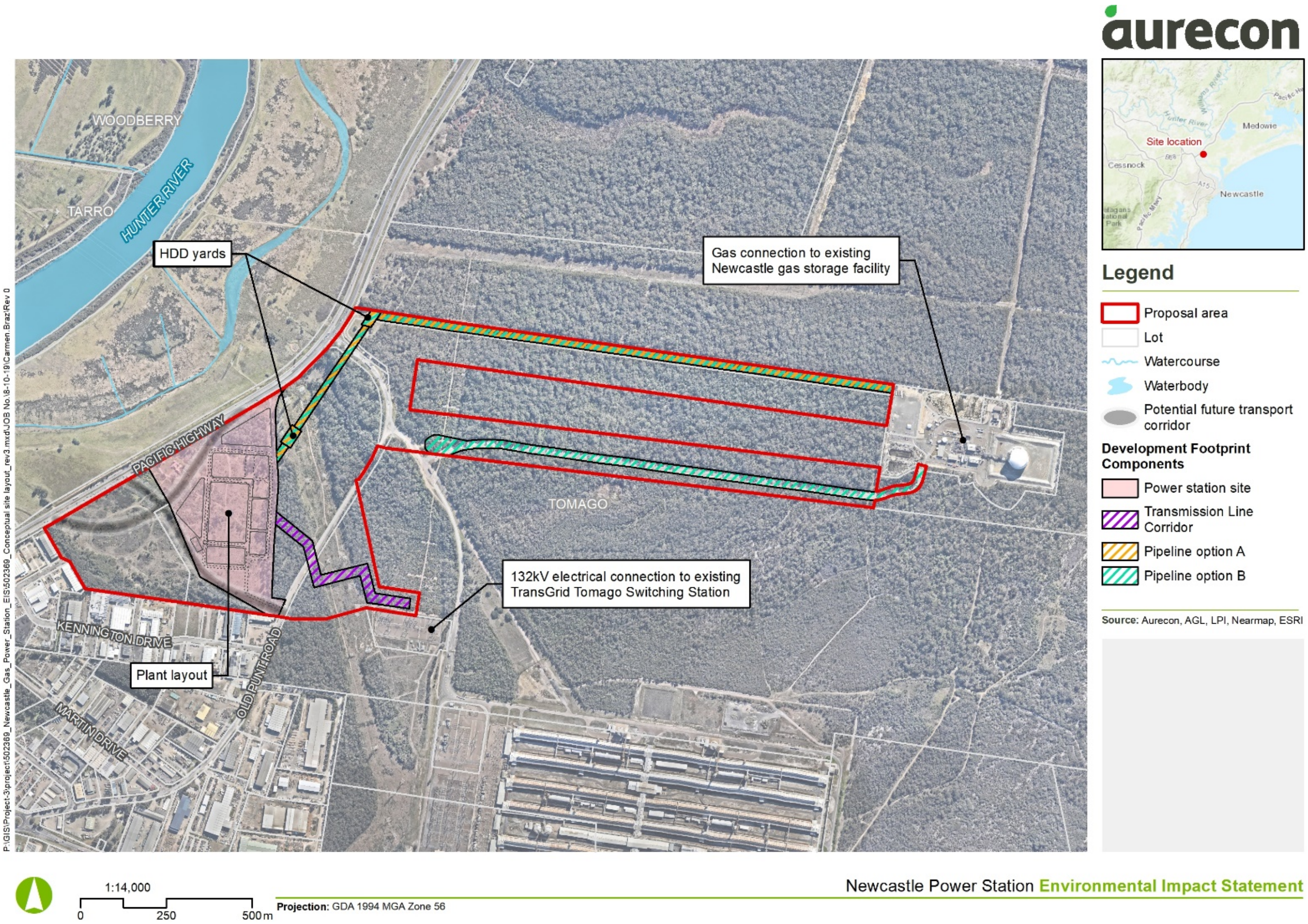

Figure 2-3 Site Layout Plan

2.3 Power station

The power station would be capable of generating approximately 250MW of electricity. The proposed power station would either consist of large reciprocating engine generators or aero-derivate gas turbine generators. Generation units would be dual fuel capable, meaning they would be able to be supplied by natural gas and/or liquid fuel.

The decision to install gas turbines or reciprocating technology would be made based on a range of environmental, social, engineering and economic factors that would be considered as the power station design progresses.

Gas Turbine Technology

Electricity would be generated by gas turbine technology through the combustion of natural gas and/or liquid fuel in turbines. Gas turbine units consist of a compressor, combustion chamber, turbine and generator. Air is compressed to a high pressure before being admitted into the combustion chamber. Fuel (natural gas or diesel as required) is injected into the combustion chamber where combustion occurs at very high temperatures and the gases expand. The resulting mixture of hot gas is admitted into the turbine causing the turbine to turn, generating power. In an open cycle configuration, hot exhaust gas is vented directly to the atmosphere through an exhaust stack, without heat recovery.

Reciprocating Engine Technology

Reciprocating engines used for power generation harness the controlled ignition of gas and/or diesel to drive a piston within a cylinder. Several pistons move sequentially to rotate a crank shaft which turns the generator.

Ancillary facilities

The power station, regardless of chosen technology, would require supporting ancillary facilities. These would include:

- Natural gas reception yard potentially including gas metering, pressure regulation, compression (if required), heating stations, pigging facilities (if required) and provision for flaring
- Generator circuit breakers, generator step-up transformers and switchyard including overhead line support gantry
- Water collection and treatment facilities
- Water storage tanks and pond(s)
- Truck loading/unloading facilities
- Liquid fuel storage tanks
- Emergency diesel generators with associated fuel storage
- Closed circuit cooling systems
- Control room
- Offices and messing facilities
- Electrical switch rooms
- Occupational health and safety systems including an emergency warning and evacuation system
- Workshop and warehouse
- Firefighting system
- Communication systems
- Security fence, security lighting, stack aviation warning lights (if required) and surveillance system
- Landscaped areas and staff parking areas
- Concrete foundations, bitumen roadways, concrete pads in liquid fuel unloading station and gas turbine or engine unit maintenance areas
- Concrete bunded areas with drains for liquid fuel tanks, liquid chemicals store, oil filled transformers (if installed) and other facilities where contaminated liquids could leak
- Level construction and laydown area
- Engineered batters to support and protect the power plant platform
- Sedimentation pond and associated diversion drain and earth bunding

2.4 Gas pipeline

Natural gas fuel would be supplied from the existing Eastern Gas Pipeline. The nearest supply point in the gas network is the AGL owned Tomago to Hexham high pressure gas pipeline (HPP) which terminates at the AGL owned and operated NGSF. The NGSF is located about two kilometres north east of the proposed power station site (see **Figure 2-3**).

A new gas pipeline connection to the Tomago to Hexham high pressure gas pipeline would supply the power station. This connection would be made just east of Old Punt Road, east of the proposed power station site. The pipeline would be constructed of approximately 100m of DN 1050 (42”) ASME Class 900 pipe.

AGL may augment the proposed gas supply by compressing natural gas in a new gas pipeline between the power station and the NGSF (potential alignment indicated by the “Gas Pipeline Investigation Area” in **Figure 2-3**). The pipeline route will use existing gas and road easements where possible. AGL will enter negotiations for any new pipeline easements in accordance with the *Pipelines Act 1967*.

The pipeline will be constructed of approximately 4.6km of DN 1050 (42”) ASME Class 900 pipe. The installation of the pipeline may require boring pits (and associated tunnelling or HDD) where it crosses existing services or roads, all other portions along the pipeline route will be trenched with an estimated depth of cover between 900 mm and 1,200 mm from the top of pipe to the surface.

Gas compression, conditioning, heating and other facilities necessary to transport and store gas maybe required and would be constructed at the proposed power station site.

2.5 Electricity transmission line

A high voltage 132kV electricity transmission line would be required to connect the proposed power station to the TransGrid Tomago 132kV switchyard, approximately 500 metres south east. The switching station would transfer the electricity produced at the power station to the regional electricity transmission system. The transmission line would be located alongside the existing transmission line running northwest from the switchyard before heading west to the power station.

2.6 Water and wastewater

Water would be required to operate the power station. Water would primarily be used for evaporative cooling and for nitrogen oxide (NOx) suppression, if necessary. When used for NOx suppression water would be injected into the combustion chamber where it would vaporise and discharge through the exhaust stack. Additionally, evaporative cooling would be used on hot dry days to reduce the temperature of the inlet air.

The water for the proposed power station would be sourced from the Port Stephens municipal water supply system via an extension of the existing water supply infrastructure on Old Punt Road. The water supply quality is potable.

Most of the water would be evaporated and discharged to the atmosphere via the exhaust stack. Any excess process water would be tankered off site.

Other uses for water at the site would include:

- Firefighting water
- Boosting the power of the power station
- Water for washing the gas turbine compressor (if installed)
- Potable water for staff amenities

The process water balance will be influenced by the engine technology installed, which has not been confirmed at this time. The expected demand rates associated with the current considered technologies are provided in **Table 2-1**. This indicates a large variance in potential water demand (1.77 to 95.8m^3/h or 42 to 2,300m^3/d).

Table 2-1 Process Water Balance (m^3/h)

Parameter	Reciprocating engine		Gas Turbine	
	Normal operation (Gas)	Standby operation (Diesel)	Base load	Peak load
Demands				
Demin Water Treatment Demand	1.51	20.68	90.75	95.68
Potable Water	0.17	0.17	0.06	0.06
Service Water	0.06	0.06	0.06	0.06
Supply				
Municipal Water	1.77	20.92	90.88	95.8
Discharge/Loss				
Process Waste Water (Tanked off site)	0.61	8.27	18.15	19.14
Septic Tanks	0.06	0.06	0.06	0.06

Potable water drains and site sewage will be collected and discharged to a site sewerage system. Septic tank(s) will be used and pumped out by truck as required. The site sewerage system will comply with the requirements of Government Agencies.

All runoff from roads, car-park and hardstand areas will be collected in a ‘pit and pipe’ stormwater system. The pit and pipe stormwater system would be provided along the roads within the proposal site and would discharge to the natural depression at the south-west corner of the proposal site, after undergoing treatment via a proposed oil and grease separator and a Bioretention Pond (shown in **Figure 7-2**).

2.7 Vehicular access

The area around Tomago is serviced by a road network adequate to cater for heavy haulage vehicles due to the existing surrounding industrial land uses. Old Punt Road is a sealed single lane, two-way council owned road. Old Punt Road connects to the Pacific Highway approximately one kilometre to the north of the proposed power station access point (as seen in **Figure 2-3**).

During construction oversized or heavy items would be transported along the Pacific Highway and Old Punt Road.

During operation, vehicular access to the proposal area would be provided via the newly formed access off Old Punt Road. This access would be used by operational staff. Parking for staff would be provided on site.

3 Legislation, policy and guidelines

3.1 Legislation and policy

An overview of the relevant legislation and policy and their relevance to the proposal is provided in **Table 3-1**.

Table 3-1 Overview of relevant surface water legislation and policy

Legislation / Policy	Summary	Relevance
Water Management Act NSW (2000)	The overall objective of the Water Management Act 2000 (WM Act) is “sustainable and integrated management of the State’s water” (DLWC 2001). Water sharing plans are the main tool through which the WM Act achieves its objectives.	Elements of the Water Management Act 2000 (including drainage management, floodplain management and controlled activities) and general principles that are relevant to this proposal have been considered in this assessment to inform potential construction, operational and cumulative phase impacts of the proposed Newcastle Gas Fired Power Station
Coastal Management Act (2018)	State Environmental Planning Policy (Coastal Management) 2018 updates and consolidates the SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection) into one integrated policy, including clause 5.5. of the Standard Instrument – Principal Local Environmental Plan. The Coastal Management SEPP gives effect to the objectives of the Coastal Management Act 2016 from a land use planning perspective, by specifying how development proposals are to be assessed if they fall within the coastal zone The SEPP requires development consent to be obtained in relation to any development for a purpose that is permissible by way of an EPI that applies to the land, and involves any of the following: ▪ destroying or removing native vegetation ▪ constructing a levee ▪ drainage works ▪ filling ▪ Harm of marine vegetation; or ▪ Any other development.	Due to the nature of the proposal, including drainage works and removal of vegetation within the proposal site, elements of the Coastal Management Act 2018 have been considered as part of this assessment
Protection of the Environment Operations (POEO) Act (1997)	The POEO Act establishes the NSW environmental framework and includes provisions for regulating certain activities particularly relating to air emissions; contaminated sites; hazardous material; noise; pesticides; forestry activities; waste; water quality; and state of the environment reporting. The NSW Environmental Protection Authority (EPA) is the independent authority responsible for administering activities under the POEO Act. The EPA use Environment Protection Licences (EPLs) as a means to regulate the impacts of pollution in NSW.	The act identifies “scheduled activities”, of which several will be undertaken as part of the proposal. It further details the required licences for undertaking these activities as well as the potential penalties applicable if such licences are not obtained. It stipulates mandatory environmental audits as well as the frameworks guiding investigations and other proceedings. Sections 120 through 123 of the act address Water Pollution specifically.

Legislation / Policy	Summary	Relevance
Hunter Water Regulation, (HWC, 2015)	Hunter Water Regulation 2010 - Clause 15 … Tomago Sandbeds: (1) A person must not engage in any extractive industry in the … Tomago Sandbeds Catchment Area otherwise than in accordance with an approval given by the Secretary. Hunter Water Regulation 2010 - Clause 10 Pollution of waters: (1) A person must not pollute any waters in a special area. In this clause: **pollute**, in relation to waters, has the same meaning as pollution of waters has in the Protection of the Environment Operations Act 1997, but extends to include disturbing geological or other matter (whether natural or artificial) in such a manner as to change, or to be likely to change, the physical, chemical or biological condition of the waters.	The pipelines contained within the proposalare partially located within the Tomago Sandbeds Catchment Area (the power station is not located within this area). Hunter Water Corporation (HWC) extracts groundwater from the Tomago Sandbeds to supplement the potable water supply for the Newcastle Region. The *Tomago Sandbeds Catchment Area* is declared a special areaunder the *Hunter Water Act 1991. The Hunter Water (Special Areas) Regulation 2003* and Hunter Water Regulation (*Public Exhibition Draft*) 2010 - makes provision for HWC to regulate activities within areas of declared special areas under the above act

3.2 Guidelines

This report has been prepared with reference to the state and federal guidelines listed in **Table 3-2**:

Table 3-2 Overview of relevant groundwater guidelines

Legislation / Policy	Summary	Relevance
Department of Agriculture and Water Resources (2018): National Water Quality Management Strategy	The NWQMS was developed collectively by the states, territories and Commonwealth during the 1990s by the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ). The NWQMS (ANZECC and ARMCANZ 2000a) provides a nationally consistent approach to water quality management and the information and tools to help water resource managers, planning and management agencies, regulatory agencies and community groups manage and protect their water resources. The NWQMS comprises a description of policies, principles and guidelines for end users and water sources. The main policy objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development. The NWQMS process involves development and implementation of a management plan for each catchment, aquifer, estuary, coastal water or other water body, by community and government. These plans focus on the reduction of pollution released into coastal pollution hotspots and other aquatic ecosystems around the country. Local government, community organisations and other agencies implement these plans using the NWQMS to protect agreed environmental values. The NWQMS consists of some 21 guideline documents which broadly cover ambient and drinking water quality, monitoring, groundwater, rural land uses and water quality, stormwater, sewerage systems and effluent management for specific industries. Two additional publications were released in 2001: ■ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) ■ Australian Guidelines for Water Quality Monitoring and Reporting (2000)	Construction and operational phases of the Newcastle Power Station have the potential to impact water quality within the adjacent Hunter River and Tomago Sandbeds. As such, construction and operational phases should integrate water quality management strategies (consistent with NWQMS) such that the environmental values of the sensitive receiving waterways are not adversely impacted. These should be included in the construction and operational EMPs.

Legislation / Policy	Summary	Relevance
	These publications outline the current approach for deriving water quality guidelines, objectives and targets. They provide highly detailed and comprehensive information for water quality monitoring and management in Australia and New Zealand. Each publication is discussed in more detail in the following sections	
NSW Water Resources Council (1993): NSW State Rivers and Estuaries Policy	The State Rivers and Estuaries Policy established the framework for the management of rivers and estuaries of NSW and related ecosystems, such as wetlands. It is based on the "Total Catchment Management" philosophy defined in the Catchment Management Act 1989. The policy is founded on the following management principles: i) Those uses of rivers and estuaries which are non-degrading should be encouraged. ii) Non-sustainable resource uses which are not essential should be progressively phased out. iii) Environmentally degrading processes and practices should be replaced with more efficient and less degrading alternatives. iv) Environmentally degraded areas should be rehabilitated, and their biophysical functions restored. v) Remnant areas of significant environmental values should be accorded special protection. vi) An ethos for the sustainable management of river and estuarine resources should be encouraged in all agencies and individuals who own, manage or use these resources, and its practical application enabled.	The third principle is most applicable and should be adhered to during the development and operation of the proposal. As per the policy: "Strategies for achieving this objective would encourage and facilitate the adoption of the best available management practices.
NSW DPI (2018): Guidelines for controlled activities on waterfront land – Riparian corridors	Controlled activities carried out in, on, or under waterfront land are regulated by the Water Management Act 2000 (WM Act). The Natural Resources Access Regulator (NRAR) administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity.	The recommended riparian corridor widths, as indicated in this guideline document, is 10m for a 1st order watercourse type and 40m for a 4th order or greater type. The proposal site is located further than 100m away from the closest categorized watercourse, thus it is not classified as waterfront land.
Water NSW (formerly Sydney Catchment Authority) (2015): Neutral or Beneficial Effect on Water Quality Assessment Guideline. February 2015	The guideline supports the implementation of the State Environmental Planning Policy (SEPP) by providing clear direction on what a neutral or beneficial effect means, how to achieve it, and how to assess an application against the neutral or beneficial effect on water quality test using the 'Neutral or Beneficial Effect on Water Quality Assessment Tool' (the NorBE Tool). The guideline also provides the decision-making framework for the NorBE Tool. A neutral or beneficial effect on water quality is satisfied if the development: ■ has no identifiable potential impact on water quality, or ■ will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or ■ will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.	The constructional phase management options as well as the stormwater management plan (SWMP) should be designed to facilitate a Neutral or Beneficial Effect (NorBE) on water quality.
Landcom (2004) Managing Urban Stormwater, Soils and Construction Volume 1, 4th Edition	These guidelines, commonly known as the 'Blue Book', provide support for councils and industry to reduce the impacts of land disturbance activities on waterways by better management of soil erosion and sediment control.	During the construction and operation phases of the proposal due consideration should be given to the erosion and sediment control mechanisms that are to be put in place to reduce the impacts of land disturbance.

Legislation / Policy	Summary	Relevance
Institute of Engineers Australia (2006): Australian Runoff Quality	Australian Runoff Quality (ARQ) guide provides an overview of current best practice in the management of urban stormwater in Australia, within the context of total urban water cycle management and integration of management practices into the urban built form. The guide provides: ■ Procedures for the estimation of a range of urban stormwater contaminants ■ Design guidelines for commonly applied stormwater quantity and quality management practices ■ Procedures for the estimation of the performance of these practices ■ Advice with respect to the development/consideration of integrated urban water cycle management practices	The expected stormwater runoff qualities would inform the necessary management and/or treatment requirements.
Hunter Water (2017): Protecting our Drinking Water Catchments - Guidelines for Development in the Drinking Water Catchments	The Guidelines for development in the drinking water catchments aim to provide guidance for anyone proposing to undertake development activities within the drinking water catchment. The guidelines exist to ensure development and land use activities within the drinking water catchments are planned and undertaken so that they do not adversely affect drinking water quality. Hunter Water expects all developments in drinking water catchments to demonstrate a Neutral or Beneficial Effect (NorBE) on water quality.	Due to the proposal power station location in relation to the adjacent Tomago Sandbeds (although not within the sandbeds) and the potential impact to drinking water in the area, the guidelines should be considered during the construction and ongoing operation of the power station. This is addressed within the surface water section of this EIS.

4 Methodology

4.1 Approach

Section 5 of this report presents a summary of the existing environmental conditions determined for the site from a combination of site walkover and desktop assessment. The culmination of these resources provided an in-depth understanding of the current environment and facilitated an assessment of potential environmental impacts and the mitigation measures associated with the construction and operation of the proposal.

Details of the site walkover and desktop assessment approach are summarised below:

Table 4-1 Summary of site walkover and desktop assessment methodology

Component	Scope
Site Walkover	Inspection and survey of local terrain, topography, vegetative cover, potential drainage pathways, watercourses, wetlands and the surrounding environment in which the proposal will interact with.
Desktop Assessment	Review of data available through the Bureau of Meteorology (BOM) to obtain localised rainfall, temperature and evaporation data for the lower Hunter River region.
	Review spatial mapping resources (Google Earth Pro and SIX Maps Digital Topographic Database) and the Port Stephens Local Environmental Plan (LEP) 2016 to enable conceptualisation of physical environmental conditions on-site and surrounding areas.
	Review of existing literature (detailed in Section 4.2 below) to amalgamate historic investigations and relevant information.
	Review of relevant legislation, policy and guidelines (detailed in Section 3.0) to address SEARs and agency requirements, and to inform potential construction, operational and cumulative impacts, in conjunction with possible mitigation controls for the proposal.
	Review of Aurecon's Concept Design Report (2019) for the proposal enabled the identification of construction and operational phase activities relevant to the Surface Water and Hydrology technical study. The potential impacts and associated mitigation measures were also assessed with consideration to the relevant components of the design
	Review of Aurecon's Surface Water Quality Assessment (Appendix C) and Flood Assessment (Appendix B) for the proposal to inform the construction and operational phase potential impacts and mitigation measures within this technical study.

4.2 Previous investigations and reports

A review of previous investigations was undertaken to characterise the current surface water and hydrological conditions within or around the proposal space, assess the potential impacts and provide recommendations to avoid, mitigate or manage these impacts. Reports relevant to the NPS site are listed below:

Preliminary site investigation reports

- Environmental Strategies, 2017a. *Phase 1 Preliminary Environmental Site Assessment – Tomago Development Site.*
- Environmental Strategies, 2018. *Additional Pre-Existing Contamination Study – Tomago Development Site, NSW*

Environmental assessment reports

- Coffey, 2011. Environmental Assessment – Newcastle Gas Storage Facility Project. Volume 1: Main Report
- Coffey, 2011a. Environmental Assessment – Newcastle Gas Storage Facility Project. Volume 2: Appendix 3 – Surface Water Assessment
- URS, 2002. Environmental Impact Statement - Tomago Gas Fired Power Station, Volume 1: Main Report

Hunter River reports

- Swanson RL, Potts JD & Scanes PR, 2017b: Lower Hunter River Health Monitoring Program: Stormwater Quality Monitoring Program 2015, Office of Environment and Heritage, Sydney
- DHI, 2008: Upgrading of Lower Hunter Flood Model at Hexham, Final Report, Phase 4

The key findings of the above listed reports are presented in the following sections.

Environmental Strategies (2017a): Phase 1 Preliminary Environmental Site Assessment – Tomago Development Site, NSW

Environmental Strategies (ES) was engaged to complete a Phase 1 Preliminary Environmental Site Assessment (PESA) of the Tomago Development Site (TDS) property. The area covered in the PESA is the same as the proposed power station site covered in the current EIS (this report).

The assessment identified the potential historic and current contaminant sources on site, which included various domestic type contaminants (general rubbish, minor oil stains, 2 septic systems, storage and use of typical domestic chemicals) as well as several cars bodies, car parts and mounded vegetation.

The following observations relating to the local hydrological systems were made:

- The topography indicates that surface water and groundwater between the site and the existing Tomago Aluminium facility (south of the site) is likely to flow south, away from the proposal site.
- Surface runoff from Tomago Aluminium is predominantly directed to a large catchment dam on the southern side of the facility, also away from the proposal site.
- A small dam approximately 15m in diameter was observed in the north-west corner of the site. Drainage channels appear to have been constructed to allow for surface runoff from the central and northern sections to drain here. The channels were vegetated and dry at the time of the investigation.
- A second dam was observed in the southern end of the site. Drainage channels appear to have been constructed to allow for surface runoff from the central and southern sections to drain here. The dam was largely overgrown and did not appear to hold water to the same degree as the northern dam (possibly only directly after periods of rain).
- The investigation indicated that the following chemicals of potential concern may be present in soil, groundwater, surface water and sediments on the site:
  - Total recoverable hydrocarbons (TRH)
  - Asbestos
  - Fluoride
  - Faecal and Total Coliforms
  - E Coli
  - Volatile Organic Compounds (VOCs)
  - CTEX (benzene, toluene, ethyl benzene, xylene)
  - 8 priority metals: (Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn))
  - Polycyclic aromatic hydrocarbons (PAHs)
  - Organochlorine pesticides (OCP)
  - Organophosphorus pesticides (OPP)
  - Polychlorinated biphenyls (PCBs)

Environmental Strategies (2018): Additional Pre-Existing Contamination Study – Tomago Development Site, NSW

Following on from the findings of the original Phase 1 ESA (ES, 2017a), a site-specific sampling program was undertaken, consisting of soil, sediment, surface water and groundwater sampling components. The assessment was undertaken over both Lots 2 and 3 of 1940 Pacific Highway Tomago.

A single surface water sample was collected at each of the following locations, as shown in Figure 4-1 :

- SW01: The small dam located in the north-west corner of the site and within area of environmental concern (AEC) 6
- SW02: A small vegetated LEP Wetland pond, located south-west of the site, adjacent to the Pacific Highway, indicated as a representative “Background Area”

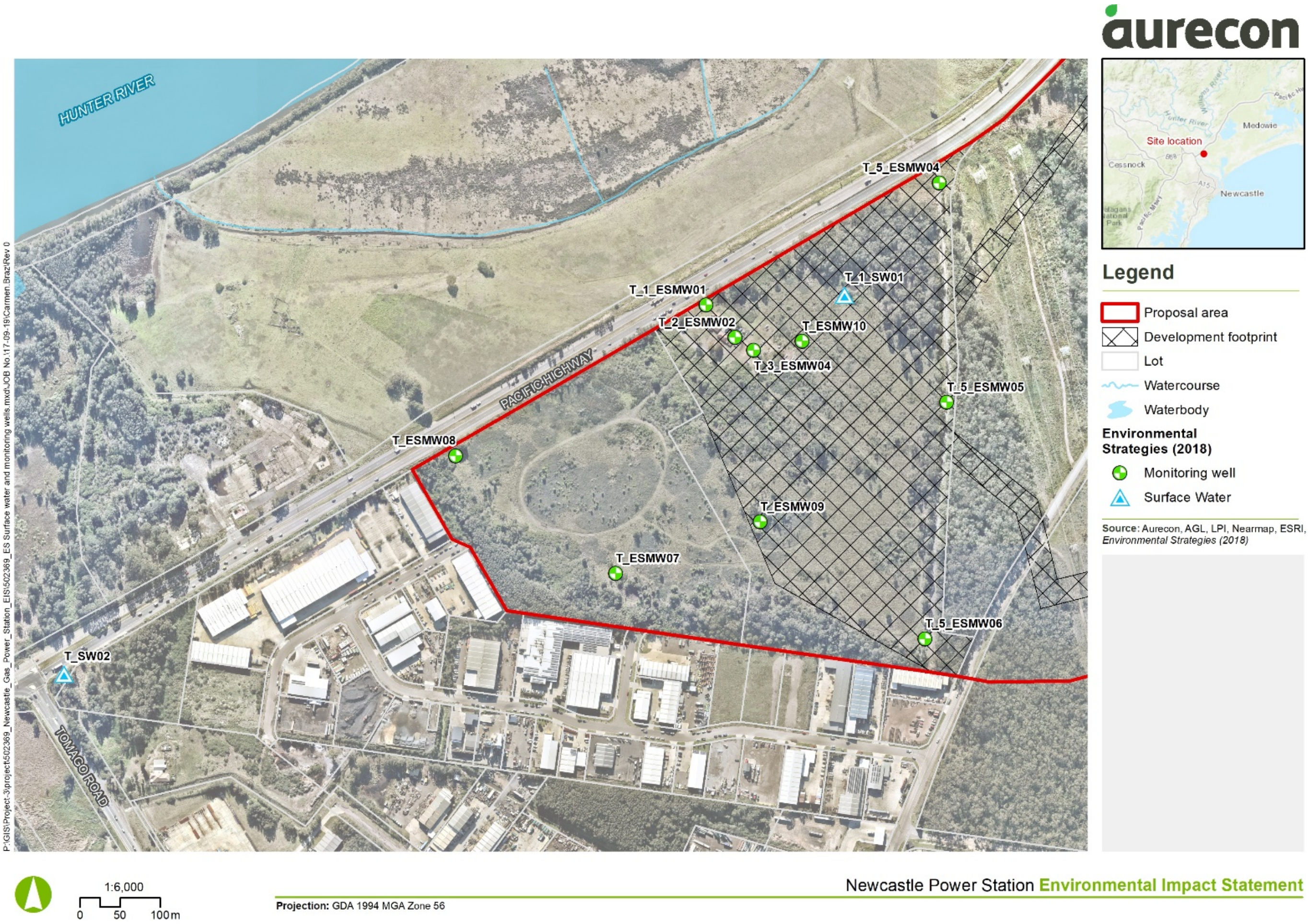

Figure 4-1 Surface and groundwater monitoring locations (ES, 2018)

Several Chemicals of Potential Concern (CoPC) were detected in both samples in elevated concentrations. ES considered the exceedances to be minor to moderate, with the following concentrations observed at SW01 above the relevant assessment criteria (ANZECC 2000 95% Level of Protection Trigger Values for Fresh Water (ANZECC, 2000)):

- Copper: 2.8 times
- Chromium: 2 times
- Lead: 1.7 times
- Zinc: 6.8 times

These metals were also detected in elevated concentration at SW02, selected as representative of background conditions and thus concluded that they are likely to be naturally occurring background levels rather than contamination/pollution.

Coffey (2011): Environmental Assessment – Newcastle Gas Storage Facility Project, Volume 1: Main Report

Coffey undertook an Environmental Assessment (EA) of the adjacent site (indicated in **Figure 4-2**) with the report finalised in May 2011. The EA report describes the proposal provides an assessment of potential impacts that may occur if the proposal is developed, and recommends measures to avoid, mitigate and / or manage those impacts.

Surface water and hydrology is addressed within the EA and Surface Water specialist study as part of the EA main report appendices.

Figure 4-2 Groundwater and surface water monitoring locations (Coffey, 2011)

The key findings of this 2011 report, pertaining to the NPS, are outlined below:

- Key potential surface water impacts relate to contamination sources such as spills, sediment runoff, fluid loss during HDD, and acid sulfate soils leachate effects.
- The likelihood of the proposal impacting surface waters in the Ramsar wetland areas of Kooragang Nature Reserve and Wetlands Centre Australia are low due to their distance from the proposal construction and operational phase activities, the planned surface runoff control measures, high groundwater infiltration rates and flat topography of the site.
- It was proposed that a surface water management plan would be prepared and implemented as part of the construction environmental management plan and operations environmental management plan. The plan would describe best practice surface water control measures to reduce the risk of contamination of surface water or the alteration of surface water flows.
- As per the 2011 report, the proposed operation's surface water management plan would provide measures at the gas plant site to manage water supply and disposal, manage surface runoff flow and erosion, and discharge or leaks of contaminated water.
- Preventing surface water contamination is key to preventing impacts to groundwater.
- Mitigation and management measures for the protection of surface water (and groundwater) would be based on the following principles:
  - Minimise land disturbance
  - Control stormwater runoff from construction sites
  - Provide sedimentation treatment for all surface runoff from disturbed areas
  - Separation of clean water (i.e., runoff from undisturbed areas), and potentially contaminated water at the construction sites

- Build temporary or permanent infrastructure to capture any spills or leaks of potentially contaminating chemicals before they enter the environment
- Collect and store wastewater before transporting offsite for treatment or disposal
- Undertake water quality monitoring to ensure that surface water management is meeting the objectives of the management plan and within criteria limits

Coffey (2011a): Environmental Assessment – Newcastle Gas Storage Facility Project, Volume 2: Appendix 3 – Surface Water Assessment

The Surface Water Assessment was undertaken by Worley Parsons as part of the Environmental Application conducted by Coffey and delivered in May 2011 for the Newcastle Gas Storage Facility (NGSF) located to the north-east of the Proposal. Since, unlike the Proposal, the NGSF was located over the Tomago Sandbed Aquifer, a focus was placed on investigating the key surface water management issues and to establish surface water management principles and concepts for the site to support the content of the main report.

The key findings of the surface water specialist study are outlined below:

- The existing surface water environment at the proposal site is defined by relatively flat topography and no defined surface drainage lines. The sites lithology is characterised by soils with high infiltration rates to groundwater and low surface run-off. The underlying groundwater sand aquifer, referred to as the Tomago Sandbed Aquifer, is a source of raw water for the Newcastle Region. The site has no significant water bodies present, however some ‘wet areas’ are located within the site as well as on the surrounding land.
- Sediment and erosion control were the primary focal points in the surface water management during the construction phase activities, designed and installed in accordance with the NSW Department of Housing “*Managing Urban Stormwater – Soils and Construction” (1998)*.
- In the unlikely event that the surface water management measures fail, potential contaminants (i.e. from leaks and spills) sourced form plant operations may be transported into receiving waters via stormwater run-off. Contaminated water from fire-fighting procedures also presents a potential source of surface water pollution.
- A conceptual Surface Water Management Plan (SWMP) was developed that recommends a myriad of controls designed to prevent the degradation of the receiving waters (surface water and groundwater)
- A water quality monitoring programme, inclusive of surface water sampling and analysis, was proposed as part of the Environmental Management Plan. The programme was likely to include monitoring during pre-construction, construction and operational phases of the proposal and incorporate key water bodies and locations within the proposed surface water management controls.
- The proposed stormwater treatment system and containment system was designed to provide adequate and efficient treatment of surface water runoff from the site through containing, collecting/treating and adequately disposing of the runoff.

URS (2002): Environmental Impact Statement - Tomago Gas Fired Power Station, Volume 1: Main Report

The Environmental Impact Statement (EIS) conducted by URS in 2002 (2002 EIS) on behalf of AGL Macquarie Generation proposed the development of a gas fired power station **within the same location as the current proposal**. The 2002 EIS focused environmental document was utilised for information regarding the surface water and hydrological characteristics of the site, as well as informing on potential impacts and associated avoidance and / or mitigation measures.

The key elements relating to surface water and hydrology from the 2002 EIS are summarised below:

- The report entailed a desktop investigation of the existing environment inclusive of regional drainage, site drainage, flooding and existing surface water quality.
- Proposal mitigation measures during construction and operation phases were implemented to:
  - minimise hydrological impact (i.e. minimise flood risk)

- minimise erosion at discharge points
  - minimise off-site discharge of suspended solids
  - minimise off-site discharge of potentially contaminated waters
  - ensure chemical, fuel and oil spills are contained and disposed of off-site by licensed waste contractor
- A SWMP would be developed for the construction phase and an ESCP developed for the operational phase with the primary aim of preventing sediment discharge offsite and to prevent erosion at discharge points.
- Once the power station was operational, approximately 30 per cent of the area would become impervious, resulting in an increase in stormwater run-off from the site. Given that construction of a detention pond would reduce the flow rate of surface water from the site and given the relative size of the site compared to the total catchment area of the Hunter River, there would likely be negligible impact on the hydraulic behaviour of the Hunter River.
- The design of the power station would incorporate a separate stormwater drainage system for clean and contaminated stormwater.
- Fuel, oil and chemical spills would be collected in sumps in bunded areas, pumped and disposed of off-site by a licensed waste contractor.
- Water to be released from the detention pond would be monitored and only released once it is determined that the water meets the relevant water quality criteria.

URS concluded that with the appropriate mitigation measures employed, the development is expected to have negligible impact on surface water quality.

Swanson RL, Potts JD & Scanes PR (2017): Lower Hunter River Health Monitoring Program: Stormwater Quality Monitoring Program 2015, Office of Environment and Heritage, Sydney

The Office of Environment and Heritage (OEH) conducted a water quality monitoring program from August 2014 to March 2015 of the lower Hunter River estuary. Their study incorporated the collection of monthly data at 14 sites spanning the entire estuarine system. Standard water quality parameters as per the *ANZECC Guidelines for Fresh and Marine Water Quality (2000)* and chlorophyll-a, total suspended solids (TSS) and nutrient data were collected and analysed to determine the following results on water quality:

- Most sites in the mid estuary (closest to the proposal site) recorded median concentrations of chlorophyll-a below 5 micrograms per litre (µg/L) for routine sites, although spikes as high as 30 µg/L were correlated with periods following increased rainfall. Overall, median values of chlorophyll-a concentrations in the lower estuary (downstream of the site) were comparable to historical records (pre-2000) of between 2 and 5 µg/L. (The NSW trigger values for chlorophyll-a that apply to coastal rivers are between 2.3 and 3.4 µg/L depending on the salinity at the site.)
- Reduced levels of chlorophyll-a recorded in the lower Hunter River were associated with tidal flows and consequentially shorter residence times of water.
- Concentrations of nitrate, nitrite and phosphates typically exceeded the NSW trigger values for coastal riverine estuaries (ANZECC 2000), albeit a decrease in overall nutrient concentration from pre-2000 levels
- Median levels of ammonium were highest in the southern extent of the Hunter River, suggesting industry as a primary source of ammonium. Alternatively, nitrates and phosphates, products of intensive agriculture and horticulture were found upstream and thus indicative of the likely nutrient driver.
- Turbidity in the southern region of the lower estuary exceeded the NSW trigger values (ANZECC 2000) of 2.8-3.5 nephelometric turbidity units (NTU) for coastal riverine estuaries, with occasional spikes following increased rainfall (>50 NTU).

DHI (2008): Upgrading of Lower Hunter Flood Model at Hexham, Final Report, Phase 4

Newcastle City Council (NCC) engaged DHI Water and Environment Pty Ltd to undertake a detailed review of flood modelling undertaken for the Lower Hunter River Flood Study.

This report provided a discussion of the modelling outcomes developed for this Lower Hunter River Flood Study Upgrade.

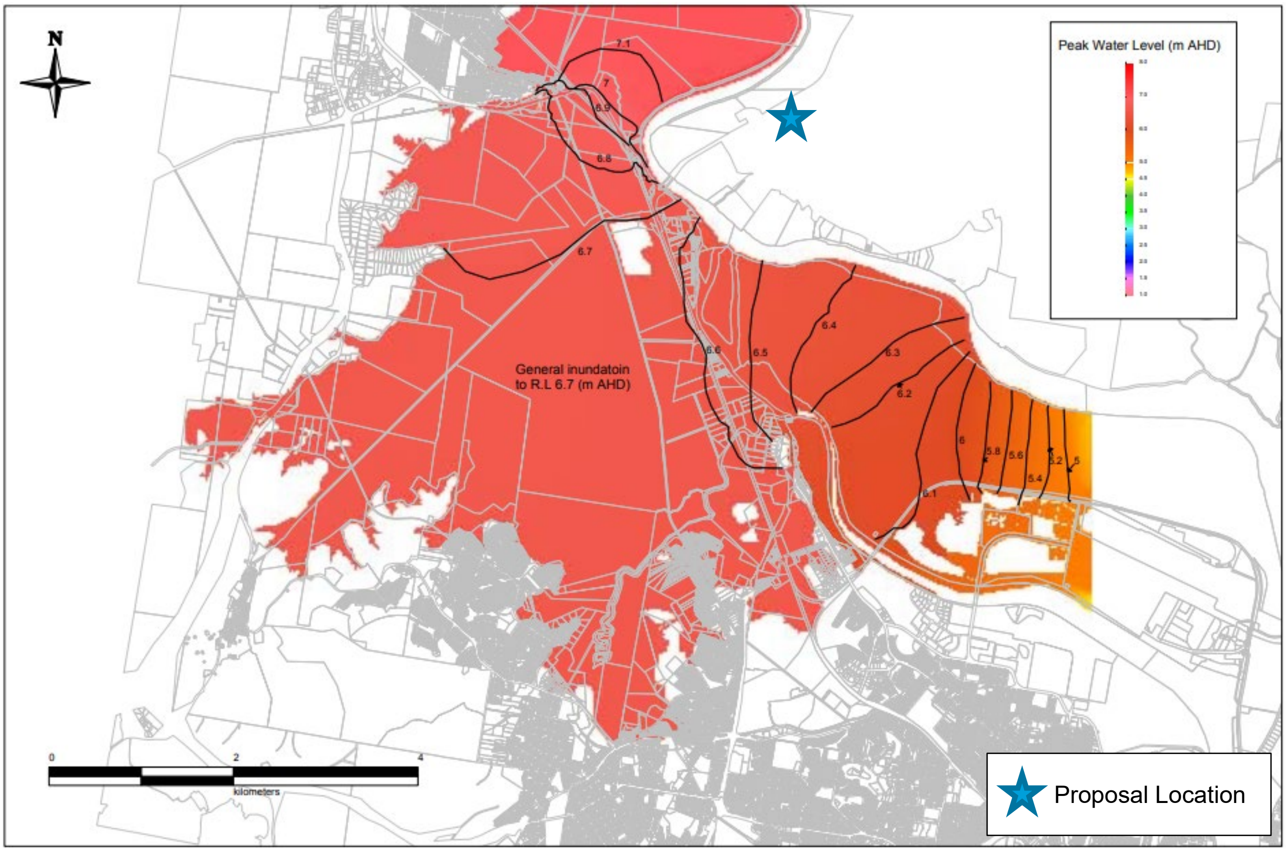

Figure 4-3 Peak Water Surface Level – PMF Design Event (DHI, 2008): Indicating study area extent in relation to proposal location

The key finding within this review relates to the classification of Hexham as a medium-high flood risk flood prone environment. Hexham is the neighbouring suburb of Tomago on the south side of the Hunter River.

5 Existing environment

5.1 Climate

5.1.1 Rainfall

Review of data available through the Bureau of Meteorology (BOM) - Monthly Statistics: Climate Data Online (http://www.bom.gov.au/climate/data/) indicates that the nearest BOM weather station is located in Kinross, (Raymond Terrace (32.77° S, 151.74° E) NSW, and is positioned approximately 6 kilometres north of the site.

Utilising the BOM climate database, the mean total rainfall for each calendar month from 1970 to 2018 (48 years) was calculated and is summarised in **Table 5-1** and presented in **Figure 5-1**.

Table 5-1 Average monthly rainfall data measured at the Raymond Terrace Station (1970 – 2018)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Avg. Rainfall (mm)	107	120	132	110	95	116	58	48	59	72	90	78	1067

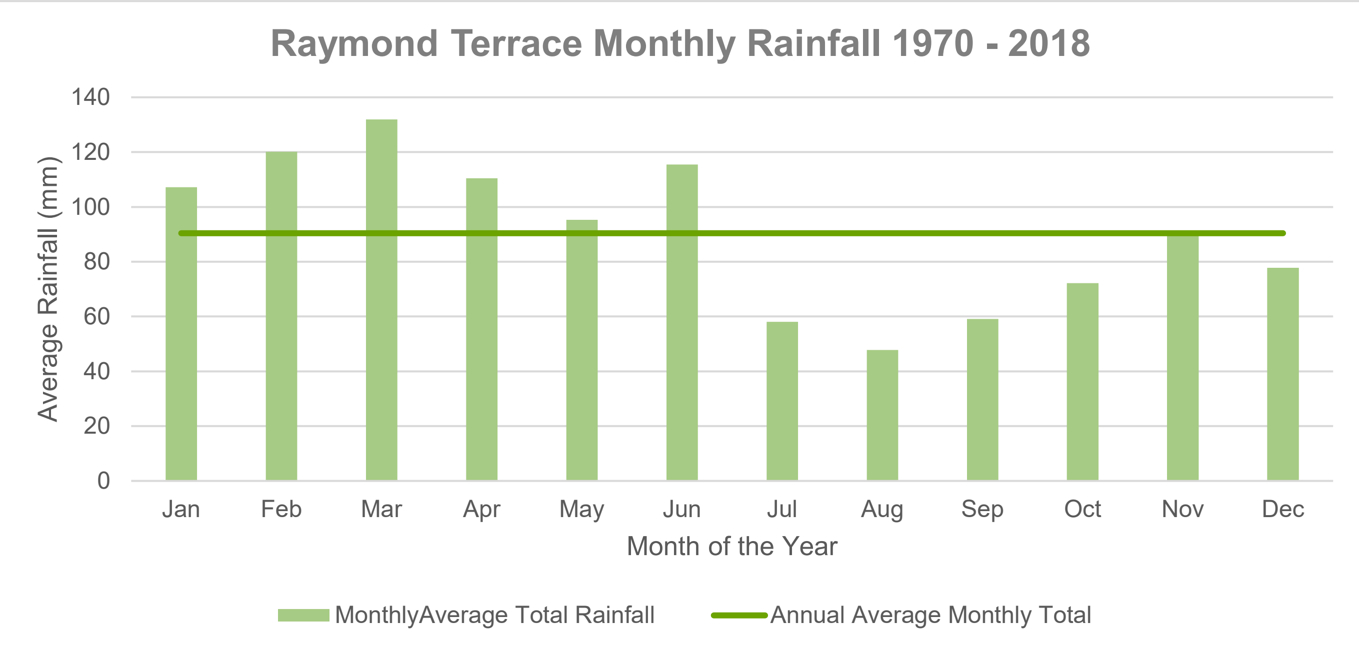

Figure 5-1 Average monthly rainfall data measured at the Raymond Terrace Station between 1970 and 2018

Analysis of the available rainfall data presented in **Figure 5-1** is indicative of a seasonal cyclic variation in total monthly rainfall amounts. The data shows evidence of a prevalent 'wet' (January-June) and 'dry' (July-December) season with an average total monthly rainfall of 90.4 mm and an average total annual rainfall of 1066.9 mm.

5.1.2 Temperature

Review of data available through the BOM - Monthly Statistics: Climate Data Online (http://www.bom.gov.au/climate/data/) indicates that the nearest BOM weather station with long term temperature data is located at Newcastle University, (32.89° S, 151.71°) NSW, and is positioned approximately 9 kilometres south of the site. **Figure 5-2** presents the 17 years of temperature data.

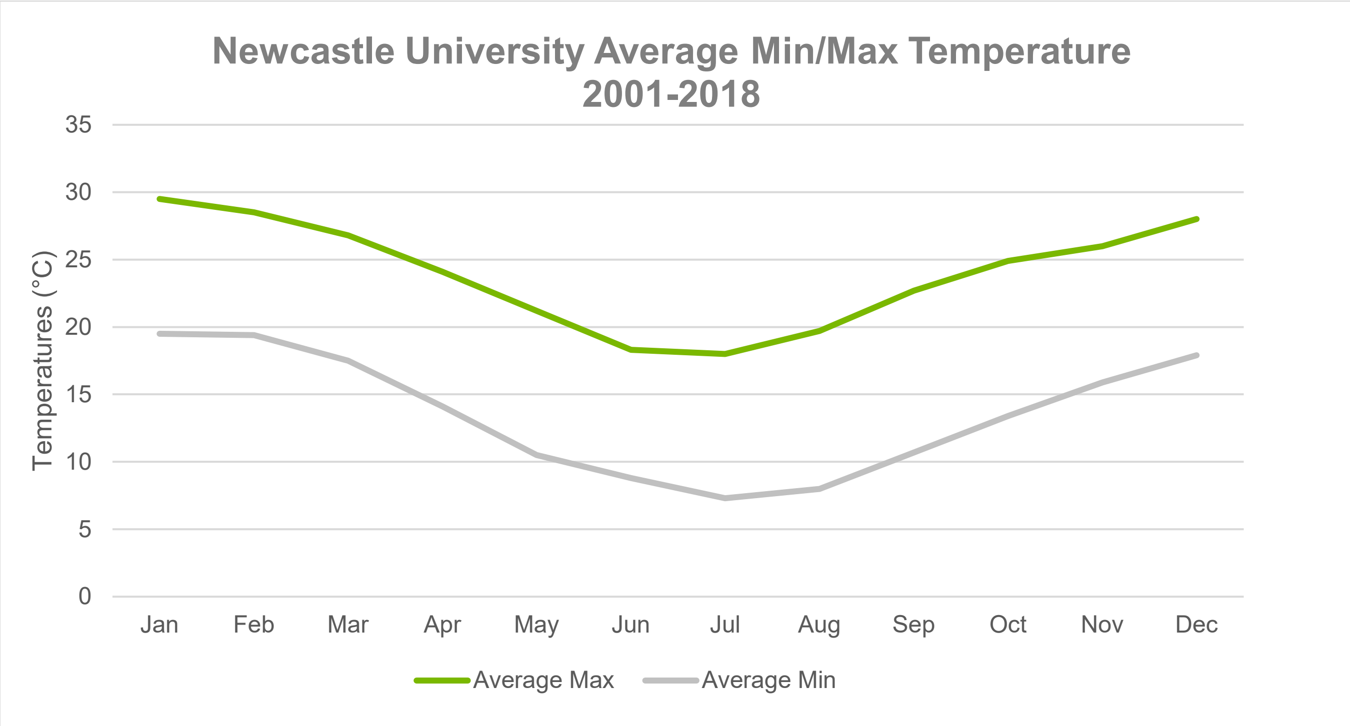

Figure 5-2 Monthly maximum and minimum temperature ranges measured at the Newcastle Station (2001-2018)

The analysis of available temperature data indicates that Tomago is positioned within a temperate climatic region characterised by mild to warm summers and moderately cool winters. Average minimum and maximum temperatures range from approximately 18-28°C (December-February) to 7-18°C (June-August) seasonally, with predominantly mild temperatures (~13-22°C) in the autumn and spring months.

5.1.3 Evaporation

Evaporation is the primary pathway in the water cycle whereby water moves from a liquid state to atmospheric water vapour. The BOM measures evaporation as the amount of water which evaporates from an open pan. The BOM generally use a Class A evaporation pan. The evaporation rate depends on elements such as cloud cover, air temperature and wind speed.

Review of data available through the BOM - Monthly Statistics: Climate Data Online (**http://www.bom.gov.au/climate/data/**) indicates that the nearest BOM weather station with long term pan evaporation data is located at Williamtown RAAF, (32.79° S, 151.84° E) NSW, and is positioned approximately 12 kilometres north-east of the site.

The mean monthly rainfall for Raymond Terrace and pan evaporation rates for Williamtown RAAF have been calculated from the available data over a corresponding time period (2009 to 2015). This is illustrated and summarised in **Figure 5-3**.

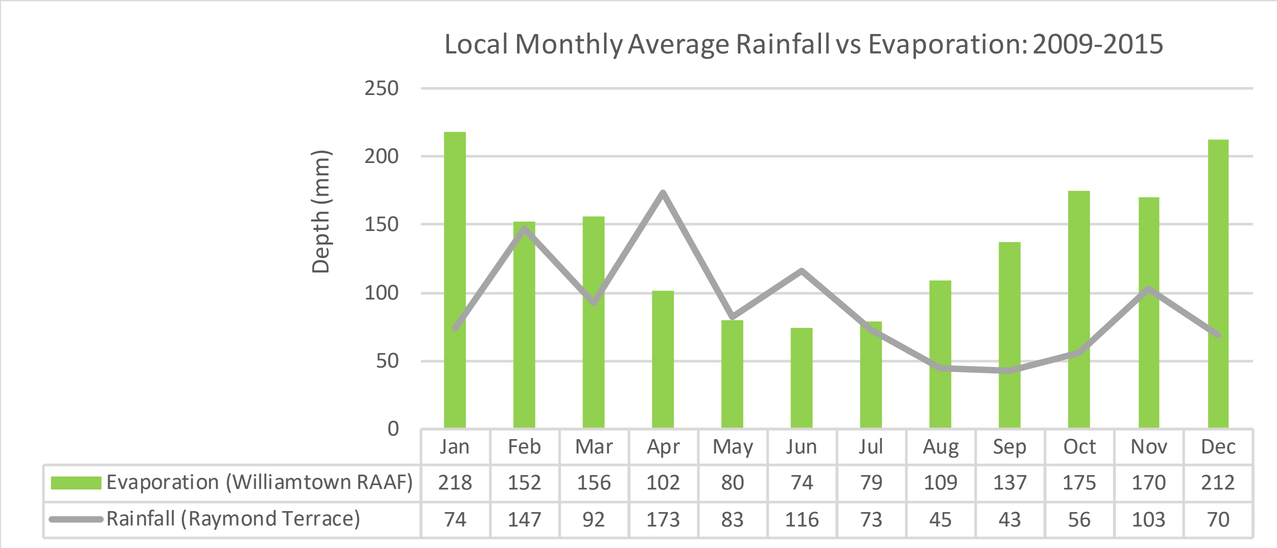

Figure 5-3 Monthly average local pan evaporation (Williamtown) and rainfall (Raymond Terrace)

Evaporation is an important factor to consider in the design phase of the proposal as there is potential for natural evaporation to occur from produced water ponds. **Table 5-2** presents a summary of monthly rainfall and evaporation totals to describe net water balance for the local area.

Table 5-2 Summary of the water balance and climate conditions for the local area

Month	Rainfall Total	Evaporation Total	Net Water Balance	Climate Condition
January	74	218	-144	Drying
February	147	152	-5	Drying
March	92	156	-64	Drying
April	173	102	71	Wetting
May	83	80	3	Wetting
June	116	74	42	Wetting
July	73	79	-6	Drying
August	45	109	-64	Drying
September	43	137	-94	Drying
October	56	175	-119	Drying
November	103	170	-67	Drying
December	70	212	-142	Drying

The results show that long term averages for rainfall totals exceeding evaporation totals April and June, resulting in net wetting conditions. Long term averages for monthly evaporation exceed rainfall totals between July and March, resulting in net drying conditions.

The observed climate conditions will affect environmental (surface water flow and quality) conditions across the site and throughout the catchment.

5.1.4 Climate Change

The NSW Climate Impact Profile report published by the Department of Environment, Climate Change and Water NSW (DECCW, 2010) indicates that within the Hunter Region, by 2050, the climate is virtually certain to become hotter year-round, with a likely decrease in rainfall in winter (5-20%), an increase in rainfall in spring (5-20%), summer (10-50%) and autumn (5-10%). Run-off and stream flow are likely to increase in summer and autumn and decrease in spring and winter.

Applying the expected local increases and decreases in rainfall and evaporation the following water balance changes could potentially occur in the catchment:

- Summer: Less dry, potentially moving into a wetting condition by February
- Spring: The current drying condition is expected to be amplified
- Winter: Limited expected change in water balance condition
- Autumn: Dryer, potentially moving from wetting to drying condition by May

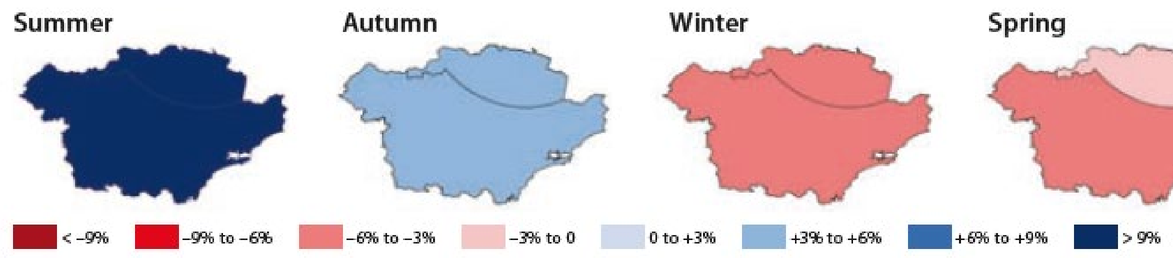

Figure 5-4 Estimated four-model mean percentage change in seasonal run-off for the Hunter region for projected 2030 climatic conditions (DECCW, 2010)

Substantial increases in runoff depths during summer could increase the potential for contaminant transfer to the environment. However, the receiving environment is likely to be wetter and off-site impacts could be minimised.

5.2 Topography

A baseline desktop analysis of spatial mapping resources and the Port Stephens Local Environmental Plan (LEP) 2016 provided detailed information on the proposal sites topographic features. The site is located adjacent to and partially within a designated floodplain area, situated between the Hunter River to the west and partially overlaying the Tomago Sandbeds to the east, within the Electrical Transmission and Pipeline investigation areas, as shown in **Figure 5-5**.

The power station site is located on a topographic high point adjacent to the Hunter River and divided by a topographic ridge approximately central to the site, as shown in **Figure 5-6**. The average elevation along the ridge is approximately 15m AHD with a high point of 16m AHD in the north west portion. A gentle slope occurs to the southern site boundaries, with elevations dropping to approximately 6-7m. The gradient north of the central ridge is slightly steeper, dropping to 8m AHD over nearly half the distance.

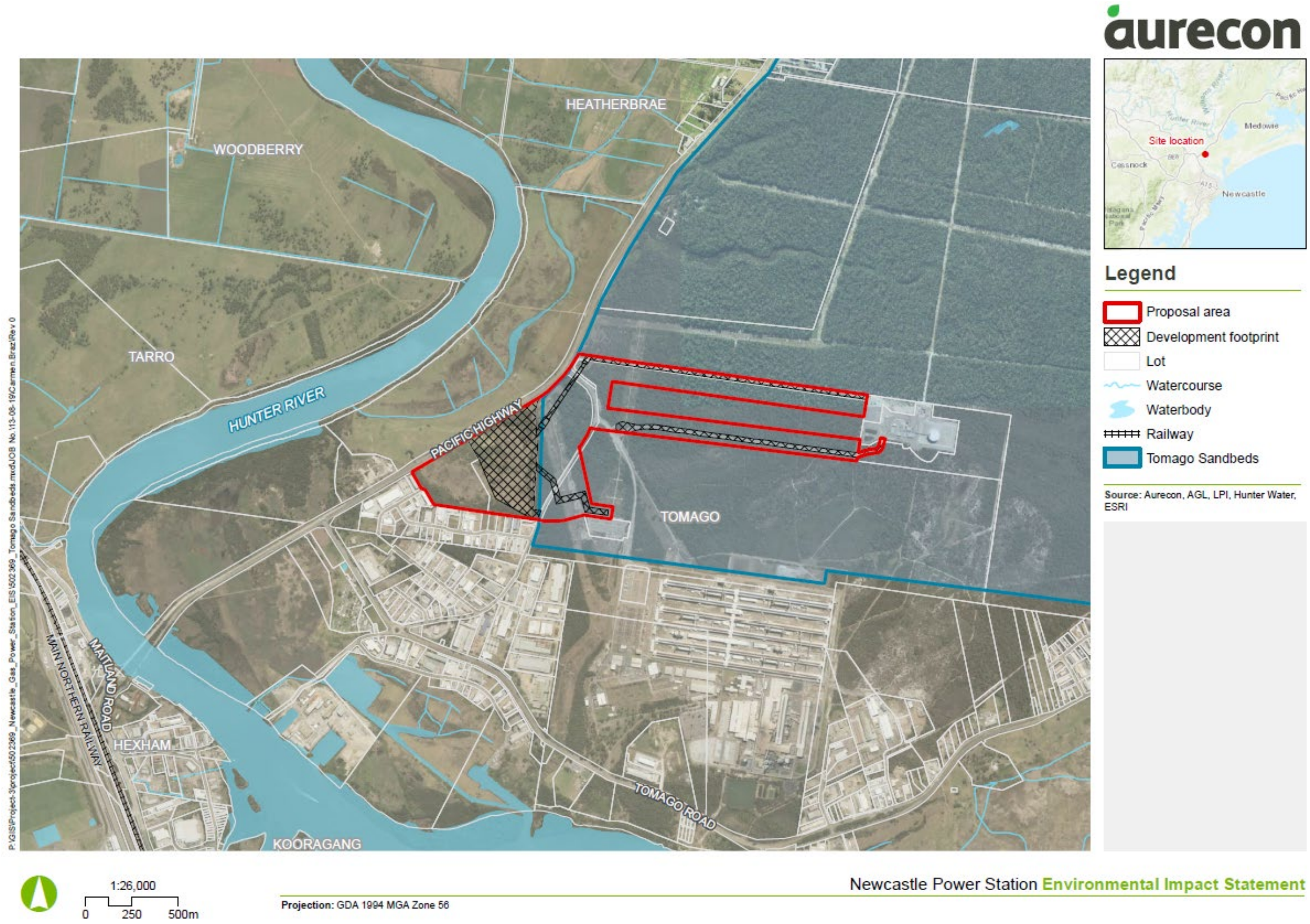

Figure 5-5 Extent of Tomago Sandbeds

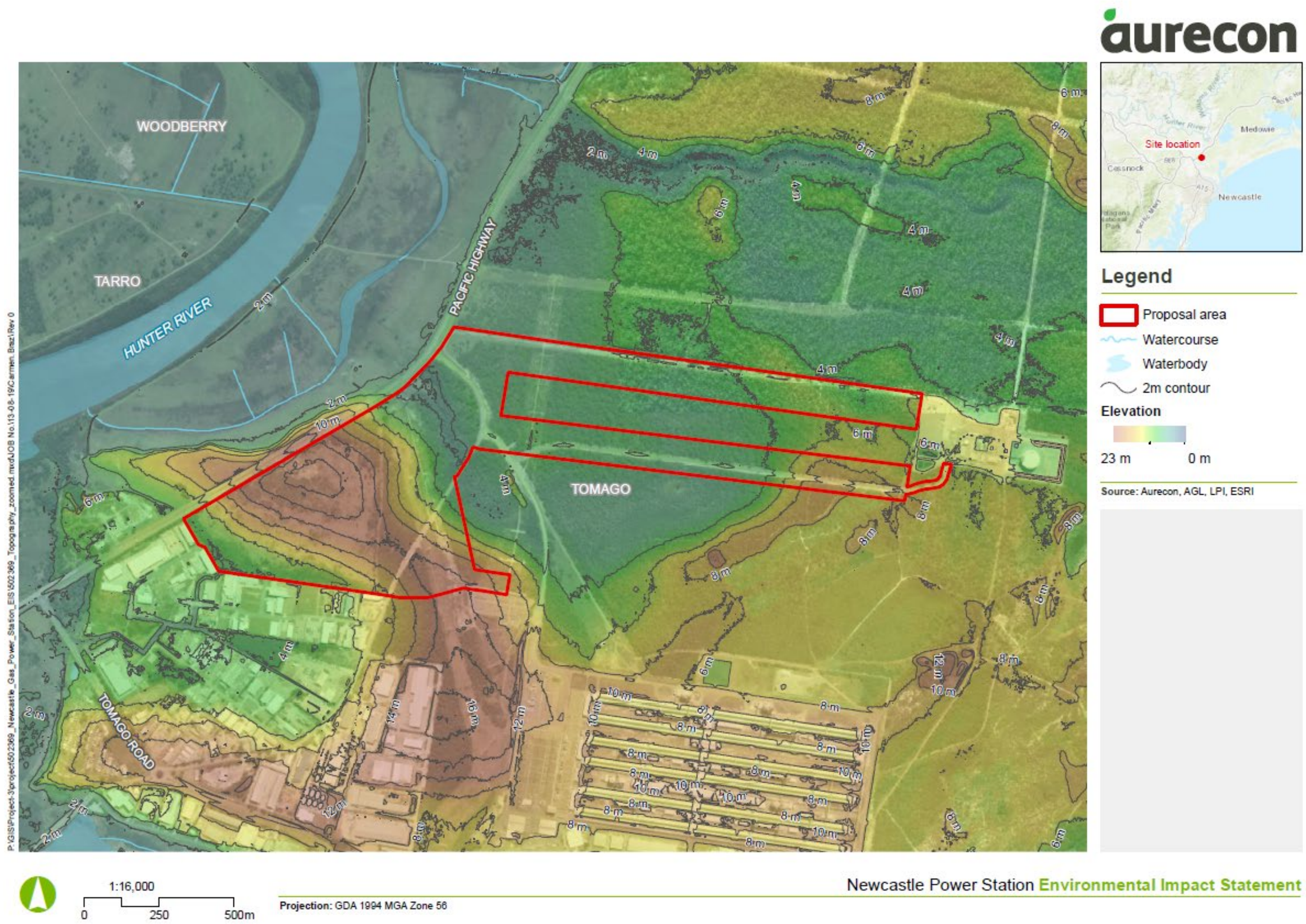

Figure 5-6 Local Topography

5.3 Surface water and hydrology

Figure 5-7 and **Figure 5-8** illustrate a plan of the local and regional hydrology respectively, including significant watercourses, wetland boundaries, waterbodies, protected zones and the existing drainage pathways within and in connection to the proposal site.

5.3.1 Local catchment

The Hunter River (shown in context of the proposal in **Figure 5-7**) is an estuarine river located approximately 450m west/north-west of the western site boundary and comprises a major low-land meandering waterway that flows south past the site before turning east and discharging to the Tasman Sea through the Newcastle Port. A tributary to the Hunter River is located approximately 150m west/north-west of the western site boundary from where it flows west and discharges into the Hunter River.

The upper reaches of the Hunter River catchment are predominantly cleared for rural activities, whilst the other areas of the catchment consist of mining, industrial and urban developments. The Proposal area is within the lower-mid estuary zone in the Lower Hunter River, which is considered highly modified, heavily urbanised and industrialised.

On a regional basis: Purgatory Creek is a small system feeding into the Hunter River from the west approximately 500 metres upstream of Hexham Bridge, whilst Ironbark Creek links the south west portion of the Hunter Wetlands and Cobbans Creek connects the north and south Hunter River arms approximately 3 kilometres downstream of the river split. On the eastern boundary of the Hunter Wetlands, three man made drains (Dawsons Drain, The Fourteen Foot Drain and The Ten Foot Drain) feed in a north-east direction from Fullerton Cove.

Review of the Survey of Tidal Limits and Mangrove Limits in NSW Estuaries undertaken by the Department of Natural resources between 1996 and 2005 (Department of Natural Resources 2006) and Water Quality Monitoring Program 2014-2015 Report (Swanson et al. 2017) indicates a relatively stable saline environment (approximately 33-35 ppt) due to regular flushing with oceanic waters on incoming tides. The tidal limit is identified as 2.1km upstream from the railway bridge at Oakhampton (approximately 40km upstream from the site).

5.3.2 Site drainage

One (1) drainage divide, two (2) drainage features, and two (2) ponds (dams) have been identified within the site boundary, these are identified in **Figure 5-8.**

The drainage feature identified as *Drainage Path 1* is a primary drainage feature located along the southern / southwestern boundary of the site and represents an ephemeral drain which captures rainfall-runoff / interflow generated from the southern half of the site. The channel drains in a westerly direction along the southern boundary flowing under the Pacific Highway (via a culvert) into rural land. Elevation mapping does not indicate a direct surficial hydraulic connection between this drain and the Hunter River / associated tributary (169m west of the site); however, stormwater flows may form a direct hydraulic connection during high magnitude or prolonged rainfall events.

Along its course, *Drainage Path 1* is intersected by two secondary drains. The first secondary drain to *Drainage Path 1* appears to be connected to the industrial estates existing stormwater drainage system, running southwards and discharging into a parcel of land between the Local Environment Plan (LEP) Wetlands and Tomago Road. The second secondary drainage to *Drainage Path 1* is aligned southwards adjacent to the Pacific Highway and industrial estate, discharging into a small vegetated LEP Wetland pond approximately 500 metres downstream.

The drainage feature identified as *Drainage Path 2* is a primary drainage feature located along the northern / north-eastern boundary of the site. *Drainage Path 2* was identified in the 2011 environmental assessment (Coffey, 2011). This suspected ephemeral drainage creek flows in a north-west direction along the property boundary, flowing towards the Hunter River. This watercourse has minimal known linkage to the primary flow of surface water from the proposed power station site. However, the downgradient slope north-east of the central topographic divide suggests a small portion of run-off could feed into this drainage path. Runoff from the electricity transmission easement areas will drain towards this path.

Drainage Paths 3 and 4 drain inward towards the low-lying saturated area south of the Newcastle Gas Storage Facility (NGSF) access road. If this area floods it will spill back up into *Drainage Path 2* and flow through to the Hunter River. Runoff from the gas pipeline easement areas will drain towards these two paths.

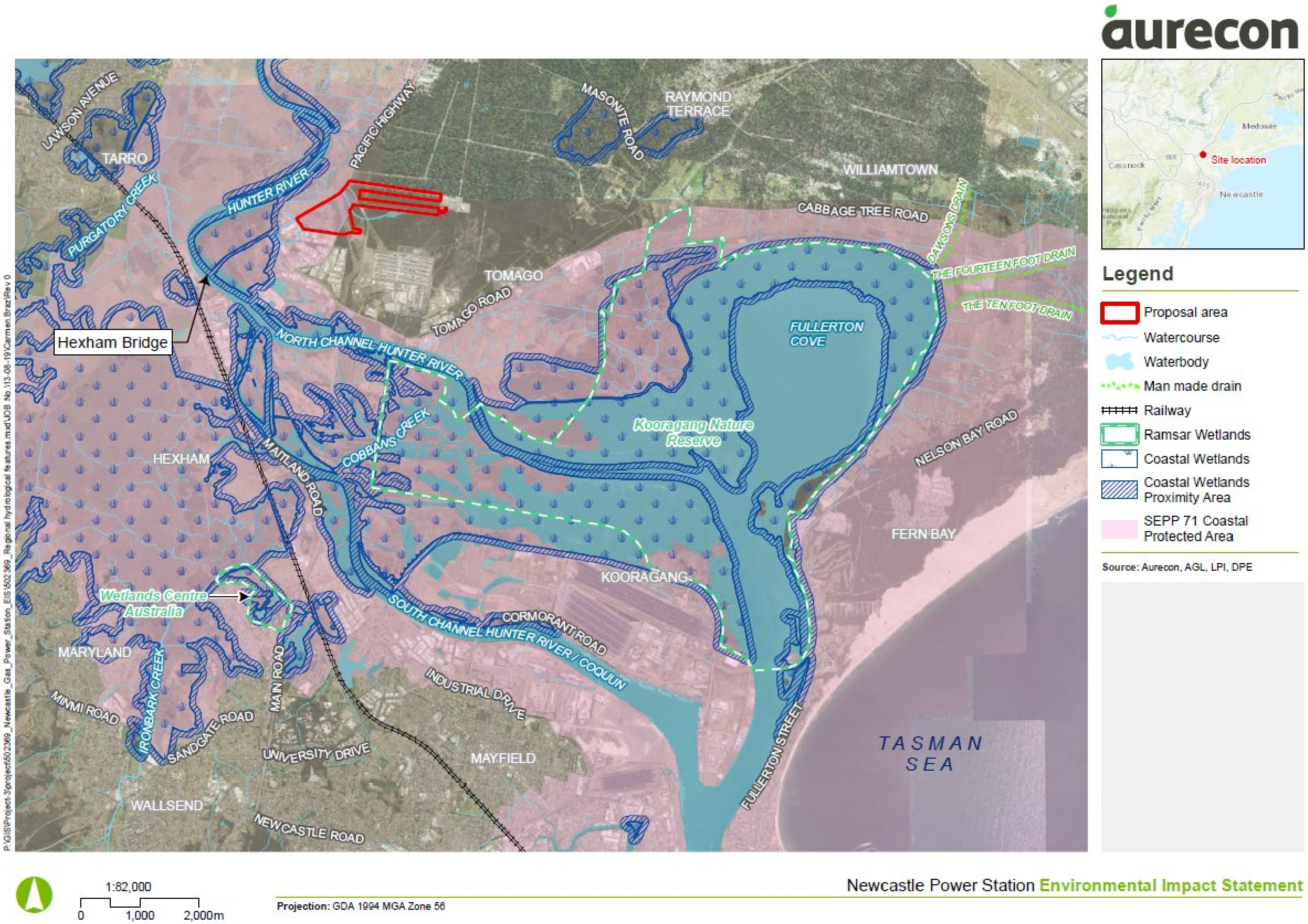

Figure 5-7 Regional surface water and hydrological features

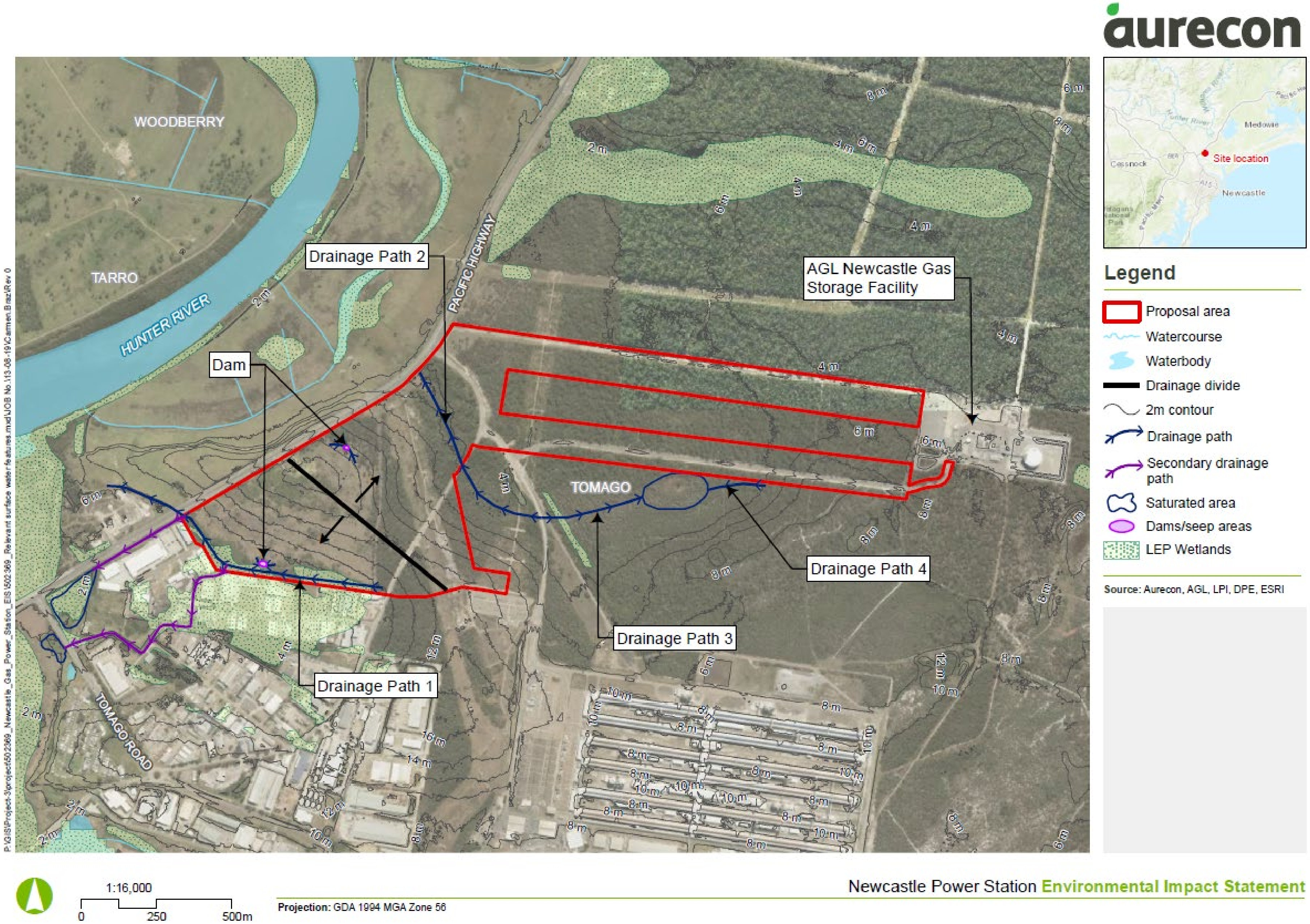

Figure 5-8 Proposal site and relevant surface water and hydrological features

5.3.3 Wetlands

Analysis of the State Environmental Planning Policy (SEPP) Coastal Management 2018 Maps and Port Stephens City Council Local Environmental Plan (LEP) 2013 revealed multiple important wetland environments are situated in proximity to the proposal site.

The Hunter Wetlands National Park is the largest wetland reserve (6,248 hectares) within a single estuary in NSW (Swanson et al. 2017). As presented in **Figure 5-7**, the wetland is devised of the RAMSAR listed Kooragang Nature Reserve, Wetlands Centre Australia and a significant surrounding area of Coastal Protected Wetlands south of the study area. These wetlands are interconnected by an array of tributaries linking the Hunter River Estuary.

The Kooragang Nature Reserve is within the tidal estuarine section of the Hunter River and includes all of Fullerton Cove (Coffey, 2011). The reserve starts approximately 3.5 kilometres downstream of the Hexham Bridge and 2.2 kilometres south-east of the Proposal site.

The Wetlands Centre Australia is pinned as a protected zone of high conservation value, near natural wetlands and artificial wetlands (Coffey 2011). This space is situated approximately 6.5 kilometres south of the proposal site.

There are no protected wetlands within the proposal site (Port Stephens LEP 2013). However, a small constituent of the LEP Wetlands, illustrated in **Figure 5-8,** has been identified in the site walkover as an important discharging point for surface water run-off south of the proposal space (Drainage Path 1). Some of the LEP wetland areas located within the Tomago Industrial Precinct have been subdivided and developed into industrial facilities. The western portion of the Proposal area is currently listed as a Coastal Protected Area under the SEPP (no. 71 – Coastal Protection) framework.

5.3.4 Flooding

Numerous reports have listed this region as flood prone, susceptible to natural river bank overflow and floodplain inundation. Most notably, a major flood event occurred in February of 1955 resulting in significant inundation and isolated Hexham for numerous days (Coffey 2011), a peak flood level of 4.00 m AHD was recorded at the Hexham bridge. Furthermore, a study of the Lower Hunter River conducted in 2008 by DHI indicated the neighbouring suburb of Hexham as a medium-high flood risk area.

Flood plans provided by Port Stephens Council and assessed by URS in 2002, indicated that a 1 in 100-year Annual Recurrence Interval (ARI) flood on the Hunter River would result in a water inundation level below the sites lowest elevation of 4 AHD at its southern boundary (Drainage Creek 1 and 2). This investigation was limited to the power station and did not include the proposed gas connection pipeline(s).

More recently, Flood Hazard Mapping (2016) provided by the Port Stephens Council LEP for the Hunter River indicates the proposed site for the power station is in a relatively low risk flood prone environment. **Figure 5-9** portrays the local extent of flood planning areas (Port Stephens LEP 2016) in connection with the proposed power station site and ancillary facilities.

The proposed power station footprint area is characterised by minimal risk flood prone land and low hazard flood fringe areas on the northern and southern borders of the site. However, the proposed gas pipelines connecting the power station to the NGSF traverse high hazard floodway and high hazard flood storage areas (**Figure 5-9**).

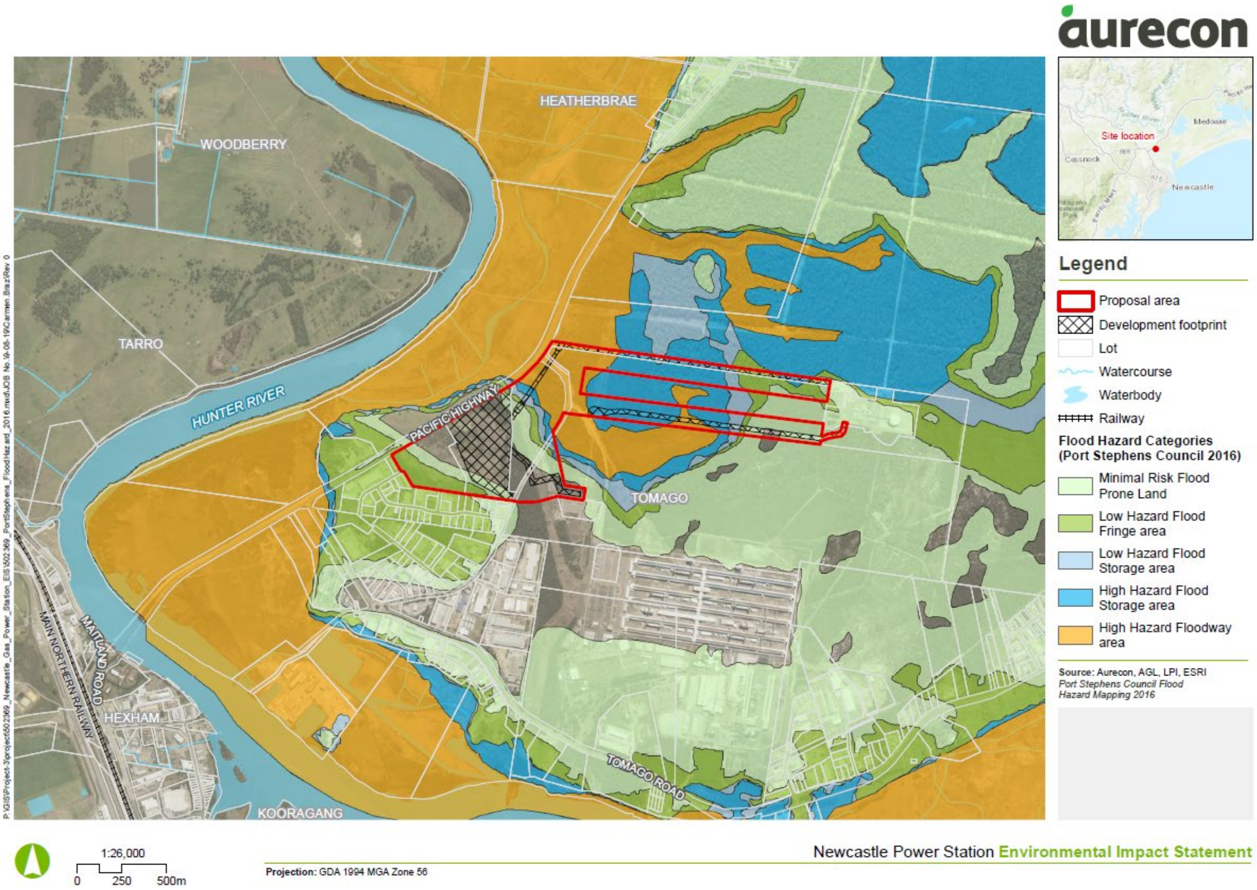

Figure 5-9 Flood Hazard Map (Port Stephens Council, 2016) with proposal site indicated

A flood assessment has been undertaken for the study area (report provided in **Appendix B**), adopting an existing model obtained from the NSW flood data portal, which found that the flooding events modelled (10% Annual Exceedance Probability (AEP), 1% AEP,1% AEP with climate change and probable maximum flood (PMF)) do not reach the proposed power station site (see **Figure 5-10** and **Figure 5-11**). However, the associated infrastructure that forms part of the Proposal, including the gas pipeline easements, would be partially affected by the 1% AEP event, 1% AEP with climate change and the PMF for the 1% AEP event (with and without climate change).

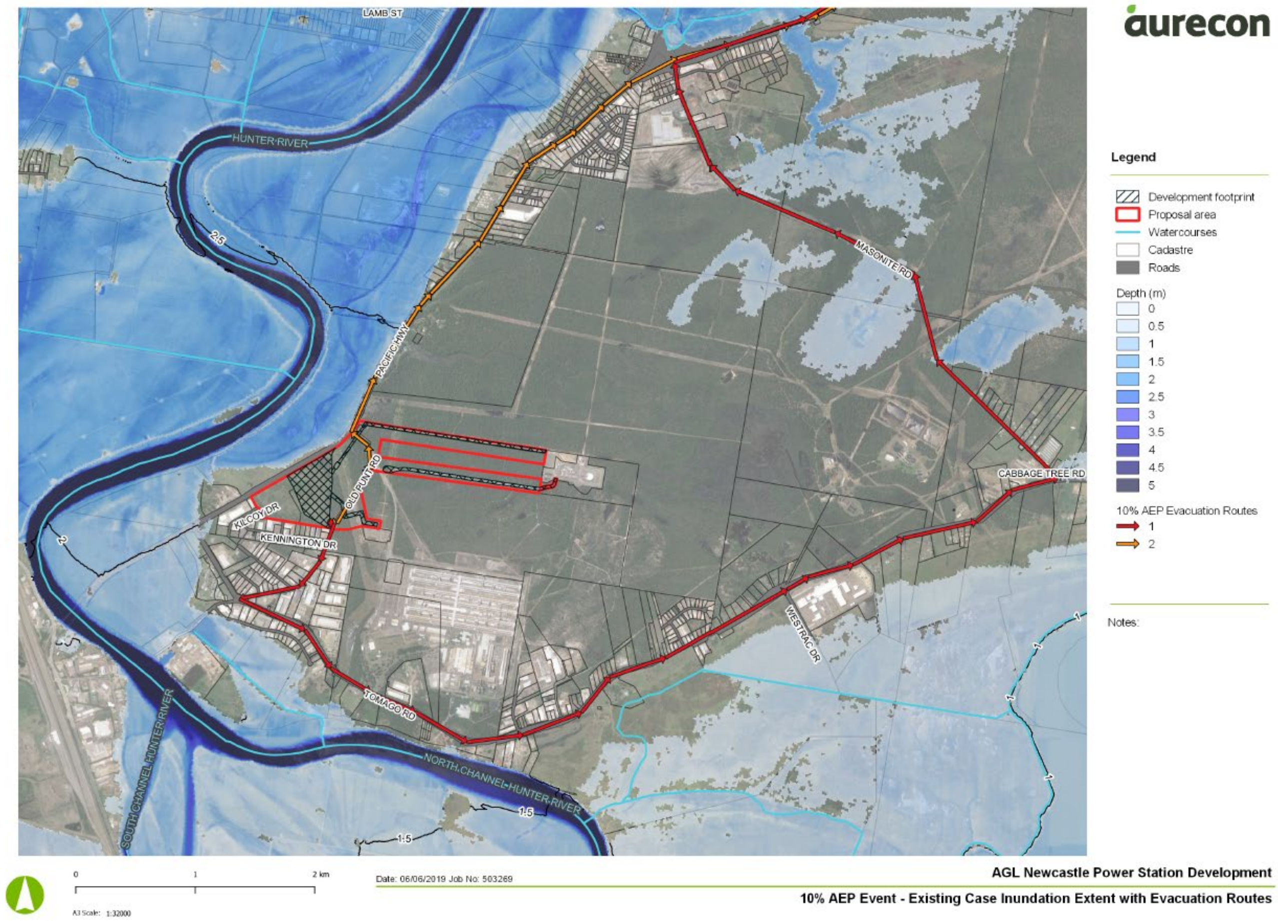

Figure 5-10 10% AEP Event - Existing Case Inundation Extent with Evacuation Routes

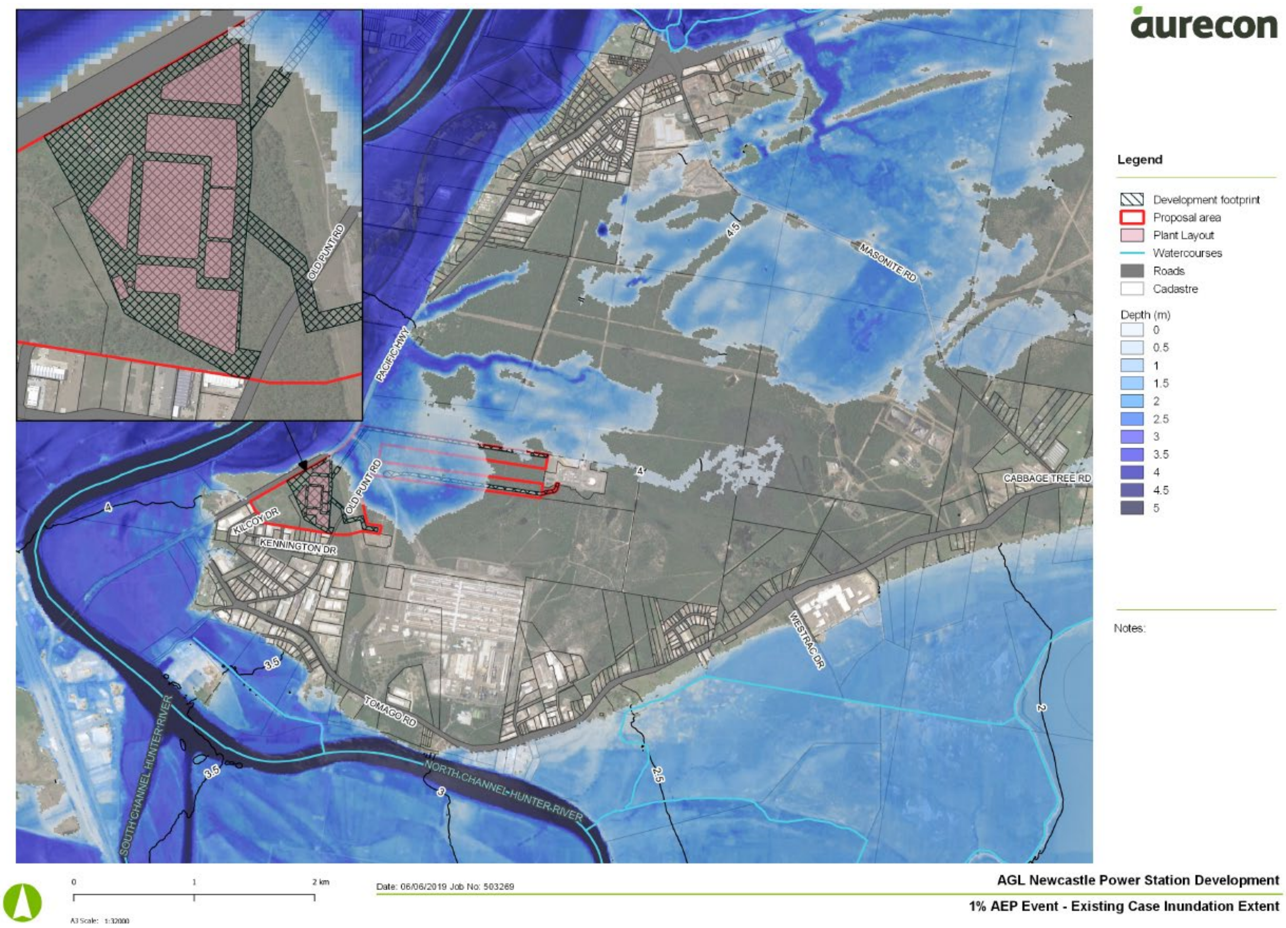

Figure 5-11 1% AEP Event - Existing Case Inundation Extent

The PMF extent showed a slight overlap with the southern end of the site (which originally lead to a shift in the power station layout). The areas through which the proposed underground gas pipelines traverse are expected to be predominantly inundated in this flood event.

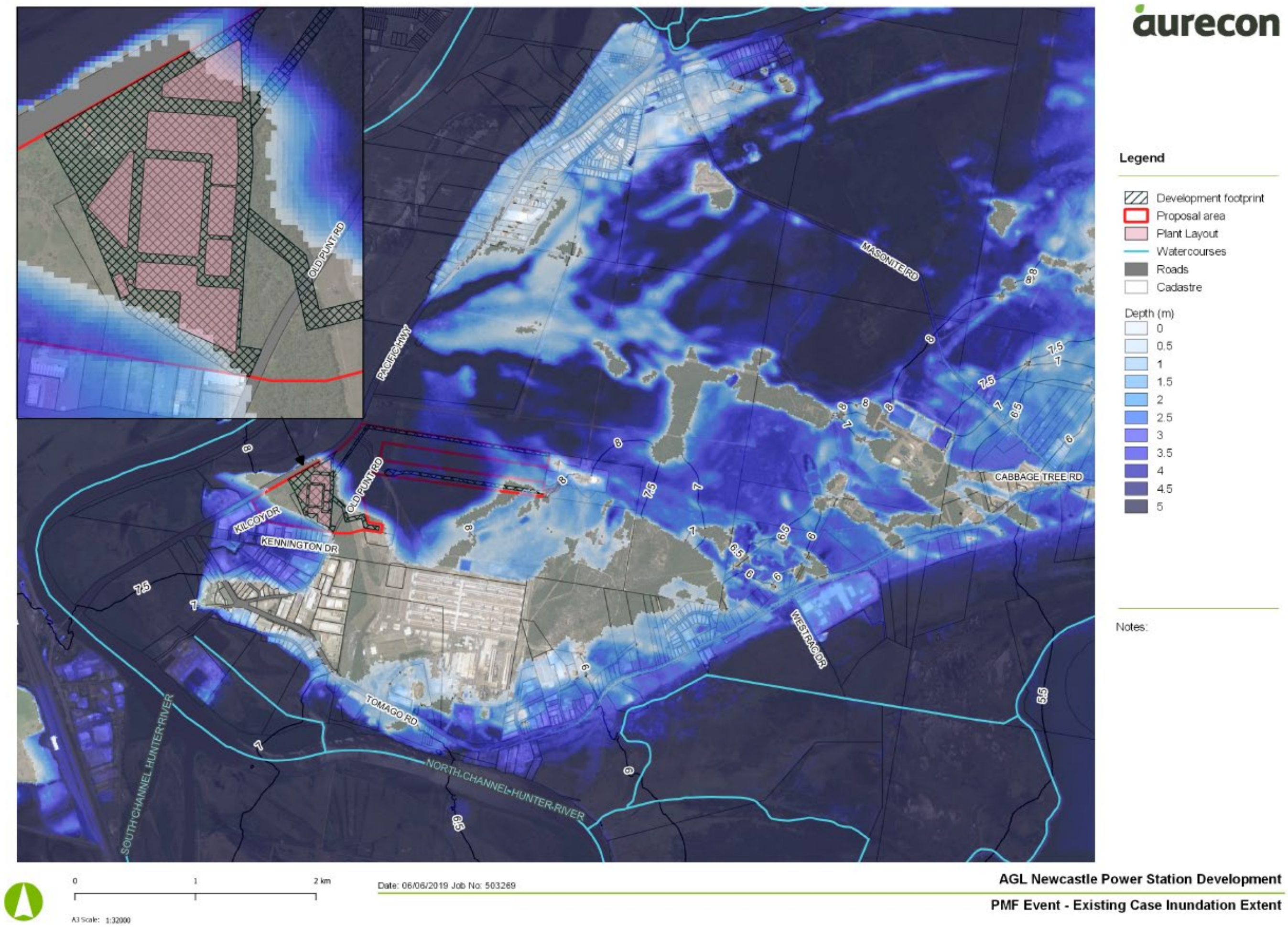

Figure 5-12 PMF Event - Existing Case Inundation Extent

5.3.5 Water quality

Hunter River

The proposed site is in a region of the Lower Hunter River classified as the lower-mid estuary zone and affected by urban development. The Lower Hunter River is considered to be highly modified, heavily urbanised and industrialised - supporting NSW second largest town (Newcastle) and the Port of Newcastle, which is now the world's largest coal exporting port.

A review of the NSW Water Quality and River Flow Objectives summarised in **Appendix A** (**Table 1a** and **Table 1b**), identifies the following Water Quality Objectives (WQOs) and River Flow Objectives (RFOs) for the Hunter River.

Table 5-3 Hunter River water quality and river flow objectives

Objective Type	Objective
River Flow Objectives	Protect pools in dry times
	Protect natural low flows
	Protect important rises in water levels
	Maintain wetland and floodplain inundation

Objective Type	Objective
	Mimic natural drying in temporary waterways
	Maintain natural flow variability
	Maintain natural rates of change in water levels
	Manage groundwater for ecosystems
	Minimise effects of weirs and other structures
	Minimise effects of dams on water quality
	Make water available for unforeseen events
	Maintain or rehabilitate estuarine processes and habitats
Water Quality Objectives	Aquatic ecosystems
	Visual amenity
	Secondary contact recreation
	Primary contact recreation
	Livestock water supply
	Irrigation water supply
	Homestead water supply
	Drinking water – disinfection only
	Drinking water – clarification and disinfection
	Aquatic foods (cooked)
	Drinking water (groundwater)

Historically, the Hunter River has been a subject of excessive industrial water pollution as regulation of industrial waste was non-existent before the 1970's. It was common practice to discharge untreated industrial contaminates such as acids, phenols, ammonium, cyanide and heavy metals. As a result, and backed by a transitioning public, stakeholder and government interest in the environment, stricter regulations began surfacing post 1970 (Swanson et al 2017). Currently, industrial discharges from larger premises are enforced by the EPA under the *Protection of the Environment Operations Act (POEO) 1997*.

To gain an insight into the current state of water quality within the entire Hunter River estuary, the Office of Environment and Heritage conducted a water quality monitoring program from August 2014 to March 2015 (Swanson et al 2017). Their study incorporated the collection of monthly data at 14 sites spanning the entire estuarine system. Standard water quality parameters as per the *ANZECC Guidelines for Fresh and Marine Water Quality (2000)* and chlorophyll-a, total suspended solids (TSS) and nutrient data were collected and analysed to determine the following results on water quality:

- Most sites in the mid estuary (closest to the proposal site) recorded median concentrations of chlorophyll-a below 5 micrograms per litre (µg/L) for routine sites, although spikes as high as 30 µg/L were correlated with periods following increased rainfall. Overall, median values of chlorophyll-a concentrations in the lower estuary (downstream of the site) were comparable to historical records (pre-2000) of between 2 and 5 µg/L. (The NSW trigger values for chlorophyll-a that apply to coastal rivers are between 2.3 and 3.4 µg/L depending on the salinity at the site.)
- Reduced levels of chlorophyll-a recorded in the lower Hunter River were associated with tidal flows and consequentially shorter residence times of water
- Concentrations of nitrate, nitrite and phosphates typically exceeded the NSW trigger values for coastal riverine estuaries (ANZECC 2000), albeit a decrease in overall nutrient concentration from pre-2000 levels
- Median levels of ammonium were highest in the southern extent of the Hunter River, suggesting industry as a primary source of ammonium. Alternatively, nitrates and phosphates, products of intensive agriculture and horticulture were found upstream and thus indicative of the likely nutrient driver

- Turbidity in the southern region of the lower estuary exceeded the NSW trigger values (ANZECC 2000) of 2.8-3.5 nephelometric turbidity units (NTU) for coastal riverine estuaries, with occasional spikes following increased rainfall (>50 NTU).

Table 5-4 presents a summary of the Turbidity, chlorophyll and overall water quality grade assigned to the Lower and Middle portions of the Hunter River Estuary based on data collected in the OEH monitoring program 2014–15 (Swanson et al 2017).

Table 5-4 Turbidity, chlorophyll-a and water quality grade for Lower-Mid Hunter River Estuary

Hunter River	Turbidity	Chlorophyll-a grade	Water quality grade
Lower Estuary	B	B	B
Middle Estuary	C	C	C

Table 5-5 presents the median water quality values for available water quality parameters based on data collected in the OEH monitoring program 2014–15 (Swanson et al 2017) at a monitoring point located in the Hunter River estuary immediately north of Hexham, where the Pacific Highway crosses the river (HNT4). The location of the monitoring point in relation to the site is shown in **Figure 5-13**

Table 5-5 Median water quality values at local water quality monitoring point (HNT4)

Parameter	Approximate Median Concentration	ANZECC Guideline Value (µg/L)	Outcome
Chlorophyll-a (µg/L)	6	4	Exceeds ANZECC trigger value
Turbidity (NTU)	4	0.5-10	Within ANZECC trigger value
Ammonia (µg/L)	20	900	Below ANZECC trigger value
Phosphate (µg/L)	45	5	Exceeds ANZECC trigger value

The results presented in **Table 5-5** show that current background levels of chlorophyll-a and phosphate generally exceed ANZECC trigger values, whilst ammonia and turbidity are within acceptable ranges.

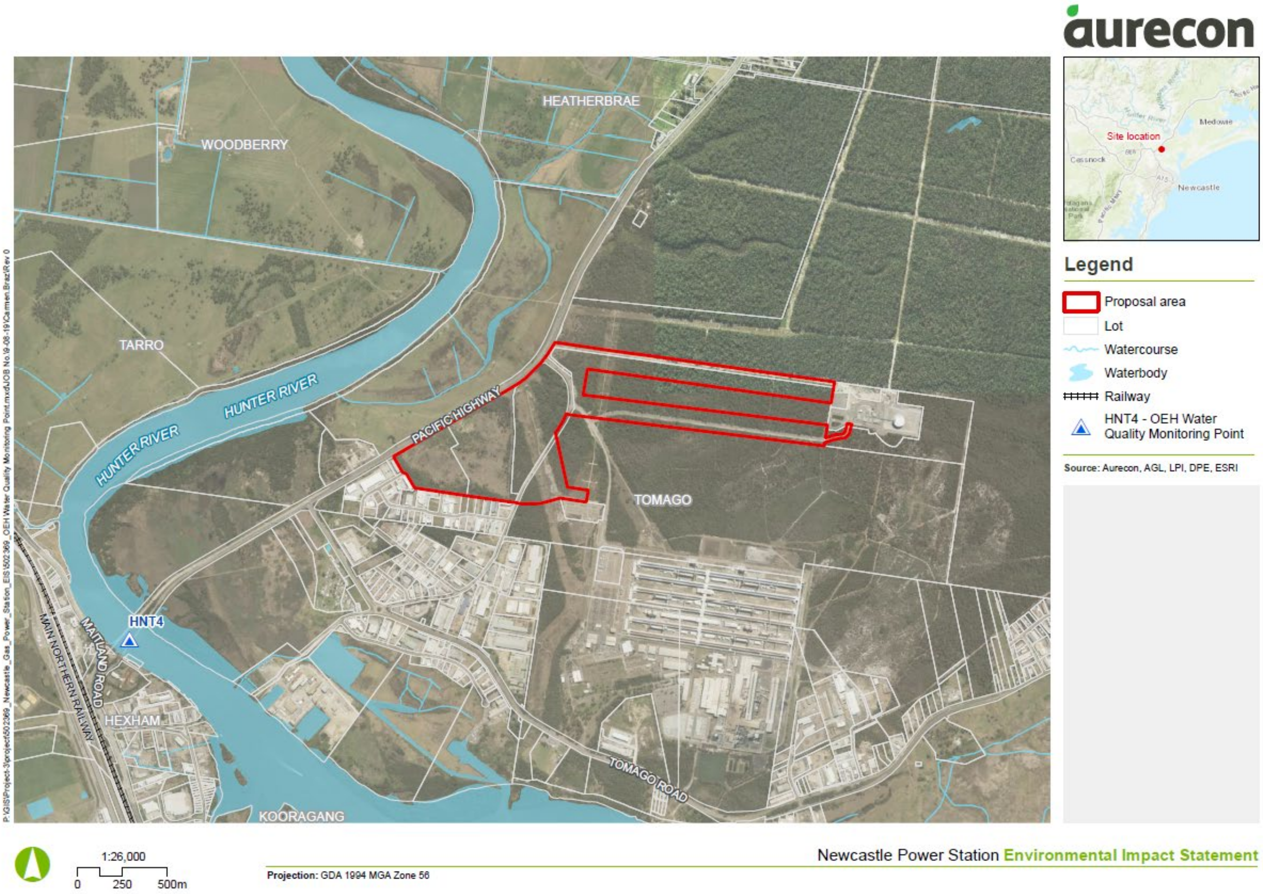

Figure 5-13 OEH Water Quality Monitoring Point

Local Surface Water

Local surface water quality data is available for both the proposed power station site as well as the proposed pipeline easement investigation areas.

Two locations representing surface water in close proximity to the power station site were sampled during a 2015 field campaign as reported in the 2018 Environmental Strategies contamination study (ES, 2018):

- SW01: The small dam located in the north-west corner of the site and within area of environmental concern (AEC) 6
- SW02: A small vegetated LEP Wetland pond, located south-west of the site, adjacent to the Pacific Highway, indicated as a representative "Background Area"

Historical data from 2011 and 2012 is also available for three sites in close proximity to the existing Newcastle Gas Storage Facility (Coffey, 2012; Coffey, 2013 & GHD, 2018):

- SW1 & SW2: Shallow pools of water in the eastern portion of the NGSF site when high water table conditions prevail
- SW3 & SW4: Upstream and downstream locations along the minor drainage line west of the NGSF site where stormwater would be dispensed (following the completion of the NGSF). Location SW4 was not sampled due to the location being dry during each of the monitoring events.

All six these locations are indicated in **Figure 5-14**.

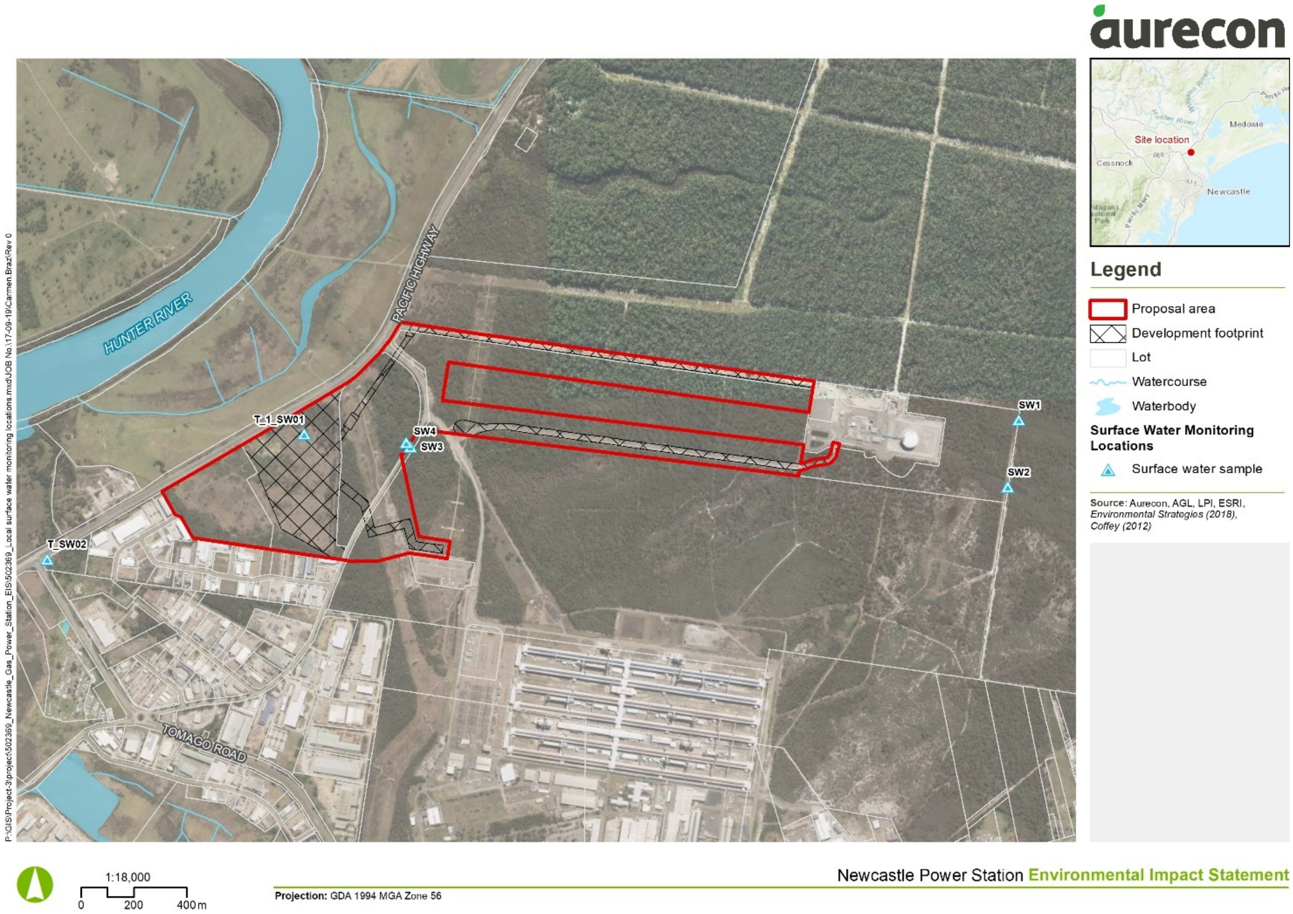

Figure 5-14 Sampling Locations (ES 2017 & Coffey 2012)

A summary of the available water quality data for the two western sites is shown in **Table 5-6**. The data shown includes the available general parameters measured in-field (DO, EC and pH) as well as the contaminates tested which exceeded the 95% Level of Protection Trigger Values for Fresh Water (ANZECC, 2000). The assessment criteria values provided for the general parameters are related but should not considered as trigger values or limits as they are not directly applicable (i.e. NSW coastal rivers typical values).

Table 5-6 Tomago Development Site surface water monitoring results (ES, 2018)

Analyte	Units	Assessment Criteria Value	16 & 17 November 2015	
			SW01	SW02
General Parameters				
Dissolved Oxygen (DO)	%	85 – 110*	68	23
Electrical Conductivity	(µS/cm)	200 - 300**	134	480
pH		6.5 - 8.0*	7.87	7.23
Metals				
Copper	µg/L	1.4***	4 (non-filtered) 5 (filtered)	11 (non-filtered) 2 (filtered)
Chromium	µg/L	1***	2	4
Lead	µg/L	3.4***	5	9
Zinc	µg/L	8***	54 (non-filtered) 43 (filtered)	99 (non-filtered) 170 (filtered)

*Lowland river trigger values for south-east Australia (ANZECC, 2000)

**NSW coastal rivers typical range (ANZECC, 2000)

***95% Level of Protection Trigger Values for Fresh Water (ANZECC, 2000)

The monitoring results indicate lowered dissolved oxygen concentrations, likely due to these being relatively stagnant water bodies which are not connected to flowing water systems. The electrical conductivity at SW02 is also slightly elevated, above the typical range of NSW coastal rivers, this is expected due to the wetland receiving local runoff from the urbanised catchment.

Seven (7) months of baseline data was collected for the surface water features located in close proximity to the NGSF, prior to the construction thereof (Jun – Dec 2011). An additional 3 months of data was collected during the construction period (Oct – Dec 2012). The most recent available monitoring data for SW3 and SW4 was collected in September 2018, these were taken from stagnant pools either side of the culvert. A summary of the data is presented in **Table 5-7**, with focus on nutrients, selected cations and anions as well as the metals tested for at the proposed power station sites (ES 2018).

Table 5-7 NGSF Surface water monitoring results

Analyte	Units	Adopted SW Threshold	Baseline Monitoring (Jun – Dec 2011)		Construction Monitoring (Oct – Dec 2012)			Operational Monitoring (20 Sept 2018)	
			SW1	SW2	SW1	SW2	SW3	SW3	SW4
Nr of Samples*			**7**	**7**	**3**	**2**	**1/2**	**1**	**1**
Dissolved Oxygen (DO)	%	N/A	19 - 98	58 - 122	51 - 87	48 - 96	168	20	15
Electrical Conductivity (EC)	(µS/cm)	1000	88 - 207	27 - 281	227 - 581	305 - 524	709 - 1560	736	750
Turbidity	NTU	N/A	2.1 - 38	0.8 - 22	5.5 – 104	23 - 40	54	n/a	n/a
pH		3.0 - 8.0	3.6 - 6.2	4.0 - 5.8	4.4 - 4.7	3.6 - 4.1	6.2	5.78	5.76
Nutrients									
Total Nitrogen	mg/L	9	0.2 – 8.2		1.9 – 7.9	1.4 – 1.7	1.6 – 3.3	1.6	1.6
Total Phosphorus	mg/L	0.5	<0.01 – 0.15		0.03 – 0.22	<0.01 – 0.02	0.1 – 0.13	0.04	0.04
Cations									
Calcium (Filtered)	mg/L	N/A	<1 - 4		1 - 2	<1 - 6	11 - 26	13	13
Magnesium (Filtered)	mg/L	N/A	<1 - 5		2 - 5	2 - 12	13 - 37	12	13
Sodium (Filtered)	mg/L	N/A	4 - 38		22 - 38	27 - 64	112 - 230	92	103
Potassium (Filtered)	mg/L	N/A	<1 - 4		1 - 4	2	5 - 7	2	2
Anions									
Total Alkalinity as CaCO3	mg/L	N/A	<1 to 3		<1	<1	<1 - 14	<1	<1
Chloride	mg/L	N/A	6 - 61		41 - 68	45 - 106	226 - 524	181	201
Fluoride	mg/L	5	0.3 – 1.2		0.4 - 1	0.4 – 1.9	2 – 2.5	3	2.9
Sulfate (Filtered)	mg/L	500	1 - 38		7 - 48	12 - 63	8 - 32	<1	<1
Metals									
Copper (non-filtered)	µg/L	50	<1 - 8		<1 – 6	1 – 3	1 - 9	2	2
Chromium (non-filtered)	µg/L	10	<1 - 22		<1 – 5	1	2 – 5	3	3
Lead (non-filtered)	µg/L	20	<1 - 7		<1 - 9	2 - 4	<1 - 3	2	2

Analyte	Units	Adopted SW Threshold	Baseline Monitoring (Jun – Dec 2011)		Construction Monitoring (Oct – Dec 2012)			Operational Monitoring (20 Sept 2018)	
			SW1	SW2	SW1	SW2	SW3	SW3	SW4
Nr of Samples*			7	7	3	2	1/2	1	1
Zinc (non-filtered)	µg/L	200	25 – 188		38 - 133	44 - 276	24 - 92	47	40

*Number of samples taken during construction monitoring were limited due to locations being dry during the sampling campaigns

The SW1 and SW2 samples represent the shallow pools of water in the east, which are largely stagnant and have a closer interaction with the local groundwater, whereas SW3 and SW4 is more representative of the local runoff (pre and post construction of the NGSF). SW1 and SW2 generally had lower EC, less turbidity and lower pH than SW3 and SW4. The observed metals' concentrations are generally lower than the two samples from the western section of the site (where the proposed Power Station will be located). The most recent samples indicate ongoing compliance with the adopted surface water thresholds.

Local Runoff (Lower Hunter)

The OEH implemented an 'event-based' stormwater quality program in 2014–15 which targeted stormwater runoff from industrial sites and urban areas in the lower estuary (south-eat of the site) to identify current sources of pollutants (Swanson et al. 2017b). The key findings of the investigation were as follows:

- Concentrations of inorganic nutrients (ammonium, nitrates and phosphates) throughout the estuary were high, often exceeding NSW trigger values for coastal riverine estuaries.
- Industrial sites are a major source of ammonium, nitrates and nitrites (NOx) and phosphates to the lower Hunter estuary with stormwater runoff for these sites delivering very high concentrations of nutrients to localised patches of the estuary. Concentrations of pollutants can be extremely high in stormwater discharges from certain industrial sites. These drains can be regarded as point source pollution.
- Concentrations of ammonium were often >1000µg/L in receiving waters during rain events with a maximum of 57,600µg/L detected. Concentrations of nitrates were often >1000µg/L in receiving waters with a maximum of 3,600µg/L detected. Concentrations of phosphates were usually below 100µg/L.
- Industrial sources of ammonium and NOx are more widespread (metal, chemical and fertiliser industries) than are sources of phosphate, which in the lower estuary appear to be localised to fertiliser-based industries on Walsh Point/Kooragang Island.
- High concentrations of dissolved zinc, copper and/or manganese were measured in port areas and in urban creeks, often approaching or exceeding ANZECC guideline criteria for 80% protection of marine ecosystems.
- Industrial discharges from secondary metal fabrication and the handling and export of metal concentrates in port areas, and roofing in urban areas, are likely sources of zinc. Machine wear and tear from vehicles in urban areas, and on-site practices and contaminated landfill in industrial areas, are likely sources of manganese. Shipping (antifouling coatings, dispatch) and contaminated landfill are the likely sources of copper to the estuary.
- In the lower estuary, freshwater runoff entering the creek mixes with oceanic water causing flocculation of fine suspended material including TOC. The creek also experiences relatively high phytoplankton blooms during low flow periods and settling of phytoplankton detritus likely contributes to sediment TOC.

The water quality data collected during the OEH monitoring programme were considered to form a viable baseline dataset against which future developments in the lower catchment could be assessed.

5.4 Local water and wastewater servicing

The Lower Hunter Water Plan (LHWP) was released in 2014 and sets out the NSW Government's water strategy for the region. The lower Hunter's water supplies are very reliable under typical climatic conditions but are vulnerable to drought (DFS, 2014). The focus of the LHWP was to deliver a mix of supply and demand measures to meet objectives, which include providing water security during drought and ensuring water supplies meet growing demands. Hunter Water Corporation (Hunter Water) is the major utility responsible for supplying drinking water to the region and for treating and disposing of wastewater. Investigations and supply-demand modelling indicated that Hunter Water's supply system could meet new growth for around 20 years, with secure supply until 2037/38 (DPI, 2017).

The main water supplies in the lower Hunter are the Chichester Dam and Grahamstown Dam, together with groundwater from the Tomago and Tomaree sandbeds. The water storages in the lower Hunter have the capacity to store 276 billion litres of water (276 GL), to manage supply in drought periods (DPI – Water, 2014). The lower Hunter's water demand is currently around 67 GL/a, with demand forecast to increase to 74.5 GL/a in 2035/36. Non-Residential demand in 2016/17 was 18.8 GL (DPI, 2017).

The proposed pipeline and electricity transmission line corridors overlie the south-western fringe of the Tomago sandbeds catchment area, a natural groundwater sand aquifer which is recharged by rainfall infiltration through the permeable sandbeds. Hunter Water extracts groundwater from this aquifer to supplement potable water supply for the Newcastle region, and the sandbeds form an important component of drought response in the lower Hunter region. A media release from Hunter Water on 20 May 2019 indicated that Hunter Water would begin to draw water from the Tomago sandbeds from June 2019 to provide additional security for the region's dams, which have fallen to their lowest levels in 13 years.

There is an existing Hunter Water pipeline along Old Punt Road, however, this network does not currently extend into the Proposal area including Lot 3 where the NPS would be developed. Potable water supply is available from Grahamstown Water Treatment Plant, with water supplied from either Grahamstown Dam or the Tomago Borefields (within the Tomago sandbeds).

The Proposal area (and the wider Tomago area) is not currently serviced by the existing Hunter Water sewer network. The nearest wastewater infrastructure includes sewage pump stations in Heatherbrae and the Raymond Terrace Wastewater Treatment Works which has recently expanded its capacity. A private sewer scheme services the industrial area to the south of the site by way of a pump out system that operates under a Trade Waste Agreement with Hunter Water.

6 Potential impacts

Due to the proximity of the site to the Hunter River, related environmental impacts must be addressed to ensure that any potential impacts that may occur during the construction and operational phases of the proposal are minimised and contained on site.

The following sections respond to the nominated SEARs while providing an overview of potential construction and operational phase issues. The potential impacts have been assessed with consideration to relevant components of the design, which were developed to lessen potential impacts to surface waters and hydrology.

6.1 Construction phase

This section identifies and assesses the potential impacts associated with the construction phase activities of the proposal.

6.1.1 Construction phase activities

The key construction phase activities for the proposed power station include the following:

- Clearing of vegetation at the proposed power station site and as required along the electrical transmission and gas pipeline(s) easements
- Demolition of existing house if not repurposed during construction and operation
- Establishment of bench (typical methodology):
  - Grubbing
  - Removal of 200-300mm of top soil (typical)
  - Stormwater management (eg. establish sedimentation fences and ponds)
  - Cut and fill to bench levels with import of quality engineered fill if required and removal of any excess/poor quality material if it can't be used on site elsewhere for landscaping, ponds etc
  - Fill is performed in layers of up to about 300mm, which is compacted before the next layer is added
- Installation of foundations and underground services
- Installation of aboveground civil, mechanical and electrical plant and equipment
- Installation of gas pipeline(s) and electrical transmission line infrastructure
- Commissioning and testing

During construction, water would be supplied by the construction contractor. The Port Stephens municipal water supply system provided by Hunter Water could be used via a temporary pipe connection to the existing water supply infrastructure on Old Punt Road. Raw water may also be delivered to site as a secondary source by contractors. Initially, tanks would be installed to store construction water, until the operational pipe network is laid with a permanent connection to the Hunter Water network. This component of the Proposal would be completed as early works, to facilitate the construction program.

Water would be used during construction for a range of purposes including excavation, dust suppression, drilling, hydrostatic testing, materials preparation and use, and amenities for the construction workforce. Construction areas and access tracks would be watered to supress dust, with the frequency of watering dependent on wind and rainfall conditions.

6.1.2 Potential construction impacts - hydrology

The hydrology of the proposed Newcastle Power Station is characterised by two drainage pathways identified as Drainage Path 1 and Drainage Path 2 in **Figure 5-8**. Drainage Path 1 is the primary pathway for surface water which lands on the south-west side of the drainage divide on the proposed power station construction area with potential to draining into a sensitive LEP wetland ecosystem. Surface water which lands on the north-east side of the drainage divide will flow towards drainage path 2 or the Hunter River.

Based on the construction phase activities, the potential hydrological impacts associated with the construction of the proposal include:

- Discharges of **sediment-laden stormwater** from stockpiled sites and cleared areas to receiving waterways resulting in sedimentation within associated near site watercourses and habitat degradation along natural waterways and wetlands
- **Scouring (erosion)** of natural waterways and wetland areas because of increased volume / rate of channelized discharges to the environment
- **Fluid loss during any HDD** required for installation of the gas pipelines (uncontrolled release of drilling fluid escaping from the borehole through fissures or weakness in the substrate resulting in increased sedimentation and turbidity in watercourses)
- **Changes to volumes and rates of flow** to the near site suspected ephemeral drainage creeks
- Localised **increases in groundwater levels** from land clearing and associated surface water seepage through the confining layer
- Localised **decreases in groundwater levels** due to a reduction in recharge to the groundwater aquifers as a result of increasing the impervious surface portion

6.1.3 Potential construction impacts - flooding

As per the results of the flooding assessment (report attached in **Appendix B**), a building platform of at least 5.1m AHD is recommended based on an assessment of the 1% AEP design flood levels. As the lowest natural elevation within the proposed power station site area is currently around 7.2m AHD, the development is expected to be immune from the 1% AEP event. The proposed building platform will also have no impact on changing flood levels or flow patterns or velocity outside the property area (see expected inundation in **Figure 5-10** through **Figure 5-12**). Similarly, during construction of the proposal no earthworks or infrastructure is expected to be located within the potential flooding area, and thus no impact on flooding events is expected.

6.1.4 Potential construction impacts - surface water quality

General

The suspected ephemeral nature of both near site drainage pathways suggests the potential for ecologically harmful surface water runoff during the construction phase activities that coincide with periods of elevated rainfall. As a result, the following potential impacts during the construction phase activities include:

- Increased loading of dissolved **nutrients** (nitrogen and phosphorous) from exposed surfaces and stockpiled materials into near site watercourses from site run-off. This process has the potential to stimulate the growth of nuisance plants, algae and cyanobacteria
- Runoff or unintended dewatering of **contaminated water** from excavations or stockpiles which include contaminated or acid sulphate soils, altering pH and water quality and causing potential soil contamination and possible downstream ecological impacts
- Discharges of **sediment-laden stormwater** derived from exposed surfaces and stockpiled materials into receiving waterways resulting in increased turbidity and deterioration of water quality in both watercourses; in particular the discharge location of Drainage Path 1 in the LEP Wetlands

- **Fluid loss during the HDD** required for installation of the gas pipelines (uncontrolled release of drilling fluid escaping from the borehole through fissures or weakness in the substrate resulting in increased sedimentation and turbidity in watercourses)
- Discharge of contaminated **hydrostatic test water**
- Accidental release of alkaline **concrete wash water**, which may cause localised soil, surface water or groundwater contamination and possible downstream ecological impacts
- **Leaks / spills of chemicals**, heavy metals, oils, and petroleum hydrocarbons during the use and operation of machinery, resulting in acute impacts to ecosystems receiving surface water run-off; in particular, the discharge location of Drainage Path 1 in the LEP Wetlands
- Leaching and groundwater facilitated **migration of chemicals**, heavy metals, oils, and petroleum hydrocarbons into near site water bodies and wetlands because of constructional phase leaks / spills
- Construction demolition wastes such as concrete, plasterboard, timber, asbestos and **contaminated soil** spreading via surface run-off to near site drainage pathways and the associated LEP Wetland area
- **Tannin leachate** from clearing and mulching discharging to near site drainage pathways resulting in eutrophication, reduced water pH and visual aesthetic issues

The risk of surface water contamination during construction could be increased in the event of a significant flood (between the 100-year ARI and the PMF), which may inundate site drainage systems and breach containment storage facilities, mobilising contaminants

Stormwater

Stormwater runoff represents a diffuse source of pollution that may carry nutrients, sediments, organic and inorganic contaminants from urban / industrial areas into drains, creeks and rivers.

Build-up and wash off are the key mechanisms influencing the generation of contaminated runoff from impervious surfaces. Build-up is the process by which dry deposition accumulates on impervious areas. Wash off is the process by which accumulated dry deposition is removed from impervious surfaces by rainfall and runoff and is incorporated into discharge.

Measurements of urban water quality for research and operational reasons have led to a substantial body of information published in technical literature. Sources and impacts of contaminants in stormwater are discussed in further detail in **Table 6-1** below. All these parameters, other than the two indicated in grey, have been identified by previous investigations as chemicals of potential concern and may already be present in the soil.

Table 6-1 Stormwater quality parameters and primary sources

Parameter	Source	Potential Impact
Suspended solids	Sources include: wet and dry atmospheric deposition, wear of roads and vehicles, construction and demolition operations, vegetation, and erosion of pervious areas by wind and water.	▪ Deposition of suspended solids can block pipes, change flow conditions in open channels and disrupt the habitat of aquatic invertebrates and fish. ▪ Turbidity associated with fine suspended solids can reduce light penetration in waterways. ▪ Suspended solids may carry sorbed contaminants that can degrade water quality.
Total phosphorous	Sources include: atmospheric deposition, tree leaves, industrial wastes, detergents and lubricants.	Phosphorous is an essential nutrient and may be a limiting nutrient at a site. Where phosphorous is limiting an increase may cause excessive and unbalanced growth of plants and algae leading to oxygen depletion (eutrophication).

Parameter	Source	Potential Impact
Total nitrogen	Sources include: industrial cleaning operations, combustion of fossil fuels, windblown pollen, spores, bacteria, fallen leaves, plant debris. Rainfall is consistently the principal source of nitrogen in runoff. Urea solutions used for removal of NOx from flue gas via wet scrubbing.	Nitrogen is an essential nutrient and may be the limiting nutrient at a site. Increased nitrogen levels may stimulate further growth and lead to eutrophication of waterways. Nitrate and nitrite in drinking water contribute to an illness known as methemoglobinemia or blue baby syndrome. Free ammonia is toxic to aquatic organisms.
Oil and grease	Sources include: operation and maintenance of vehicles and machinery, natural compounds leached from vegetation, and plant litter.	Oil and grease is a composite of potentially thousands of organic chemicals with different toxicities and properties. Materials classified as oil and grease are often unsightly, may be toxic and may adversely affect dissolved oxygen levels by limiting transfer from the atmosphere and by oxygen demand from molecular breakdown.
Total lead	Sources include: tyres, industrial emissions, lead water pipes and soldered joints, plastic pipes and guttering, paints, lead roofs, and flashing. Lead in stormwater runoff is mostly associated with suspended solids.	Lead is a cumulative metabolic poison, which bioaccumulates in plants, animals, and bacteria.
Total zinc	Sources include: wear from tyres and brake pedals, combustion of lubricating oils, and corrosion of galvanised roofs, fittings, pipes and other metal objects. Zinc in stormwater is mostly associated with dissolved solids.	Zinc is an essential and beneficial element to human growth, which bioaccumulates easily in plants and animals. Water containing elevated concentrations of zinc has an undesirable taste and may have an opalescent appearance. Environmental guidelines are frequently exceeded.
Total copper	Sources include: wear of tyres and brake linings, combustion of lubricating oils, corrosion of roofs and water pipes, wear of moving parts in engines, industrial emissions. Copper salts are used in water supply systems to control biological growth in reservoirs and pipes. Copper in stormwater is mostly associated with dissolved solids and colloidal material.	Copper is an essential element in human metabolism. Large doses may lead to widespread irritation and damage. Dissolved copper imparts a colour and undesirable taste to drinking water It is toxic to aquatic organisms and rapidly accumulates in plants and animals. Environmental guidelines are frequently exceeded.
Total cadmium	Sources of cadmium include combustion, wear of tyres and brake pads, possible combustion of lubricating oils, industrial emissions, agricultural use of sewage use, fertilisers and pesticides, corrosion of galvanised metals and some landfill leachates.	Cadmium is highly toxic and a carcinogenic. It bioaccumulates in liver and kidneys of humans and animals and tends to be concentrated by shellfish.
Total chromium	Sources include: corrosion of welded metal plating, wear of moving parts in engines, fire sprinkler systems, corrosion inhibitors and sewage sludge applied to land. Chromium in stormwater runoff is mostly associated with suspended solids.	Chromium occurs in trivalent and hexavalent forms. In chlorinated or aerated water hexavalent chromium is the predominant form. Hexavalent chromium is associated with liver and kidney damage, gastrointestinal irritation and increased risk of cancer.
Total nickel	Sources include: corrosion of welded metal plating, wear of moving parts in engines.	Nickel is found at low background concentrations in most natural waters and is moderately toxic to freshwater organisms at acute exposure.
Total iron	Sources include: Corrosion of vehicles, roadside equipment, drains, burning of coke and coal, iron and steel industry emissions, landfill leachate, silt and clay particles, and potable water supplies.	Iron is widely distributed in the environment and is an essential element in human nutrition. In water it occurs mainly in divalent (ferrous) and trivalent (ferric) states. The ferrous form occurs under reducing conditions. The ferric form occurs under oxidising conditions. Iron causes staining and has an astringent taste. It may be toxic to fish and invertebrates at high concentrations.
Total manganese	Sources include: wear of tyres and brake pads, steel manufacturing, manufacture of paints and dyes, fertilisers, glass, ceramics and fireworks.	Manganese is an essential trace element for microorganisms, plants and animals (CCREM 1987) and can be bioconcentrated up to four orders of magnitude, possibly to facilitate essential uses. It is present in natural waters in suspended form (similar to iron) although soluble forms may persist at low pH or low DO. Its toxicity is low compared to other trace metals. In potable water supplies it imparts an undesirable taste to beverages, and stains plumbing fixtures and laundry.
Total mercury	Sources include: emissions from the chlor-alkali industry, coal combustion. Sorption onto suspended matter or bottom sediments is the most important process controlling the concentration of mercury in natural waters	Mercury is a highly toxic element that serves no known beneficial physiological function. Mercury can exist in the environment as the metal, as inorganic salts, and as organomercurial compounds such as methyl-mercury. Mercury causes a wide range of toxic effects in humans, fish and invertebrates.

Parameter	Source	Potential Impact
Total coliforms	Sources include: Animal and human waste, soil, vegetation. Can result from leaking wastewater pipes, leaking sceptic systems, direct contamination or leachate from stockpiles.	Total coliforms are a sensitive measure of possible faecal contamination but does not confirm the presence of faecal contamination as the indicator can also reflect contaminants derived from soil and vegetation.
Faecal coliforms	Sources include: Animal and human waste. Can result from leaking wastewater pipes, leaking sceptic systems, direct contamination, or leachate from stockpiles.	Faecal coliforms are an indicator of faecal contamination of a water source.

6.2 Operational phase

This section identifies and assesses the additional potential impacts associated with the operational phase activities of the proposal.

6.2.1 Operational phase activities

The power station is intended to be operated as a peaking plant capable of achieving fast start and ramp-up period to full capacity. The power station would have duel-fuel capacity, using both natural gas and diesel fuel as back up. Apart from routine maintenance on the power station and associated ancillary facilities, the operation would require minimal personnel. The control room would be available for local operation.

6.2.2 Potential operational phase impacts – hydrology

Operational phase impacts to surface water and hydrology for the Newcastle Power Station are primarily driven by changes in stormwater runoff discharge patterns and the facilitation of surface contaminants into the LEP Wetland and potentially the Hunter River.

Based on the concept design, a significant proportion of the area within the power station footprint would become impervious post construction, currently anticipated at around 30%, resulting in an increase in stormwater run-off from the proposed power station site. These intensifications in flow rate during periods of higher rainfall have the potential to erode natural waterway channels, particularly Drainage Path 1 and the connected LEP Wetland discharging locations (See **Figure 5-8**).

6.2.3 Potential operational impacts - flooding

As per the results of the flooding assessment (**Appendix B**), a building platform of at least 5.1m AHD is recommended to ensure the power station would not be affected by the 1% AEP design flood levels. As the power station footprint is naturally 7.2m AHD and higher, the development would be immune from the 1% AEP event. Associated infrastructure including transmission lines and pipeline easements would be partially affected by the 1% AEP event or greater, which may cause a temporary loss of access for maintenance activities, and inundation of the pipeline route until flood waters subside and drain away.

The proposed building platform will have no impact on changing flood levels or flow patterns or velocity outside the property area (see expected inundation in **Figure 5-11**. Associated infrastructure including electricity and pipeline routes would have minimal above-ground presence and are expected to have a negligible effect on existing flooding conditions.

6.2.4 Potential operation phase impacts - surface water quality

The local LEP Wetlands, the three local low-lying seep areas and the Hunter River are all potential receptors of contaminated or sediment-laden site storm water if the appropriate water management systems and mitigation measures are not implemented.

Without management measures and systems in place, operation of the Proposal also has the potential to cause surface water contamination. Potential operational impacts include:

- Storage, transport, use and handling of diesel fuel, chemicals, oils, greases, solvents, demineralisers and firefighting products on site has the potential to introduce surface contaminants to surface water runoff and impact the quality of surrounding surface waters and wetlands through stormwater discharge and plant wash down routines
- Runoff from roads, car-parks and hardstand areas may also contain low to medium levels of hydrocarbons, metals, suspended sediments and nutrients resulting from the operation of vehicles and machinery
- Leaks or spills due to overflow or failure of hydrocarbon storage tanks, septic systems, process water storage ponds.

The risk of surface water contamination during operation could be increased should one of the following events co-occur:

- A significant flood (between the 100-year ARI and the PMF), which would inundate site drainage systems and potentially breach containment storage facilities, mobilising contaminants
- A significant fire event, which would require large volumes of firewater to be applied across the NPS, mobilising contaminants

Proposed mitigation measures are listed in **Section 7.2**.

6.3 Potential cumulative impacts

This section identifies and assesses the potential cumulative impacts and management options associated with the proposal. The potential impacts have been assessed with consideration to relevant components of the power stations concept design, which were developed to manage impacts to surface waters.

A review of the EIS undertaken by URS in 2002 did not identify any significant cumulative impacts associated with surface water and hydrology at the proposed Newcastle Power Station site.

However, further assessment during the execution of the current study identified several of the adjacent industrial sites, located immediately south of the proposed Newcastle Power Station site, as potential existing sources, which may contribute to conceivable cumulative impacts.

The current concept design for stormwater runoff and operational waste water identifies the stormwater drainage network within the industrial estate as a potential flow pathway for clean stormwater. In alignment with the sites potential operational impacts and mitigation measures, the combination of water discharge from the power station and existing industrial estate land uses has the potential to continually degrade the natural integrity (i.e. erosion and water quality) of Drainage Path 1 and the adjoined LEP Wetland and Hunter River system.

7 Mitigation

7.1 Construction mitigation measures

Construction Environment Management Plan (CEMP)

Potential impacts to hydrology and surface water quality during construction phase activities can be managed for all stages of the Newcastle Power Station through the following measures:

- Preparation of a construction environment management plan (CEMP)
- Preparation of a suitably detailed soil and water management plan (SWMP) containing an erosion and sediment control plan (ESCP), based upon the preliminary erosion and sedimentation management report (ESMR).

Further management measures should be included within the proposal CEMP to mitigate potential water quality impacts from construction phase activities outside of the ESMR scope, such as:

- Leaks / spills;
- Use of firefighting foams or fire retardants;
- Contamination of runoff from exposed hazardous materials (e.g. asbestos ridden demolition waste) or exposed / stockpiled contaminated soils
- Gross pollution from plastics / waste materials.

Construction sedimentation basins

The uncontrolled discharge of sediment-laden stormwater poses one of the largest risks for impacting the surrounding surface water during the construction phase. To mitigate this risk the planning and development of suitably sized sediment basins prior to any major earthworks is proposed.

Initially, before the cut and fill operations have been completed, at least two sediment basins would be required to capture the runoff generated on both sides of the central ridge, as indicated in **Figure 7-1**.

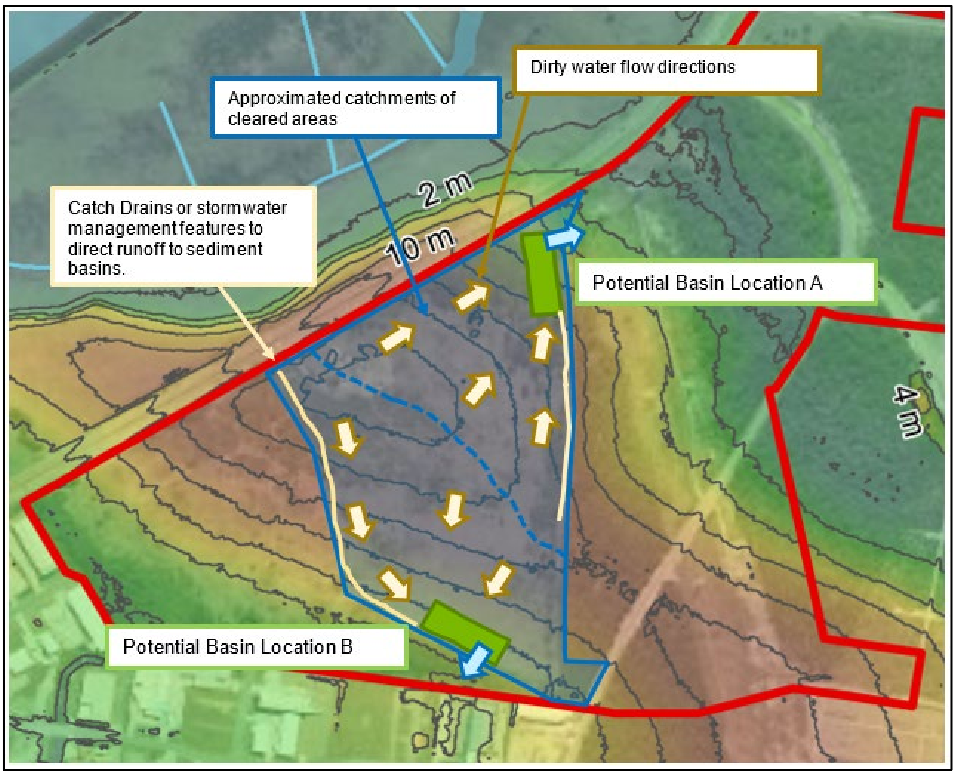

Figure 7-1 Concept diagram of potential basin locations

An indicative study was done to assess the availability of space to implement sediment basins for the construction phase. Conservative assumptions were made regarding duration of construction works, soil types and basin dimension requirements to minimise the risk of underestimating the area required for the basin placement. Basin sizing estimates were based on design guidelines, as set out in the Soils and Construction Guide Volume 1 (Landcom, 2004) for managing urban stormwater by the NSW government.

The disturbed area was split into the two sub-catchments indicated (maximum area of 8 hectares each) with the low points as potential basin sites at the periphery of the area of disturbance. The basins were conservatively estimated to have an upper limit estimate of total required footprint area of 0.60 hectares each with a minimum internal depth requirement of approximately 2.3 m.

Whilst these estimates, specify very large footprints, given the available space and fall across the site, implementation (subject to detailed design) appears feasible. It is noted that the proposed developed area is to consist of a series of process water storage ponds in the operational phase, which are in similar locations and size to the estimated construction phase sediment basins indicated. Therefore, construction of these basins for re-use or modification into permanent basins, subject to detailed design, appears feasible.

It is recommended that any basins be constructed and operated to be compliant with relevant best practice guidelines including the 2008 IECA Best Practice Erosion and Sediment Control (BPESC) document and Volume 1 of the 2004 Fourth Edition Landcom guidelines for Managing Urban Stormwater: Soils and Construction.

Excavation Dewatering

A site-specific Dewatering Procedure should be developed which would include a process for testing whether the water meets discharge criteria or requires further treatment before being discharged. Water treatment including flocculation and pH adjustment may be required prior to discharge due to the potential presence of sediment and acid sulphate soils. The procedure would provide instruction on treatment methods and dosages, use of water testing equipment (e.g., pH probe and turbidity meter), discharge processes and locations, water quality monitoring requirements, permits required and records to be taken. Any water which cannot be treated to meet discharge criteria would be removed by sucker truck and transported for offsite disposal at a licenced facility.

Flood impact mitigation

To minimise the risk of adverse environmental impacts due to flooding during construction, a Flood Preparedness Plan would be prepared based on the PMF design event. The plan would include monitoring of weather forecasts and flood warnings to enable flood preparedness procedures to be implemented ahead of potential flooding events, and site-shut down to be undertaken when required, to minimize harm to persons, plant and the environment. Notably, this plan would focus on the risk of spreading contaminants (such as sediment, hydrocarbons or chemicals) in floodwaters.

Control actions would include filling excavations, completing erosion and sediment controls, removing hazardous materials and waste from the site, and sealing tanks and containers to prevent overflows. In addition to the plan, an environmental risk assessment should be completed prior to commencing excavation or trenching work in the event of a flood warning, to minimise unnecessary additional exposure.

Works would be scheduled to avoid wet seasons and heavy rainfall, where possible and BoM and local flood warning services would be monitored. In the event of a flood warning, an environmental risk assessment will be completed prior to commencing excavation or trenching work.

General mitigation measures

The following management options are 'best practice' measures for mitigating against potential adverse effects on surface water resources in connection with the proposal:

- The use of onsite **dirty water diversion drains** to redirect site derived runoff to sediment retention basins, where water may be stored, flocculated and tested / assessed for potential water quality issues prior to release to specified discharge points (See below in **Figure 7-2**). Spill kits would also be kept onsite and at all ancillary facilities in the case of a spill.

- Incorporation of **clean water diversion berms,** where appropriate around the site, to minimise the volume of runoff that could potentially be impacted.
- Installation **of silt fences, sediment traps, contour berms and energy dissipaters** will further mitigate potential for sediment laden waters or water containing gross pollutants (i.e. oils, construction wastes) to discharge to the environment along with reducing both onsite and offsite erosion.
- The use of **dedicated re-fuelling areas** and appropriate fuel and liquid storage in accordance with the CEMP will minimise the potential for contaminant spills to impact the near site drainage pathways and connected LEP Wetlands.
- The management and storage of **hazardous materials and chemicals** will include appropriate bunding in accordance with relevant Australian Standards. The bunded areas should have sufficient capacity, include isolations valves and have appropriate alarm systems fitted to all tanks. Inspection and required maintenance will be done after significant rainfall events. Licenced contractors would be engaged to collect, transport and dispose of liquid hazardous materials, waste solvents, paints and hydrocarbon products to an appropriate off-site facility in accordance with relevant NSW Environment Protection Authority (EPA) guidelines.
- A designated **concrete washout area** would be established away from drainage lines and water bodies, which would be lined with impervious material. The washout capacity would be regularly checked before being used. The wash water would be left to evaporate, with dried concrete removed for recycling as required. Inspection of the capacity of the washout area and integrity of the liner would be undertaken prior to each use, and prior to rainfall events or site shut down, with improvements made as required. Wash water would be pumped out as required to maintain capacity or prior to rain events and disposed of as contaminated water.
- The application of appropriate construction and demolition **waste storage and disposal** methods in accordance with the CEMP and *Protection of the Environment Operations Act 1997* during possible demolition of the onsite property. This aims to reduce any transportation of harmful contaminant via surface water run-off into the surrounding waterway systems.
- A **Spill Response Procedure** would also be developed to detail the strict precautionary measures that should be made when using or transporting fuels and chemicals, as well as details relating to the management of spills, including requirements for immediately containment, and removal of the impacted material from the site.
- Minimisation of the area of **exposed and unstable ground surfaces** during construction, alongside resealing or revegetating surfaces as soon as applicable.
- The **re-use of water** collected in the sediment basins for dust suppression during construction and landscaping post construction if required.
- A procedure would be developed and implemented to minimise the risk of **drilling waste** (in the form of drilling fluids and hydraulic stimulation fluids) contaminating watercourses during drilling, completion, hydraulic stimulation and workover activities. The HDD entry and exit sites would be securely bunded to prevent the release of leachate from excavated material, drilling fluids, or spills entering the surrounding environment. Drilling fluid spills or frac out would be immediately contained, cleaned up and reported.
- During **hydrostatic testing of the pipes** the use of chemical treatment would be avoided where possible. Chemical concentrations would be calculated such that they are consumed in the hydrotesting process and only trace volumes would be present in any discharge. Water used in pressure testing would be collected following testing and disposed of off-site at a licensed facility.
- Incorporating a designated **stable vehicle access road** and construction phase car park within the CEMP and ESCP to minimise the destabilisation of surface sediments.
- Management and maintenance of the **sewage system** will be carried out by suitably trained personnel.

- Any mulch stockpiles from cleared vegetation will be located at high points away from watercourses, with upgradient water diverted to avoid entering the stockpile. Mulch will not be used as an erosion control in the floodplain or along concentrated flow paths to minimise the potential for **tannin leachate**.

When implemented correctly, these constructional phase management options are designed to facilitate a Neutral or Beneficial Effect (NorBE) on water quality, in accordance with the *Guidelines for Development in the Drinking Water Catchments (Hunter Valley) (2017)*.

7.2 Operational mitigation measures

Conceptual Surface Water Management Plan (SWMP)

A Surface Water Quality Assessment was undertaken to support the current EIS study (the report is included in **Appendix C**). The report includes a conceptual surface water management plan. The primary objective of the plan was to outline the key surface water quality management issues and to establish surface water quality management principles and concepts.

To inform the surface water quality assessment, a conceptual Surface Water Management Plan (*SWMP*) was developed for various surface water management area categories that were identified within the power station. This plan should be expanded during the detailed design phase. The current operational SWMP is summarised as follows:

- General pervious areas: This includes undeveloped pervious areas and general plan areas. No controls required, infiltration into the groundwater system as currently occurs.
- General hardstand areas: This includes general impervious areas such as handstand around equipment/building and car parks etc.
- Road areas: Also considered hardstand area.
- Roof areas: Building roof areas.
- Enclosed workshops: Runoff within enclosed workshops will be bunded and disposed to trade waste.
- Ponds: Runoff collected within the ponds will be contained within the ponds for evaporation, off-site disposal or treatment and on-site disposal.

Once operational, the power station is unlikely to have a significant impact on the surrounding surface water features, other than a potentially minor increase of pollutants due to the increase in impervious areas.

It is proposed to capture all runoff from roads, car-park and hardstand areas in a 'pit and pipe' stormwater system. The pit and pipe stormwater system would be provided along the roads within the proposal site and would discharge to the natural depression at the south-west corner of the proposal site, after undergoing treatment via the proposed oil and grease separator and a proposed Bioretention Pond (as shown in **Figure 7-2**). The site layout shown is currently an indicative one, the final design will be determined pending the type of engine technology used.

Design surface levels of the proposal site would be regraded to facilitate the stormwater system. To minimise the impact on the downstream environment, the captured stormwater would be treated through the following stormwater controls:

- **Wet sump oil and grease separator (Gross Pollutant Trap (GPT))**: This would facilitate the removal of the majority of entrained oils and greases, suspended solids and associated attached metals from stormwater runoff. Wet sump oil and grease separator will also capture any small to medium spill that occurs on the hardstand area and should be selected to provide a design treatment rate equivalent to a 1 in 3-month Average Recurrence Interval (ARI) peak flow. The oil and grease separator should be able to remove all oil/grease to <5 mg/L, and coarse sediment.
- **Bio-Retention System**: Treated discharge from the wet sump oil and grease separator would be discharged into a bio-retention system. Bio-retention systems consist of selectively vegetated areas with enhanced filter media. Stormwater runoff is slowly filtered through the enhanced filter media, where

physical and bio-chemical processes facilitate the removal and breakdown of common stormwater contaminants. Filtered stormwater would be collected and discharged to the natural depression downstream. The base of the bio-retention filter media would be lined such that it will be separated from the groundwater system.

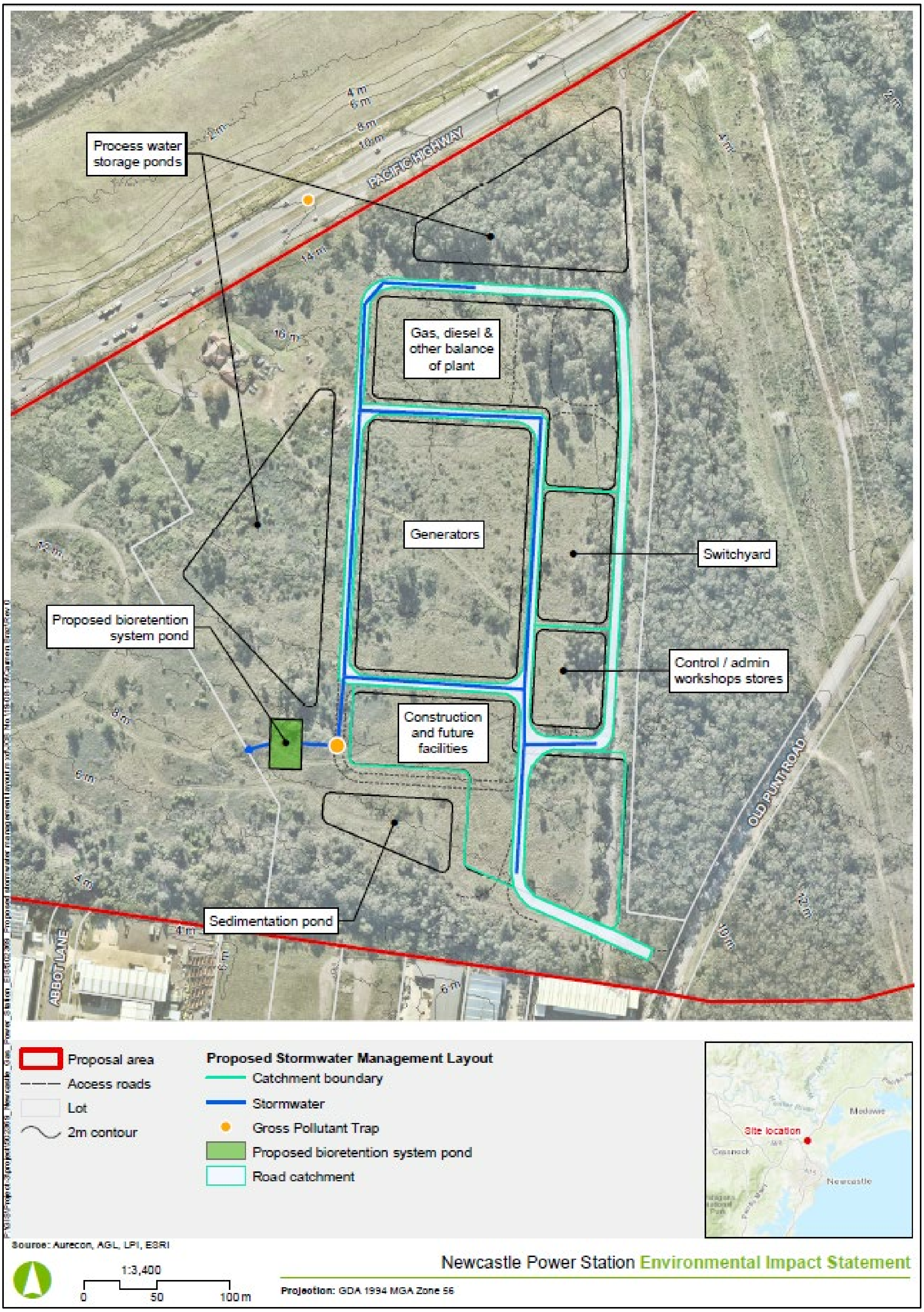

Figure 7-2 Proposed Indicative Stormwater Management – Site Layout

The wet sump oil and grease separator and bio-retention system will be implemented at the outlets of the stormwater system prior to discharging into the natural depression downstream (**Figure 7-2**).

Bio-retention systems will be sized to achieve the Water Quality Stripping targets and the NorBE requirements as set out in the Port Stephens DCP Part B4, *Drainage and Water Quality*. Preliminary water quality modelling indicates that approximately 735 m^2 of bio-retention filter area will be required. **Figure 7-2** indicates potential location and sizes for the proposed bio-retention systems. Further detail on the stormwater control systems are provided in the Surface Water Quality Assessment (**Appendix C**).

General mitigation measures

The following measures are additional mitigation measures not currently detailed in the above conceptual SWMP:

- The civil design of the power station will incorporate the principles outlined in Port Stephens Council DCP 2007 to ensure that the post-development flow rate and volume is equal to pre-development for all storm events, despite the increase in impervious area, which would negate this impact.
- Runoff generated when undertaking **maintenance or cleaning activities** within enclosed workshop areas would be the lowest quality waste water generated by the Proposal, and along with any oily or contaminated water, would be collected in a designated drainage system for transport to an appropriate liquid waste disposal facility
- A **chemical drains system** would be established for chemical spills and stormwater falling into outdoor chemical storage areas, comprising a sump for collection, testing and treatment of water before piping to the process waste water system
- A **process waste water** system would be established to collect waste water in ponds or tanks for temporary storage and evaporation. Process waste water and solids/sludge would be periodically removed from site by tankers for disposal at a licenced waste water facility
- **Potable water drains and site sewage** would be discharged to a site sewerage system. Septic tank(s) would be used and treated via a standalone septic treatment system or pumped out by truck as required.
- Access roads into the site would be affected by several of the design flood events modelled, and evacuation routes would need to be considered. The safest and most direct evacuation route would be to exit the site by turning left onto Old Punt Road and then right onto the Pacific Highway, however, for events above the 10% AEP, all potential evacuation routes appear to be inundated, and the NPS site becomes isolated, so early evacuation of the site would be required in accordance with Government flood warnings. A **Flood Preparedness Plan** should be prepared for the Proposal based on the PMF design event.
- For the operation phase of the proposal (post construction), an **Operational Environmental Management Plan (OEMP)** would be prepared and implemented. This would be specific to the activities of the operational power station and associated environmental risks.
- The preparation and development of an **Erosion and Sediment Control Plan (ESCP)** for the operational phase to reduce water flow velocities at discharge points. The plan would also ensure discharge rates are moderated to eliminate erosion downstream.
- The implementation of a **water quality monitoring program** to monitor discharge from all surface runoff control facilities (e.g. wet sump oil and grease separator) to ensure contamination levels do not exceed limits set out by either the baseline trigger values or *ANZECC Guidelines for Fresh and Marine Water Quality (2000)*.

When implemented correctly, the proposed mitigation measures are designed to facilitate a Neutral or Beneficial Effect (NorBE) on water quality, in accordance with the *Guidelines for Development in the Drinking Water Catchments (Hunter Valley) (2017)*.

8 Residual impact

Based on a review of environmental information available for the site, the following relates to potential residual impacts (with mitigation in place) relating to the SEARs outlined in **Section 1.3**:

- In relation to the construction phase:
  - with adequate mitigation in place (including adhering to the documents specified in the plans outlined in **Section 7.1**), there is a low risk of residual impacts.
  - peak construction water demands would be negligible compared to existing water usage and total water supply in the region. The Proposal would not affect other water users in the region during construction.
- In relation to the operation phase:
  - with adequate mitigation in place (including adhering to the documents specified in the plans outlined in **Section 7.2**), there is a low risk of residual impacts.
  - potential operational impacts on surface water quality of receiving waterways may be predominately attributed to discharge of sediment laden and contaminated stormwater originating from the site. Once operational, assuming all recommended mitigation measures are adhered to, the power station is unlikely to have a significant impact on the surrounding surface water features.
  - waste water generated by the Proposal would not impact on local sewer infrastructure and would either be removed from site for processing at a licensed facility or treated to meet discharge criteria and discharged offsite as clean storm water.
  - given the relative size of the Proposal area and the development footprint compared to the total catchment area of the Hunter River (around 22,000 km^2), it is expected that there would be negligible impact on the hydraulic behaviour of the Hunter River due to any residual runoff pattern changes.
  - the Flood Assessment identified that there would be no effect from the proposed development on existing flood behaviour, nor would the development impede access to existing road networks. The development is thus not expected to have any impacts on existing community emergency management arrangements for flooding.
  - worst case operational water demands (continuous operation) represent a small percentage of the total water supply available in the region (0.03%) and a fractional increase on current annual water usage (0.12%). Therefore, the Proposal would not affect other water users in the region during operation.

All plans outlined in **Sections 7.1** and **7.2** should include contingency approaches, in the unlikely event of an incident with proposed mitigation in place.

Neutral or Beneficial Effect (NorBE)

Neutral or Beneficial Effect (NorBE) assessments apply to all releases of water, wastewater and other contaminants from the site that may affect water quality, during both construction and operation. A development is considered to demonstrate NorBE if the development:

- Has no identifiable potential impact on water quality, or
- Will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or
- Will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority.

The processes set out in the *Neutral or Beneficial Effect on Water Quality Assessment Guideline 2015* (WaterNSW, 2015) detail a methodology for determining the potential impact a project may have on the receiving catchment. By applying the underlying principles of a formal NorBE assessment a high-level comparable assessment was informed. Further details of the water quality assessment are provided in **Appendix C**, this is summarised below:

- Potable water drains and site sewage shall be collected and discharged to a site sewerage system. Septic tank(s) shall be used and will be pumped out by truck as required.
- To ensure NorBE is achieved, the modelled pollutants loads for the developed case should aim to achieve 10% less than the pre-development case for total suspended solids (TSS), total phosphorous (TP) and total nitrogen (TN). For gross pollutants, the modelled post development load only needs to be equal to or less than pre-development load, This would be achieved by incorporating a bioretention system with a footprint of at least 735m^2, refer to **Table 8-1**.
- Moreover, to meet NorBE requirements, the concentration of pollutants for the post-development case should always be equal to or less than the concentration for the pre-development case. This is impractical for a risk-based approach and the natural variability of rainfall events. As a result, NorBE will be deemed to be met if the post development case pollutant concentrations are equal to or less than the pre-development case concentrations between the 50th and 98th frequency percentiles when run-off occurs. This would be achieved by incorporating a bioretention system with a footprint of at least 735m^2, refer to **Table 8-2.**

Table 8-1 Water Treatment Results for 735m^2 Bio-retention pond and a wet sump oil/grease separator

	PRE - DEVELOPMENT RESIDUAL LOAD	POST - DEVELOPMENT RESIDUAL LOAD	UNIT	WATER QUALITY STRIPPING TARGET (MIN)	WATER QUALITY STRIPPING RESULTS	NorBE MINIMUM REDUCTION	NorBE ACHIEVED REDUCTION	SATISFACTORY
TSS	1.08E+04	675	kg/yr	90%	94.50%	10%	93.70%	**Y**
TP	6.79	4.95	kg/yr	60%	75.70%	10%	27.10%	**Y**
TN	36.3	32.5	kg/yr	45%	64.50%	10%	10.40%	**Y**
Gross Pollutants	0	0.133	kg/yr	90%	100%	0%	0.00%	**Y**

Table 8-2 Total Phosphorous & Nitrogen Concentration for 735m^2 Bio-retention

Total Phosphorous Concentration (mg/L)			Total Nitrogen Concentration (mg/L)		
	PRE - DEVELOPMENT RESIDUAL LOAD	**POST - DEVELOPMENT RESIDUAL LOAD**		**PRE - DEVELOPMENT RESIDUAL LOAD**	**POST - DEVELOPMENT RESIDUAL LOAD**
50th percentile	0.135	0.1	**50th percentile**	1.25	0.6
98th percentile	0.4	0.14	**98th percentile**	2.4	0.6

- The increase in unvegetated hardstand would likely increase the loading in the runoff associated with these parameters. However, the addition of the proposed treatment systems resulting in the removal rates indicated above could potentially reduce the loading to less than the background values.
- The overflow from the treatment system will flow to the depression in the southern section of the site, from where the largest portion will evaporate or seep into the ground. Previous groundwater quality analyses (as discussed in the Groundwater report of this EIS) revealed elevated concentrations of several Chemicals of Potential Concern (CoPC) indicating potential existing contamination. Any seepage from the depression is likely to be of a superior quality compared to the existing background conditions.

Assuming the proposed mitigation measures are adopted - the only discharge from the proposal site to the surrounding receiving hydrological system will be stormwater runoff. Runoff from roads, car-parks and hardstand areas may contain low to medium levels of hydrocarbons, metals, suspended sediments and nutrients resulting from the operation of vehicles and machinery.

When implemented correctly, the mitigations including the SWMP is designed to facilitate a Neutral or Beneficial Effect (NorBE) on water quality, in accordance with the Guidelines for Development in the Drinking Water Catchments (Hunter Valley) (2017).

Additional water quality guidelines exist in the form of a previous surface water monitoring study at the Newcastle Gas Storage Facility site (Coffey, 2013) as well as the ANZECC guidelines (SW lowland rivers trigger values) which provide guidance for concentration limits of common indicator parameters (shown in **Table 8-3**).

Table 8-3 Surface Water concentration limits

	Total Suspended Solids (mg/l)	Total Nitrogen (mg/l)	Total Phosphorous (mg/l)
Locally adopted SW Thresholds	1000	9	0.5
ANZECC NSW lowland rivers trigger values	N/A	0.5	0.05

The ANZECC NSW lowland rivers trigger values serves only as default guideline values. Where available regional guideline trigger values are available, these values should be used instead. Thus, the locally adopted SW thresholds presented by Coffey 2013 are deemed appropriate. The 98th percentile concentration results from the MUSIC water quality assessment model predicts that a 735m^2 bioretention pond would provide total nitrogen and total phosphorous concentrations below these local thresholds (**Table 8-2**). This result is in addition to the more stringent NorBE results which predict discharge from the bioretention pond to be of equal or less concentration compared to the pre-development case.

9 Management plans

A site-specific overarching Soil and Water Management Plan would be prepared prior to commencement of any construction works to guarantee that impacts are minimised. The requirements of the conditions of approval and relevant standards would be incorporated, and this will be expanded to incorporate the management plans listed in **Table 9-1**.

Table 9-1 Environmental safeguards related to direct/prescribed and indirect impacts

Document	Environmental Safeguard	Timing
Soil and Water Management Plan (SWMP)	A Soil and Water Management Plan (SWMP) will be prepared as part of the CEMP and implemented throughout construction. It would include, but not be limited to: ■ Erosion and Sediment Control Plan ■ Stormwater management strategy ■ Dewatering Procedure ■ Acid Sulphate Soil Management Plan	Pre-construction Construction
Erosion and Sediment Control Plan	A site-specific Erosion and Sediment Control Plan would be developed in accordance with the Blue Book. At minimum this would include: ■ Scheduling construction works to avoid wet seasons and heavy rainfall, where possible ■ Incorporating a designated stable vehicle access road and construction phase car park ■ Minimisation of the area of exposed and unstable ground surfaces during construction ■ Undertaking dust suppression ■ Resealing or revegetating surfaces as soon as applicable ■ Locating stockpiles, sediment basins, bunds and vehicle wash-downs away from drainage lines ■ Using geofabric on stockpiles throughout the course of construction ■ Installation of sediment controls including silt fences, sediment traps, contour berms and energy dissipaters ■ Establishing dirty water drains to direct site runoff to a sediment retention basin ■ Sediment basin sizing and location and maintenance regime ■ Procedure for flocculating dirty water and water quality testing requirements ■ Procedure for dewatering and designated discharge point/s ■ Monitoring and inspection requirements	Construction
Dewatering Procedure	A Dewatering Procedure would be developed to instruct: ■ Process for testing whether water meets discharge criteria – Field testing (eg in excavation) – Static testing (holding tanks) ■ Water treatment methods including flocculation and pH adjustment ■ Discharge process and location/s including avoiding erosion or scour	Construction

<table>
<tr><th>Document</th><th>Environmental Safeguard</th><th>Timing</th></tr>
<tr><td rowspan="3"></td><td>Water quality monitoring requirements
Parameters
Criteria
Locations
Frequency
Permits and records required</td><td></td></tr>
<tr><td>Any water which cannot be treated to meet discharge criteria would be removed by sucker truck and transported for offsite disposal at a licenced facility.</td><td>Construction and Operation</td></tr>
<tr><td>Care would also be taken not to dewater shallow groundwater where possible, to prevent oxidation of previously un-oxidised ASS.</td><td>Construction</td></tr>
<tr><td>Acid Sulphate Soil Management Plan (ASSMP)</td><td>An Acid Sulphate Soil Management Plan (ASSMP) would be prepared which would include an emergency protocol where acidic runoff is generated</td><td>Construction</td></tr>
<tr><td>Flood Preparedness Plan</td><td>A Flood Preparedness Plan would be developed based on the PMF event, and would include:
Roles, responsibilities and communication procedures including emergency contacts
Monitoring procedures for rainfall and flood warnings
Site shut-down and flood preparedness procedures to minimise harm to persons, plant and the environment
Actions in the lead up to the flood (such as monitoring water levels, filling excavations, completing erosion and sediment controls, removing hazardous materials and waste from the site, barricading, sealing tanks and containers to prevent overflows, tying down loose items)
Actions at the time of the flood (may include further evacuation, rescue, pollution prevention, spill response, and contingency measures)
Actions post-flood (including clean up and rectification)
Evacuation routes and procedures
Rescue procedures
Procedure for resuming operations
Reporting requirements and corrective actions
During its development, the Flood Preparedness Plan would be discussed with the SES and Council to ensure alignment with community evacuation arrangements.</td><td>Construction and Operation</td></tr>
<tr><td>Spill Response Procedure</td><td>A Spill Response Procedure would be developed including:
Training and PPE
Precautionary measures for handling and storage of chemicals and fuels
Spill response protocols (control, contain, clean up)
Contaminated soils to be disposed of appropriately
All spills to be reported</td><td>Construction and operation</td></tr>
</table>

Document	Environmental Safeguard	Timing
	■ Spill kits to be restocked following use Spill kits to be maintained in appropriate locations in accordance with Australian Standards, including where required inside machinery and vehicles. All vehicles, plant and equipment to be checked regularly for fuel tank and line leaks or failures Bunds and sumps should be regularly inspected, and capacity maintained by regular draining and disposal	
Operational water management plan (OEMP)	The OEMP will include a stormwater capture and management strategy including: ■ Drainage and temporary water storage systems, including separation of clean and dirty/contaminated water ■ Use of GPT (sediment and oil/water separator) and bioretention area ■ Reuse options (e.g. irrigation) ■ Water quality monitoring ■ Clean water discharge location and method ■ Disposal of contaminated water and sewage at a licensed facility	Operation

10 Monitoring requirements

The application of a water quality monitoring program is important in ensuring operational phase mitigation measures are effective, and contamination (fuels, chemicals, gross pollutants etc.) levels within the whole drainage system and discharge locations do not exceed the appropriate trigger values.

A surface water quality monitoring program is recommended as part of the CEMP and OEMP surface water management plans. Monitoring should incorporate preconstruction monitoring of water quality parameters to form a baseline dataset to which the construction and operational monitoring trigger values could be compared against. Where the dataset is insufficient, the concentrations would be compared to limits set out by the *ANZECC Guidelines for Fresh and Marine Water Quality (2000)*.

Preconstruction baseline monitoring data is restricted to collection along Drainage Path 1 and 2. Due to the suspected ephemeral nature of Drainage Path 1, monitoring would be concentrated after periods of increased rainfall.

Construction and operational phase monitoring would be conducted within the primary proposal space and stormwater control facilities (e.g. sediment retention ponds) to satisfy regulatory requirements. The following monitoring locations are recommended for monthly testing and following elevated periods of rainfall:

- Construction phase sediment retention ponds (construction only)
- Wet sump oil and grease separator
- Bio-retention system outflow
- Drainage Path 1 and 2
- LEP Wetlands Drainage Path 1 discharge location

Regular inspection, monitoring and maintenance of erosion and sediment control structures would be undertaken in accordance with the ESCP and Blue Book. In addition, inspections would be undertaken immediately prior to and following heavy rainfall and rectifications made as required.

11 Conclusions

Management measures implemented for construction and operational phases of the proposal would sufficiently mitigate potential hydrological and water quality impacts to receiving waterways to ensure a NorBE result is achieved.

Construction and Operational Environmental Management Plans (CEMP and OEMP) will be developed to outline the environmental risks, mitigations proposed (including avoidance, management and engineering measures), monitoring requirements, contingency planning and responsibility allocation.

A comprehensive Soil and Water Management Plan will be developed. This overarching document will need to include the following focus areas:

- Surface Water Management Plan
- Groundwater Management Plan
- Construction Waste Management Plan (in the CEMP)
- Dewatering Procedure (in the CEMP)
- Acid Sulfate Soil Management Plan
- Spill Containment Plan
- Erosion and Sediment Control Plan

By incorporating relevant treatment mechanisms - an oil and grease separator and a Bioretention System - stormwater runoff is expected to be minimally impacted by the construction and operational activities and can be discharge to the environment.

Ongoing monitoring during construction and operation should be conducted to ensure the expected outcomes are achieved and the management plans are being adhered to.

12 Limitations

This report has been prepared for AGL Energy Limited (the Client). This report has not been prepared for use by parties other than the Client, and the Client's respective consulting advisers and construction contractors.

This report has been prepared based on the scope of services. Aurecon cannot be held responsible to the Client and/or others for any matters outside the agreed scope of services. Other parties should not rely upon this report and should make their own enquiries and obtain independent advice in relation to such matters.

This report has been prepared by Aurecon with reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with the Client. Information reported herein is based on the interpretation of data collected (data, surveys, analyses, designs, plans and other information), which has been accepted in good faith as being accurate and valid.

It should be noted that many investigations are based upon an assessment of potentially contaminating processes which may have occurred historically on the site. This assessment is based upon historical records associated with the site. Such records may be inaccurate, absent or contradictory. In addition, documents may exist which are not readily available for public viewing.

Except where it has been stated in this report, Aurecon has not verified the accuracy or completeness of the data relied upon. Statements, opinions, facts, information, conclusions and/or recommendations made in this report ("conclusions") are based in whole or part on the data obtained, those conclusions are contingent upon the accuracy and completeness of the data. Aurecon cannot be held liable should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Aurecon leading to incorrect conclusions.

The report should not be applied for any purpose other than that originally specified at the time the report was issued.

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Appendix A

Hunter River Water Quality and River Flow Objectives

Table 1a Hunter River water quality objectives for estuary waterways affected by urban development

Protection, Purpose and Application	Indicator	Numerical Criteria (Trigger Values)
Aquatic Ecosystems *Maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term* ■ All natural waterways; ■ Even in areas greatly affected by human use, continuing improvement is needed towards healthier, more diverse aquatic ecosystems; ■ Water quality in artificial watercourses should ideally be adequate to protect native species that use them, as well as being adequate for human uses; ■ At any point where water from the artificial watercourse flows into a natural waterway.	Total Phosphorous	Lowland rivers: 25 µg/L (flowing to the coast)
	Total Nitrogen	Lowland rivers: 350 µg/L (flowing to the coast)
	Chlorophyll-a	Lowland rivers: 5 µg/L
	Turbidity	Lowland rivers: 6–50 NTU
	Salinity (EC)	Lowland rivers: 125–2200 µS/cm
	Dissolved Oxygen	Lowland rivers: 85–110%
	pH	Lowland rivers: 6.5–8.5
	Temperature	See ANZECC 2000 Guidelines, Table 3.3.1
	Chemical Contaminants	See ANZECC 2000 Guidelines, chapter 3.4 and Table 3.4.1
	Biological indicators	Multiple criteria through recognised protocols.
Visual Amenity *Aesthetic qualities of waters* ■ All waters, particularly those used for aquatic recreation and where scenic qualities are important	Visual Clarity and Colour	Natural visual clarity should not be reduced by more than 20%; Natural hue of the water should not be changed by more than 10 points on the Munsell Scale; The natural reflectance of the water should not be changed by more than 50%.
	Surface Films and Debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour; Waters should be free from floating debris and litter.
	Nuisance Organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.

Protection, Purpose and Application	Indicator	Numerical Criteria (Trigger Values)
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 but may not be achievable for some time in some areas - In waterways where communities do not require water quality of a level suited to primary contact recreation, or where primary contact recreation will be possible only in the future	Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median bacterial content in fresh and marine waters of < 230 enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).
	Algae & blue-green algae	< 15 000 cells/mL.
	Nuisance organisms	Use visual amenity guidelines; Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation; Toxic substances should not exceed values in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
	Visual clarity and colour	Use visual amenity guidelines.
	Surface films	Use visual amenity guidelines.
Primary Contact Recreation *Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed* - In the immediate future to waters within and immediately upstream of recognised recreation sites. For many other waters, this is a long-term objective	Turbidity	A 200mm diameter black disc should be able to be sighted horizontally from a distance of more than 1.6 m (approximately 6 NTU).
	Faecal coliforms	Median over bathing season of < 150 faecal coliforms per 100 mL, with 4 out of 5 samples < 600/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
	Enterococci	Median over bathing season of < 35 enterococci per 100 mL (maximum number in any one sample: 60-100 organisms/100 mL).

Protection, Purpose and Application	Indicator	Numerical Criteria (Trigger Values)
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water. (Note, it is not necessary to analyse water for these pathogens unless temperature is greater than 24 degrees Celsius).
	Algae & blue-green algae	< 15 000 cells/mL
	Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	pH	5.0-9.0
	Temperature	15°-35°C for prolonged exposure.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed the concentrations provided in Tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
	Visual clarity and colour	Use visual amenity guidelines.
	Surface films	Use visual amenity guidelines.
Irrigation Water Supply *Protecting the quality of waters applied to crops and pasture* ■ All current and potential areas of irrigated crops, both small- and large-scale ■ Local requirements for irrigation water quality, such as salinity, apply	Algae & blue-green algae	Should not be visible. No more than low algal levels are desired to protect irrigation equipment.
	Salinity (electrical conductivity)	To assess the salinity and sodicity of water for irrigation use, several interactive factors must be considered including irrigation water quality, soil properties, plant salt tolerance, climate, landscape and water and soil management. For more information, refer to Chapter 4.2.4 of ANZECC 2000 Guidelines.
	Thermotolerant coliforms (faecal coliforms)	Trigger values for thermotolerant coliforms in irrigation water used for food and non-food crops are provided in Table 4.2.2 of the ANZECC Guidelines.

Protection, Purpose and Application	Indicator	Numerical Criteria (Trigger Values)
	Heavy metals and metalloids	Long term trigger values (LTV) and short-term trigger values (STV) for heavy metals and metalloids in irrigation water are presented in Table 4.2.10 of the ANZECC 2000 Guidelines
Aquatic Foods *Protecting water quality so that is suitable to produce aquatic foods for human consumption and aquaculture activities* ■ Applies to all waters where aquatic foods are taken for non-commercial and commercial harvesting	Algae & blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	Shellfish guideline: The median faecal coliform concentration should not exceed 14 MPN/100ml; with no more that 10% of the samples exceeding 43 MPN/100 ml. Standard in edible tissue: Fish destined for human consumption should not exceed a limit of 2.3 MPN E Coli / g of flesh with a standard plate count of 100,000 organisms /g.
	Toxicants (as applied to aquaculture activities)	Metals: Copper – less than 5 µg/L; Mercury – less than 1 µg/L; Zinc: less than 5 µg/L. Organochlorides: Chlordane – less than 0.004 µg/L (saltwater production); PCBs – less than 2 µg/L.
	Physico-chemical indicators (as applied to aquaculture activities)	Suspended solids: less than 40 µg/L (freshwater) Temperature: less than 2 °C change over 1 hr.

Table 1b Hunter River - river flow objectives for estuary waterways affected by urban development

Objective	Description	Measures to achieve objectives
Protect pools in dry times *Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows*	During dry times, some streams stop flowing and form pools. Pools and wetlands are refuges for aquatic plants and animals. Pumping water from these areas can make it more difficult for many species to recover after a drought.	■ 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 low flows*	Water extraction and storage are high in dry times and impose long artificial droughts that increase the stress on aquatic plants and animals.	■ 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 50-70% 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. ■ In streams with little water use or important conservation values, minimise risks to ecosystems during low flows. ■ Review management of town water supplies to assess whether changes may help achieve the objective without significantly affecting reliability.

Objective	Description	Measures to achieve objectives
Protect important rises in water levels *Protect or restore a proportion of moderate flows ('freshes') and high flows*	Rain causes peaks in river flows. This 'pulsing' of flows may trigger migration of animals and reproduction of plants and animals; provide over-bank flows to wetlands and floodplains; shape the river channel; control water quality and nutrients; and provide necessary freshwater inputs to estuaries. Water storage and extraction can alter or remove freshes, inhibiting these vital processes. The height, duration, season and frequency of higher flows are all important.	■ 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 30-50% of moderate to high flows (i.e. 30-50% 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*	Floodplain and wetland ecosystems develop in response to the flow patterns and the nature of the landscape between the river and wetlands or floodplains. Floodplain works can change the flooding patterns, which will lead to changes in habitat and vegetation. These changes can be expected to reduce or change (or both) the diversity and abundance of species in the ecosystem. In particular, they can lead to reduced numbers of native fish and to water quality problems	In management plans and actions for waterways, 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 Flooding patterns should not be altered without proper environment assessment
Mimic natural drying in temporary waterways Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways	In urban areas, the preponderance of hard-surfacing (e.g. paved or concreted areas) and garden-watering can cause streams and wetlands to be 'wetter' than natural. In streams and wetlands that would dry out naturally if these impacts were absent, this can create problems in maintaining habitat and vegetation, nutrient cycling, and signals for breeding. It can also lead to a high-water table and associated salinity problems. Natural wetting and drying cycles produce diversity of habitat and, therefore, high species diversity.	Identify any streams where unnatural flows have greatly reduced drying periods. Assess potential short-and long-term environmental, economic and social effects of this change and of possible management alternatives. Decide what, if any, action is appropriate to implement this objective in streams and wetlands on a case-by-case basis, after giving due consideration to local views.
Maintain natural flow variability *Maintain or mimic natural flow variability in all streams*	Australia's rainfall and river flows are naturally variable. The way that we currently store and divert river water can reduce natural pulsing of water down rivers and maintain artificially high or stable river heights. In urban areas and other places where the ability of the land to absorb or detain rainfall is reduced, more water runs off rapidly, so water levels will rise higher. These changes often create problems with streambank stability, biodiversity and signals for breeding and migration	Identify streams with unnatural flow variability and develop appropriate actions to mimic natural variability. Identify streams or development proposals with potential to have or cause flow variability problems and take early action.

Objective	Description	Measures to achieve objectives
Maintain natural rates of change in water levels *Maintain rates of rise and fall of river heights within natural bounds*	Water levels may rise too quickly in urban areas, with risk to people and aquatic plants and animals. If water levels fall too fast, water does not drain properly from riverbanks and they may collapse. Migration of aquatic animals may also be restricted by such sudden falls in river height.	Identify locations where water levels often rise or fall faster than they would naturally. Identify the reasons (in urban areas, usually the result of increased hard-surfacing) and impacts. Remedial action requires case-by-case assessment. Identify potential problems and take early action
Manage groundwater for ecosystems *Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems*	Some shallow groundwaters are directly linked to flows in streams and wetlands. They may provide base flows in rivers during dry periods and they may be primary sources of water for floodplain and riparian vegetation. Also, seriously depleting groundwater in dry times may lead to unnatural recharge of groundwater from surface waters during the next flow event. Lowering groundwater levels in many coastal areas may expose acid sulfate soils.	Implement the State Groundwater Policy (DLWC 1997a, 1998b). Identify any streams or ecosystems that may depend on high groundwater levels and assess whether impacts on these may be caused by changed recharge rates or excessive pumping or drainage. Identify areas where groundwater may be rising and likely to threaten ecosystems or surface water quality. Determine appropriate action to keep groundwater level changes within acceptable bounds.
Minimise effects of weirs and other structures *Minimise the impact of instream structures*	Most instream structures (e.g. weirs) convert flowing water to still water, thus altering habitat and increasing risks of algal blooms or other water quality problems. Barriers prevent passage of plant propagules (e.g. seeds) and animals.	Implement the NSW Weirs Policy (DLWC 1997b). Identify and take action to minimise the impact on native plants and animals of other structures (e.g. floodgates, tidal barriers, culverts) that impede movement of water.
Maintain or rehabilitate estuarine processes and habitats	Coastal lagoons, estuaries and river mouths often change naturally in response to storms and tides. Flood mitigation structures, weirs and other works also affect estuaries by limiting tidal flow, changing salinity conditions or altering water levels. Development of estuarine areas can also disturb acid sulfate deposits, which may release large amounts of sulfuric acid and toxic metals into the estuarine environment. Upstream management of rivers also affects estuaries and lagoons. Stormwater carries nutrients, organic matter and sediments. Scouring because of flooding can affect the opening and closing of river mouths. Reduced freshes and flooding in estuaries severely depletes food sources for estuarine species. These effects can contribute to the decline in the number and abundance of species that use estuaries as habitat, nursery grounds or both.	Dredging beyond the minimum needed to maintain navigation channels should be subject to environmental assessment before proceeding. Minimise draining or disturbance of potential acid sulfate soils. Ensure water-based activities have minimal impact on fish habitat. Tidal wetlands should continue to receive tidal flushing; minimise the impact of flood levees and gates, roads and other barriers. Other processes potentially affecting estuary health should be addressed such as the impact of increasing urbanisation.

Appendix B
EIS Flood Modelling Report

Newcastle Power Station

Flood Modelling Report

AGL Australia

Reference: 503269

Revision: 2

6/09/2019

aurecon

Bringing ideas to life

Contents

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Executive Summary

Aurecon Australia Pty Ltd (Aurecon) has been engaged by AGL Energy Limited (AGL) to undertake an Environmental Impact Statement (EIS) for a proposed dual fuel power station, gas pipelines, electricity transmission line, and associated infrastructure in Tomago, NSW (the Proposal). To inform the EIS, Aurecon has undertaken flood modelling and prepared this flood assessment report.

An existing hydraulic model of the lower extent of the Hunter River catchment was developed for Port Stephens Council by a specialist engineering firm. This model was adapted and used in the Aurecon flood assessment of the Proposal. The flood assessment has modelled a range of events from frequent to extreme to determine:

- Flooding impacts of the Proposal
- Hydraulic classification of the site
- Design building platform level of the proposed power station site
- Evacuation routes for a range of events
- Alignment of this study in response to a series of NSW guidelines including Floodplain Development Manual, Floodplain Risk Management Guidelines, and Standard Secretary's Environmental Assessment Requirements (SEARs)

The Proposal area is located on a topographic high point beside the Hunter River, and the proposed power station site is predominantly located above the flood planning level. This means the built surface of the power station infrastructure would be above the flood level and would, therefore, remain free from inundation. The power station is considered to have good flood immunity. Flood modelling determined that the entire Proposal area would be immune from flooding impacts during the 10% Annual Exceedance Probability (AEP) flood, and the development of the power station, which would be the most significant ground-level development as part of the Proposal, would not be impacted by the design flood events including the Probable Maximum Flood (PMF). The Proposal would therefore not have any effect on the pattern of flood flows or on flood levels.

The proposed gas pipeline route between the NPS and the NGSF crosses both high hazard floodway and high hazard flood storage areas which would be partially affected by the 1% AEP event and the PMF. The proposed electrical transmission line crosses some minimal risk flood prone land but is not expected to be impacted by the design flood events. The associated infrastructure (pipelines and transmission lines) would be predominantly above or below ground with minimal features in the floodway or flood storage area. Flooding may cause a temporary loss of access for construction or maintenance activities, and inundation of the gas pipeline route until flood waters subside and drain away. Flooding is not expected to have any impact on above or below ground infrastructure associated with the Proposal.

The modelling has identified that there is no effect from the proposed development on the existing flood behaviour, and nor would the development be impacted by these flood events. As the development would not impact on local flood behaviour, or impede access to existing road networks, the development is not expected to have any impacts on existing community emergency management arrangements for flooding.

Access roads into the site would be affected by several of the design flood events, and evacuation routes would need to be considered. The safest and most direct evacuation route would be to exit the site by turning left onto Old Punt Road and then right onto the Pacific Highway, however, for events above the 10% AEP, all potential evacuation routes appear to be inundated, and early evacuation of the site would be required in accordance with Government flood warnings. A Flood Preparedness Plan should be prepared for the Proposal based on the probable maximum flood design event

The assessment has considered the relevant provisions of the NSW Floodplain Development Manual and the Floodplain Risk Management Guidelines and has addressed the requirements of the SEARs and Agency Comments.

1 Introduction

1.1 Study Background

As part of an Environmental Impact Statement (EIS) being prepared for AGL Energy Limited (AGL), Aurecon Australasia Pty Ltd (Aurecon) has undertaken a flooding assessment to determine the flood impacts of a proposed dual fuel power station, gas pipelines, electricity transmission line, and associated infrastructure in Tomago, NSW (the Proposal). An existing hydraulic model developed for Port Stephens Council (Council) by a specialist engineering firm was adapted and used in the Aurecon flooding assessment to evaluate inundation levels at the proposed development, the surrounding area and along proposed access routes for a series of design flood events, including:

- 10% Annual Exceedance Probability (AEP)
- 1% AEP
- Probable Maximum Flood (PMF)
- 1% AEP with Climate Change Scenario

Assessing up to and including the PMF event enables changes in the nature and consequences of flooding to be assessed as flood severity increases (DIPNR, 2005).

The process for this flooding assessment is outlined in the following diagram (Figure 1) and is in accordance with the NSW Floodplain Development Manual.

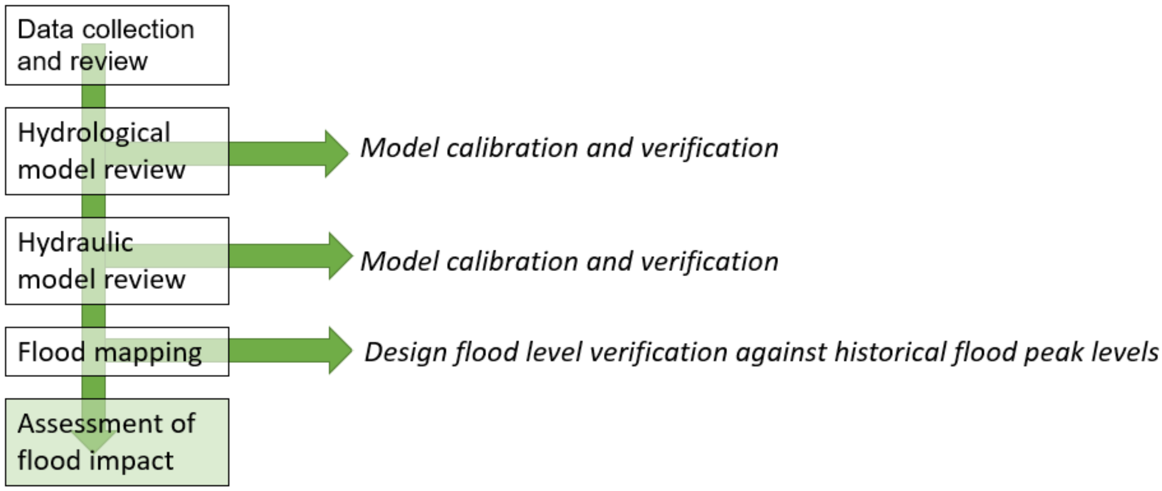

Figure 1 Assessment process

1.2 Report Terminology

Design floods are defined according to their likelihood of occurring in any given year. In the revised 2019 edition of the Australian Rainfall and Runoff Guidelines, published by Geoscience Australia, the design events are defined by a frequency descriptor, AEP and Annual Recurrence Interval (ARI) (Table 1). The new and preferred terminology is AEP, and this has been adopted for this report.

Table 1 Frequency Descriptors

Frequency Descriptor	Annual Exceedance Probability (%)	Annual Recurrence Interval	Description
Frequent/ Rare	10%	10	There is a 1 in 10 chance of this design event occurring in any one year
Rare/ Very Rare	1%	100	There is a 1 in 100 chance of this design event occurring in any one year
Extreme	PMP/ PMF	N/A	PMP - the greatest depth of precipitation for a given duration that is physically possible over a given catchment size storm area at a particular location at a certain time of year. PMF - is a hypothetical flood estimate relevant to a specific catchment whose magnitude is such that there is negligible chance of it being exceeded.

(Ball et al., 2019)

1.3 Study Area

The Proposal area includes the power station site as well as corridors for gas pipelines to supply the proposed power station with gas from the eastern Australia gas transmission pipeline via the Jemena network and, as an option, from the Newcastle Gas Storage Facility (NGSF); and a new electricity transmission line to transfer the electricity produced to the national electricity network via connection to the existing TransGrid Tomago 132kV switching station (Figure 2).

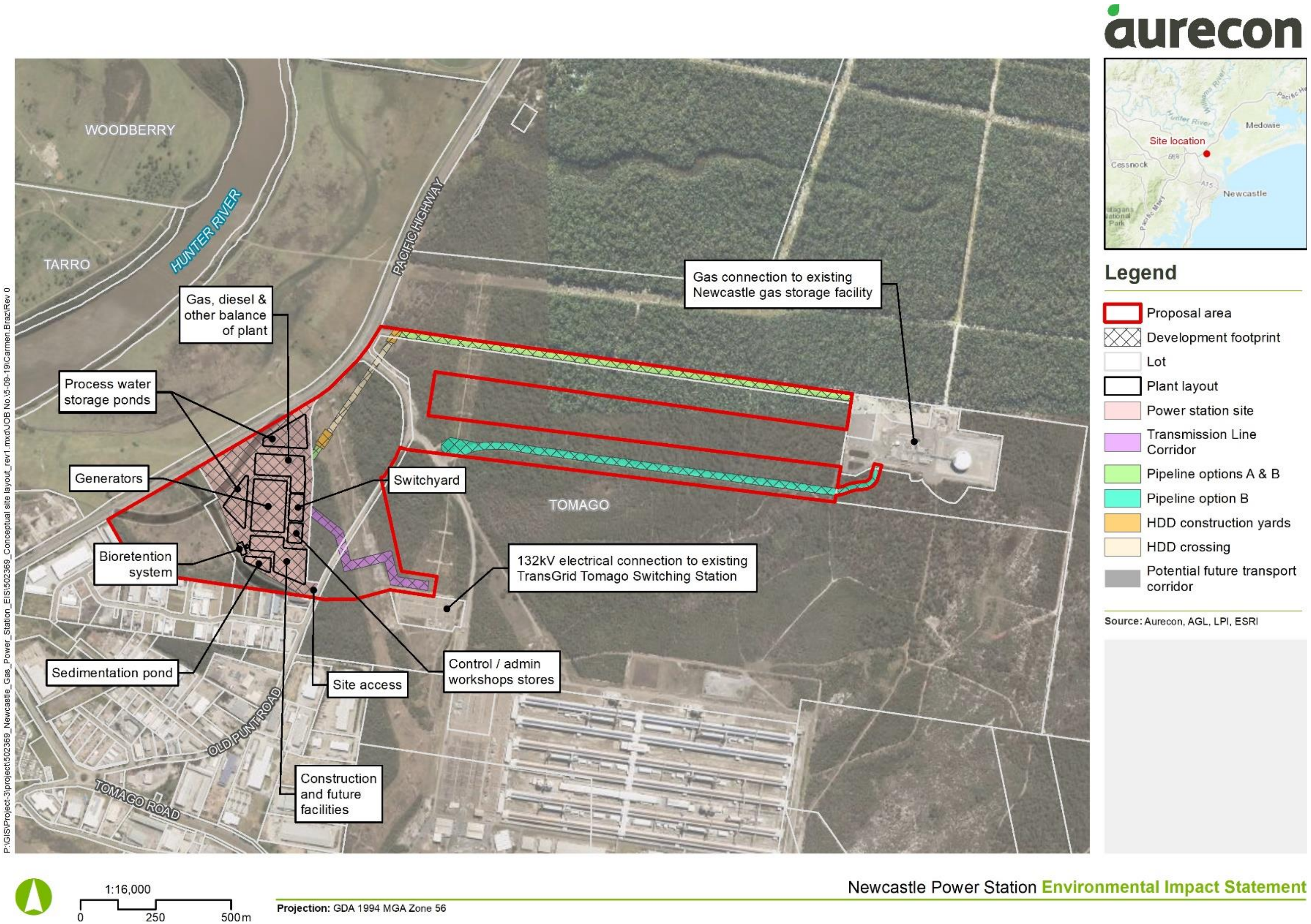

Figure 2 Conceptual site layout

The proposed power station would be located on Lot 3 DP1043561, which is near the intersection of the Pacific Highway and Old Punt Road, as shown in Figure 3**Error! Reference source not found.**. The proposed electrical transmission lines and gas pipelines would extend east into Lot 4 DP 1043561, Lot 202 DP 1173564 and part of Lots 1201, 1202 and 1203 DP1229590.

The Proposal area is located within the Hunter River Catchment (Figure 4). This catchment is one of the largest catchments in the coastal areas of NSW with an area of more than 21,000 km^2 and discharges through the Newcastle Port into the sea (BMT WBM, 2017). The upper reaches of the catchment are rural whilst the other areas of the catchment consist of mining, industrial and urban developments. The Proposal area is surrounded by industrial developments. The Hunter River lies approximately 700 metres north of the proposed power station site, and a tributary to the river is located approximately 150 metres north-west of the western boundary of the Proposal area. The Proposal area is located on a topographic high point beside the Hunter River, divided by a central ridge with an average elevation of 15 m AHD, sloping to around 6-7 m with a low point of 4 m AHD. The power station would be developed on land which is 7.2m AHD or higher.

Flooding in the Proposal area could occur due to either the Hunter River overtopping its banks and levees, tidal inundation, or by excessive rainfall over the local catchment or any combination of these mechanisms (BMT WBM, 2017). To date, the principal flooding mechanism in the lower Hunter River catchment has been major flooding of the Hunter River. The historical peak flood level for the Hunter River at the Hexham Bridge is 4.00 m AHD in 1955, which was a major river flood and the largest flood on record in the Hunter River. Flood behaviour varies across the catchment in response to topographical features and flooding mechanisms such as high road banks and levees which have been installed. The proposed power station site is predominantly located above the flood planning level, with the southern extent bordering minimal risk flood prone land. The proposed gas pipeline route between the NPS and the NGSF crosses both high hazard floodway and high hazard flood storage areas (refer to Figure 5).

1.4 Study Objectives and Requirements

The objective of this assessment is to complete an impact assessment of the proposed project features relative to potential flooding levels for the site based on a series of guidelines and requirements including:

- Floodplain Development Manual, Department of Infrastructure, Planning and Natural Resources, New South Wales Government, 2005 (DIPNR, 2005)
- Project specific Secretary's Environmental Assessment Requirements (SEARs) and Agency Comments, received February 2019 (DPE, 2019)
- Floodplain Risk Management Guide, Office of Environment and Heritage, New South Wales Government, 2019 (OEH, 2019)
- Australian Rainfall and Runoff, Geoscience Australia, 2019 (Ball et al., 2019)

The proposal has been declared critical State Significant Infrastructure (CSSI), due to the economic, environmental and social aspects that are essential to NSW. The EIS, and supporting technical studies, have been prepared to fulfil the requirements of the SEARs and Agency comments received. The requirements related to flooding, and where these have been addressed in this assessment, are detailed in Table 2.

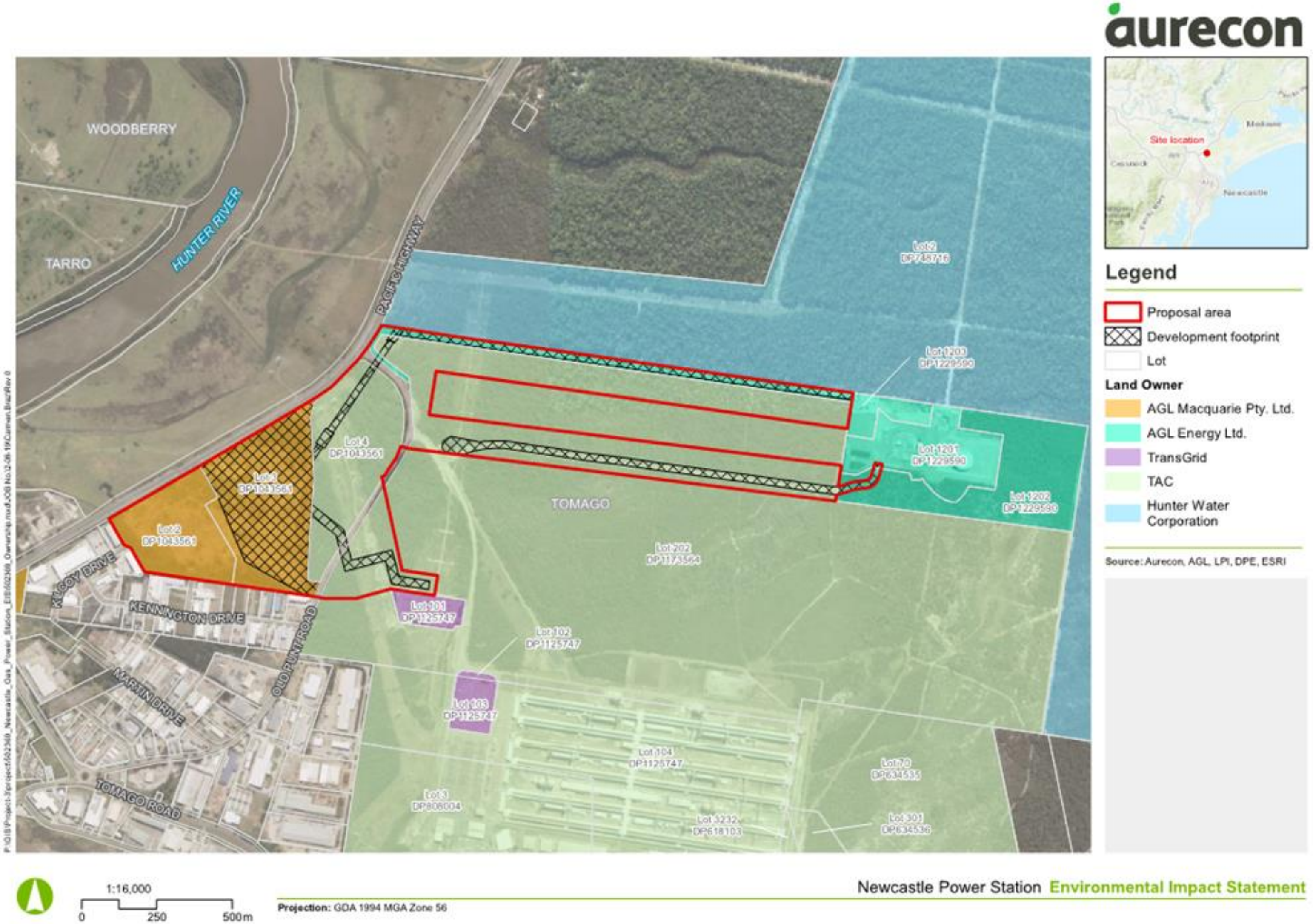

Figure 3 Proposal area and Lot boundaries

Figure 4 Lower Hunter River catchment and Newcastle Port

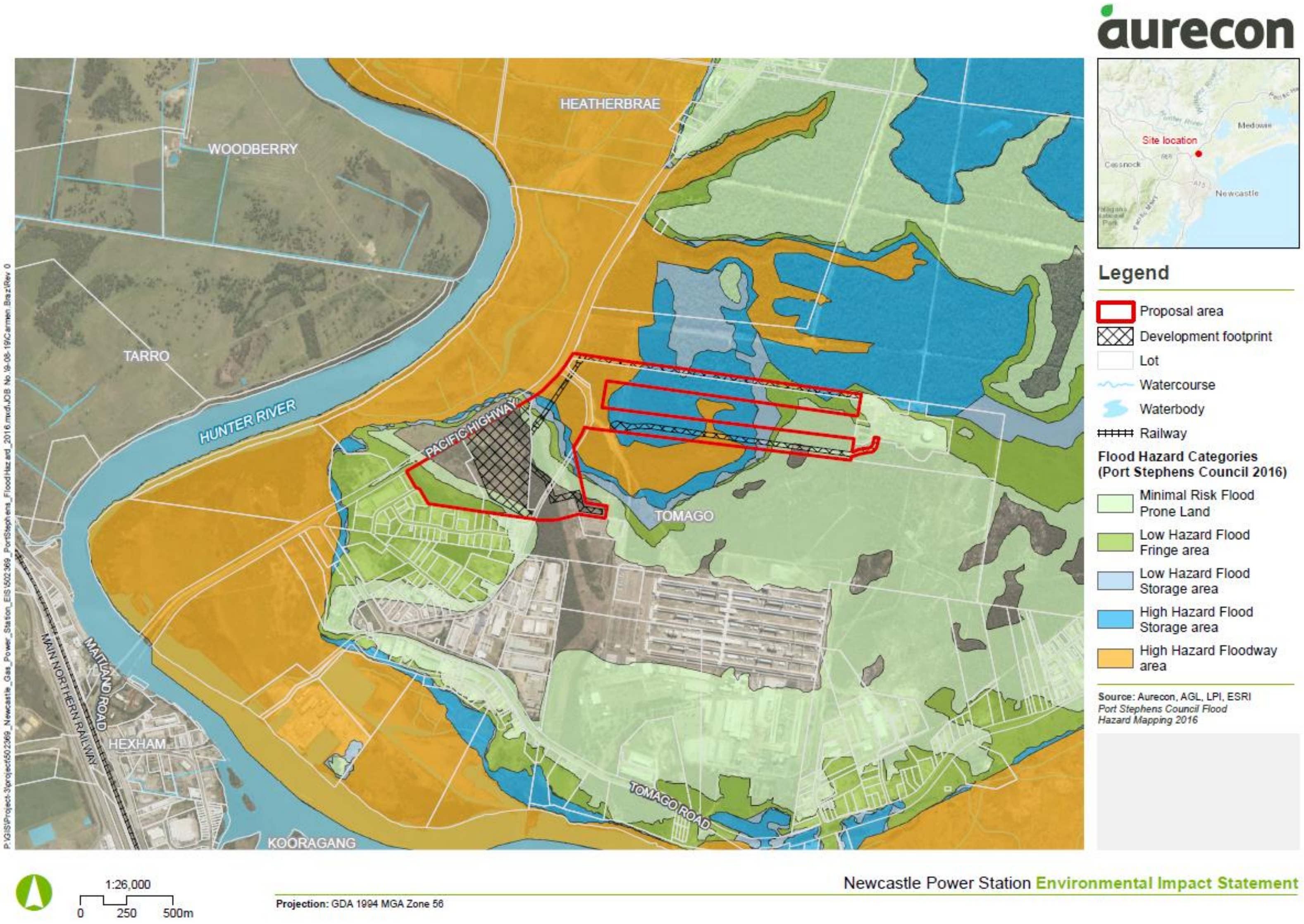

Figure 5 Proposal area in the context of Council flood hazard mapping

This study is a desktop flooding assessment using a hydraulic model and a series of design flood events to consider the flood immunity of the Proposal. The hydraulic model has been used to determine whether the site is within flood prone land and whether the Proposal, particularly the power station which would be the most significant ground-level development, would cause impacts on any of the following, in accordance with the OEH standard environmental assessment requirements:

- Existing flooding conditions
- Other properties, assets or infrastructure
- Land use and existing ground conditions
- Evacuation routes

From the assessment of impacts, the building platform level for the power station to ensure immunity in a range of flooding events and evacuation routes from the site can be determined.

Table 2 SEARs and Agency Comments

SEARs and Agency Comments	Where and how addressed in this report
Planning Secretary's Environmental Assessment Requirements **Key Issues – Water** – including: - An assessment of the flood impacts of the project	This report provides an assessment of the flood impacts of the project.
Office of Environment and Heritage (OEH) Standard Environmental Assessment Requirements **Flooding and coastal erosion** 13) The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 (NSW Government 2005) including: a. Flood prone land. b. Flood planning area, the area below the flood planning level. c. Hydraulic categorisation (floodways and flood storage areas).	Section 1.3 describes existing flooding behaviour in the study area, and Figure 5 identifies the flood prone land and flood planning area based on PSC's Flood Hazard Maps. The proposed development is located outside the flood planning area. Section 5 and Figures 5 to 8 identify the potential flooding based on design events, including the 1% AEP, which is the principle flood planning event. Sections 1.3, 5.1 and 6 identify that the site is not flood liable land, and therefore does not have a hydraulic categorisation. The nearest hydraulic categorisation to the site is flood fringe.
14) The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event.	Section 5.1 describes the flood assessment and modelling results of the 1 in 10 year, 1 in 100 year, 1 in 100 year with Climate Change and PMF.

<table>
<tr><th>SEARs and Agency Comments</th><th>Where and how addressed in this report</th></tr>
<tr><td>15) The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios:

a. Current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.</td><td>Section 5.1 assesses a range of design events including a 1 in 100 year with Climate Change design event and the PMF design event. The PMF scenario is worse than a 1 in 200 or 1 in 500 year flood. These scenarios are, therefore, sufficient to assess sensitivity to increased rainfall intensity due to climate change.

Afflux was also assessed to be near negligible, showing the development would not discernibly alter the existing flooding patterns. The modelling has identified that there is no effect from the proposed development on the existing flood behaviour, and nor would the development be impacted by these flood events.</td></tr>
<tr><td>16) Modelling in the EIS must consider and document:

a. The impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood.

b. Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories.

c. Relevant provisions of the NSW Floodplain Development Manual 2005.</td><td>Section 5.1 describes the flood modelling undertaken, and the modelling results are included here and in Section 6. This assessment has found that there is:

a) No impact on existing flood behaviour for a range of design flood events including, 1 in 10 year, 1 in 100 year, 1 in 100 year with climate change and PMF

b) No impacts on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land

c) This assessment has:

▪ Reviewed the relevant flood studies and Council guidelines, which have been prepared in accordance with the NSW Floodplain Development Manual

▪ Undertaken a flood assessment in accordance with the Floodplain Risk Management Process described in the NSW Floodplain Development Manual

▪ Provided ground level information and assessed potential flood impacts from a series of design flood events

▪ Considered the proposed development including access and emergency evacuation in light of floodplain risk management

The assessment has therefore considered the relevant provisions of the NSW Floodplain Development Manual.</td></tr>
</table>

SEARs and Agency Comments	Where and how addressed in this report
17) The EIS must assess the impacts on the proposed development on flood behaviour, including: a. Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure. b. Consistency with Council floodplain risk management plans. c. Compatibility with the flood hazard of the land. d. Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land. e. Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site. f. Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses. g. Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the State Emergency Services (SES) and Council. h. Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council. i. Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES. j. Any impacts the development may have on the social and economic costs to the community as consequence of flooding.	Sections 5 and 6 of this assessment identify that: a) The proposal would not cause increases in flood affectation of other properties, assets and infrastructure. b) The proposal and this assessment are consistent with Port Stephens Floodplain Risk Management Plan, which is consistent with the NSW Floodplain Development Manual. c) No impact on the flood hazard of the land. The proposed power station site is outside of the flood hazard mapping area. d) No impact on the hydraulic functions of flow conveyance or flood storage e) No effect to beneficial inundation of the floodplain environment. f) No impact to existing ground conditions, banks or water courses. g) No impact to the existing community emergency management arrangements. h) The proposal does not create any risk to life from flood, which requires specific management measures. i) Site evacuation routes have been recommended based on the flood assessment. j) No impacts on social and economic costs to the community as a consequence of flooding.

2 Study Data

2.1 Previous Studies and Survey Data

The Williamtown-Salt Ash Flood Study, which has been relied on to inform this Aurecon flood study, was prepared by the engineering consultancy, BMT WBM Pty Ltd (BMT WBM) for Port Stephens Council in 2005. The purpose of the study was to determine the flood behaviour in the Williamtown-

Salt Ash area in the lower Hunter River and establish the basis for subsequent floodplain management activities in the catchment.

As part of the Williamtown-Salt Ash Flood Study, a hydrological model was developed using XP-RAFTS software and a hydraulic model was developed using TUFLOW software to simulate flood behaviour in the catchment. The hydraulic model combined survey data including aerial LiDAR Survey, bathymetric and photogrammetry, and incorporates road, rail, embankments and levee data into the model to present significant features in the area.

A further review of this flood study was undertaken in 2012 by BMT WBM, which assessed the impacts of climate change on the previously determined flood levels in the study area. Topographic data for the catchment (originally photogrammetry data) was updated in the TUFLOW model to aerial LiDAR Survey (ALS) data set obtained from NSW Department of Planning in 2007.

As part of ongoing studies in the Lower Hunter, BMT WBM reviewed the Flood Frequency Analysis (FFA) of the hydraulic model in 2012 and therefore the flood flows were updated. Of significance, the flood level of 4.8m AHD for the 1% AEP, the principle flood planning event, was consistent between the analyses.

The model was refined again in 2017 by BMT WBM as part of the Williamtown-Salt Ash Floodplain Risk Management Study and Plan with 2013 LiDAR data set acquired by NSW Land and Property Information. The 2013 LiDAR data provided the best representation of development conditions in the floodplain and incorporated modified landforms for major developments which had been completed in recent years. This includes the major industrial WesTrac facility in Tomago which required filling of the flood plain to provide flood immunity.

3 Model Development

3.1 Hydrologic Model

Aurecon has adopted the TUFLOW model originally prepared for the Williamtown-Salt Ash Flood Study, updated most recently in 2017, which was retrieved from the NSW Flood Data Portal (OEH and SES, 2019). Both the hydrologic and hydraulic models used in the study had been calibrated and verified to available historical flood event data confirming that the models could predict real flood events with accuracy (BMT WBM, 2019).

Through the investigation of the hydraulic model it has been determined that a combination of hydrographs and XP- RAFTS outputs built the hydrologic inputs for the hydraulic model. The design flood hydrology adopted for this study is based upon techniques and data recommended in Australian Rainfall and Runoff (Institution of Engineers Australia, 1987).

This hydrologic information has been adopted as Port Stephens Council relies upon this model to assess development applications. Updates to Australian Rainfall and Runoff (Geoscience Australia, 2019) have not been considered as part of this assessment as a consequence. The range of design flood events that have been considered provides sufficient sensitivity for possible alternate design flood levels.

3.2 Hydraulic Model

3.3 Software Platform and Modelling Approach

The TUFLOW model adopted for this assessment is a 2-dimensional (2D) hydraulic model. Aurecon updated the model from TUFLOW's Classic to Heavily Parallelised Compute (HPC) version, to accelerate simulation times. Some of the Classic TUFLOW functionalities were also updated for HPC, in a way that TUFLOW HPC would be able to appropriately and accurately produce results. The results produced were compared to the Classic version of results and were found to produce a similar result, particularly within the area of interest.

The model covers the lower extent of the Hunter River catchment. The entirety of the model is represented in a 2D domain whilst culvert structures are represented by 1D elements. The model is simulated on a cell size of 20m. The TUFLOW software build which is being used to simulate the 2D model is version 2018-03-AD, single precision.

3.3.1 Modelling Extents

The hydraulic model extent covers an area from Walls End in the south to Anna Bay in the north-east and upstream to Kings Hill, which is approximately 412 km². The model does not include most of the coastline and is presented in Figure 6.

3.3.2 Topography

Due to a large model boundary, a 20 m cell size is deemed appropriate to represent the floodplain and estuary accurately, this also allows practical simulation times. The updated 2013 ALS data provides a base for topographic information in the model. Adjustments to the topography have been made by BMT WBM to represent features such as railways, roads, embankments and levees using modification files created.

3.3.3 Roughness

The provided model uses six roughness values (Manning's n) within the hydraulic model. These are defined in Table 3 and visually represented in Figure 6 as material types.

Table 3 Land Use Roughness Values

Land use type	Manning's n
Default floodplain	0.035
Dense forest and mangroves	0.150
River channel	0.020
Urbanised areas	0.060
Large buildings	2.000
Estuarine channel	0.015

The adopted Manning's n value for the proposed power station site is 0.060, as the plant will contain both pervious and impervious areas, making 'urbanised areas' the closest land use type. These values are within expected values that are typical for flood impact assessments.

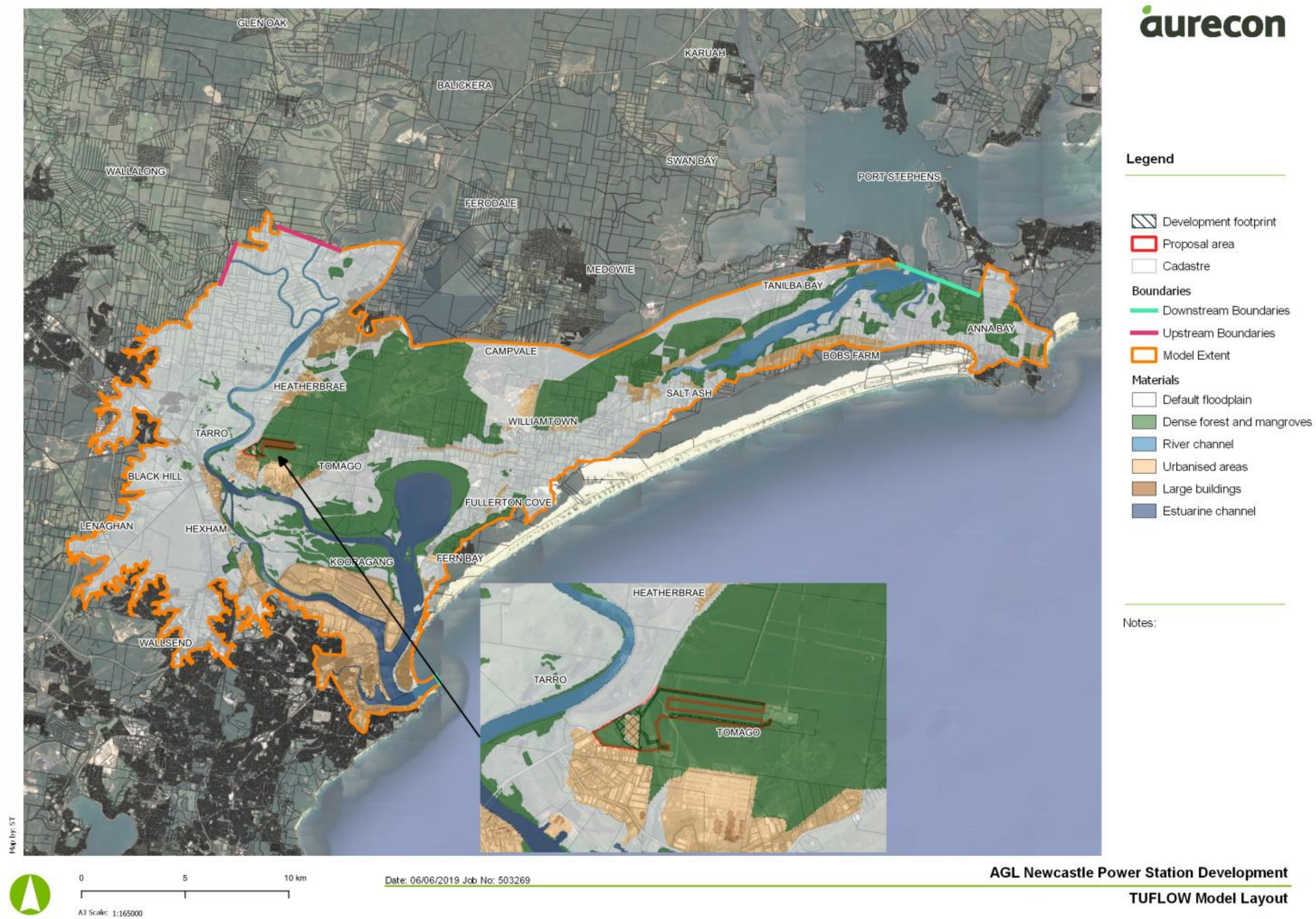

Figure 6 Hydraulic model extent

3.3.4 Hydraulic Structures

Within the adopted model hydraulic structures have been represented in 1D and 2D elements. The bridges are modelled as a 2D layer flow constriction which applies a series of loss values and dimensions to the structure. Whereas culvert structures are represented by 1D network connect to an upstream boundary and downstream boundary. These boundaries connect the 1D domain to the 2D. A series of attributes including invert levels, structure type, blockage and loss factors are applied according to TUFLOW's recommendations.

3.3.5 Boundary Conditions

The provided XP- RAFTS model outputs and hydrographs from the adopted model from BMT WBM were applied as inflows into the TUFLOW model. A series of inflows and outflows are part of this TUFLOW model and can be seen in Figure 6. Inflows are represented by a flow vs time (QT) boundary, whereas outflows are using a water surface level vs time (HT boundary). An HT boundary has been used at the downstream outflows as the tailwater conditions needed to represent the fluctuation of the sea level.

3.4 Assumptions

It has been assumed that:

- The predeveloped model remains representative of the hydrologic risk and current development conditions of the floodplain
- The proposal is CSSI and that the building platform level of the site will need to be higher than the 1% AEP plus free board (typically between 0.6m – 0.9m)
- Predetermined hydrology provided with the existing model for Climate Change has adopted a 20% increase in flows and 0.9m in sea level rise
- The manning roughness for the proposed power station development is 0.06
- The design footprint and conceptual site layout has been based on provided plans for the site
- The plant is designed to be constructed by cut/ fill.

4 Design Events

4.1 Design Events

A series of design events have been chosen to assess the potential flooding at the Proposal area to address the SEARs requirements. These include the 10% AEP, 1% AEP, PMF and 1% AEP with Climate Change Scenario (Table 4). These range of events have been identified to assess whether the development of the Proposal would be affected by this range of flood events and whether the development itself would impact on the existing flooding conditions in the vicinity of the proposed new infrastructure. The proposed power station is the focus of this assessment, as it is the most significant ground-level development and would require site levelling and construction of impermeable surfaces. The gas pipelines and electricity transmission lines would predominantly be located above or below ground with minimal features in the floodway or flood storage area.

Table 4 Design Events

Design Event	Approximate Inflows (m^3/s)
10% AEP	2,800
1% AEP	9,400
1% + Climate Change	11,300
PMF	28,300

4.2 Climate Change

The climate change scenario suggested by NSW Floodplain Management Guidelines identifies planning horizons of 2050 and 2100 (Department of Infrastructure, 2005). These guidelines combined with Australian Rainfall and Runoff 2019 Climate Change predictions determine the inputs into climate change design floods. These are described below:

- Rainfall Intensity-Frequency-Duration (IFD) relationships
- Rainfall temporal patterns
- Continuous rainfall sequences
- Antecedent conditions and baseflow regimes
- Compound extremes (e.g. riverine flooding combined with storm surge inundation)

(Geoscience Australia, 2019)

As the Hunter Catchment discharges through the Newcastle Port into the sea, Sea Level Rise (SLR) will need to be factored into the climate change assessment and combined with an increase in design rainfall intensities. The potential for future sea level rise is expected to be the largest driver of floodplain management around coastal and estuarine systems, including the Hunter Estuary and Port Stephens (BMT WBM, 2017). The following 1% AEP with Climate Change Scenarios were provided with the model from BMT WBM in Table 5.

Table 5 Planning Horizons

Planning Horizon	Sea Level Rise (SLR)	Increase in Flows
2050	0.4 m	0%
2050	0.4 m	10%
2050	0.4 m	20%
2100	0.9 m	0%
2100	0.9 m	20%
2100	0.9 m	30%

The scenario deemed appropriate would be the planning horizon, 2100, with a SLR of 0.9m and a 20% increase in flows. The upper limit of 0.9m is suggested by the NSW Flood Risk Management Guideline as this is the expected increase on the NSW coast. Within these guidelines it is also noted that throughout catchments within NSW the average increase in extreme rainfall by 2070 is 15%. However, due to the planning horizon being 2100, a 20% increase in rainfall has been implemented.

5 Modelling Results

5.1 Design Events

The proposed power station site is approximately located above 7.2m AHD and is above the Council flood planning area, but near the floodplain due to the proximity to the Hunter River (Figure 5). The proposed power station would also be situated above the flood level for all design events (Figures 7 to 10), based on the existing topography. During the 10% AEP, 1% AEP and 1% AEP with Climate Change Scenario events, the proposed power station site would remain above the flood extent and would therefore not experience any flood impacts. However, the PMF inundation extent reaches to the northern and southern boundaries of the proposed development, as seen in Figure 10. The predicted inundation impacts are based on a conceptual site layout and the features which would be impacted are the edge of the proposed process water storage pond (northern feature) and the edge of the proposed construction and future facilities (southern feature). The power station and its component features would be designed and engineered such that the development would be built outside of the PMF inundation extent.

The potential inundation from the PMF is considered insignificant as velocities and water surface level do not change because of the presence of the proposed building platform for the power station site, as shown by the afflux results in Figure 11 (i.e., the built surface of the power station infrastructure would be above the flood level and would, therefore, remain dry). Afflux is the difference in flood levels where the existing results are subtracted from the design results. The proposed power station is therefore considered to have good flood immunity. Associated infrastructure that forms part of the Proposal, including the gas pipeline easements, would be partially affected by the 1% AEP event, 1% AEP with climate change and the PMF (Figures 8, 9 and 10). This may cause a temporary loss of access for construction or maintenance activities, and inundation of the pipeline route until flood waters subside and drain away, however, this flooding is not expected to have any impact on above or below ground infrastructure associated with the Proposal.

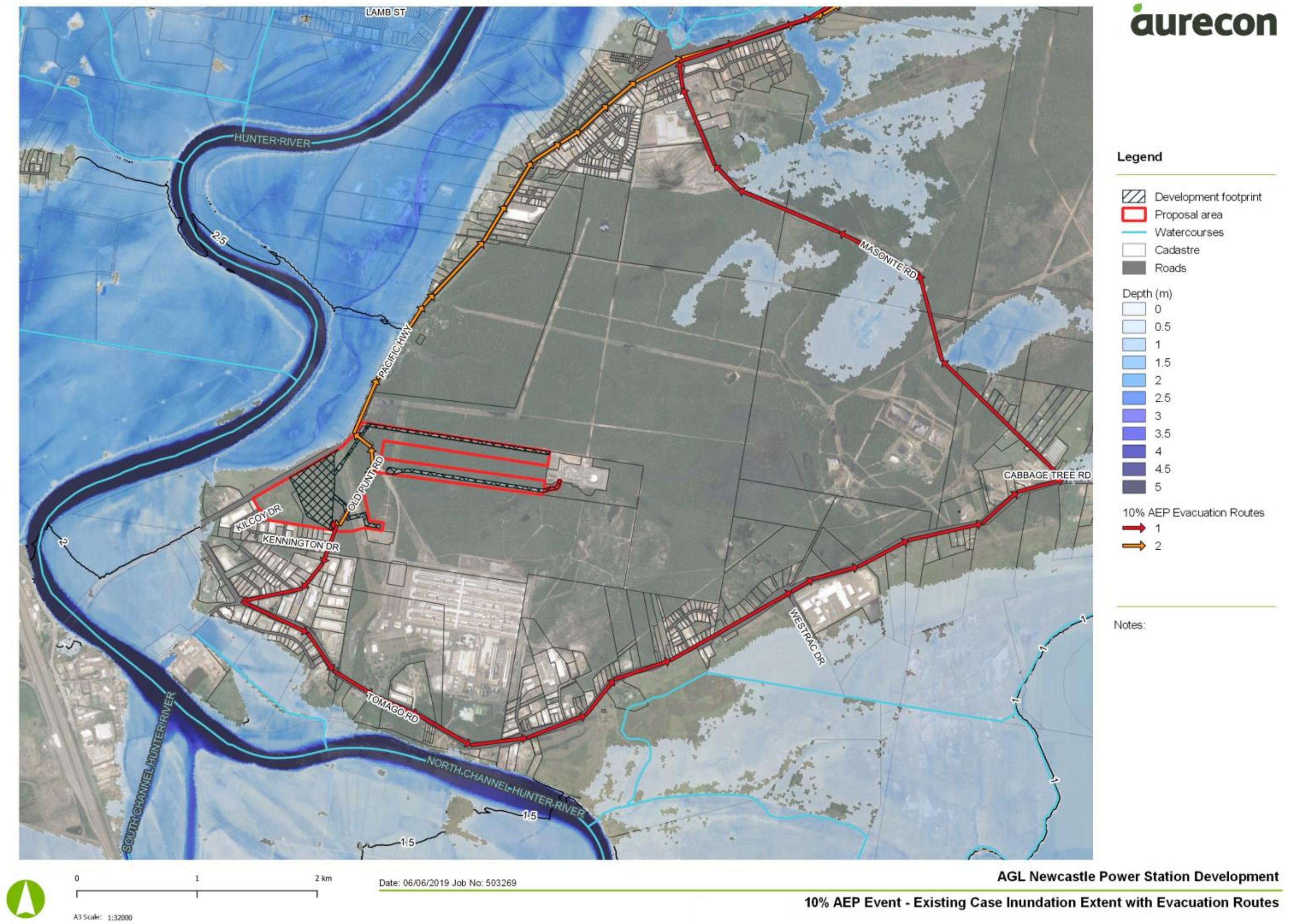

Figure 7 10% AEP inundation extent and evacuation routes

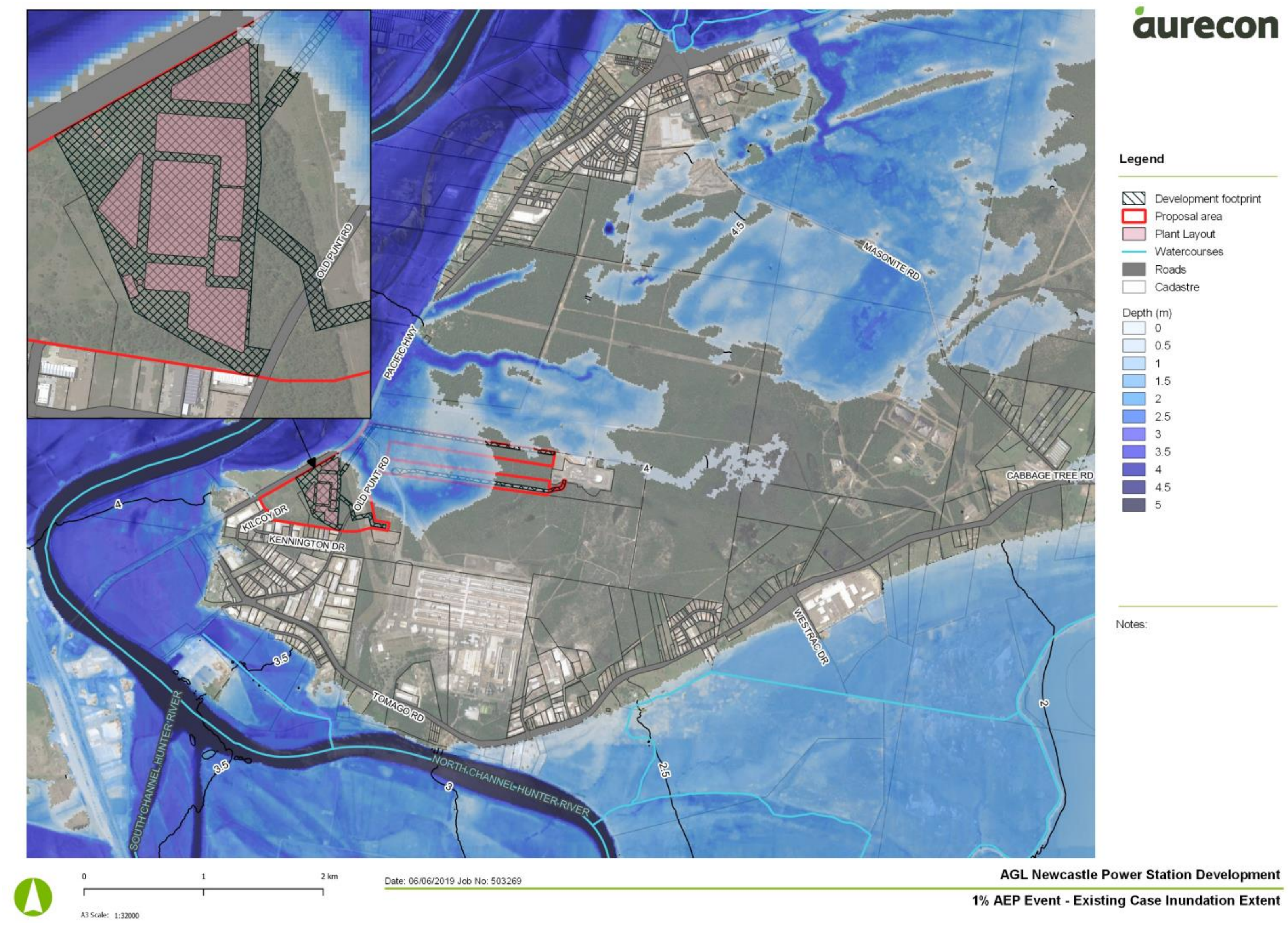

Figure 8 1% AEP inundation extent

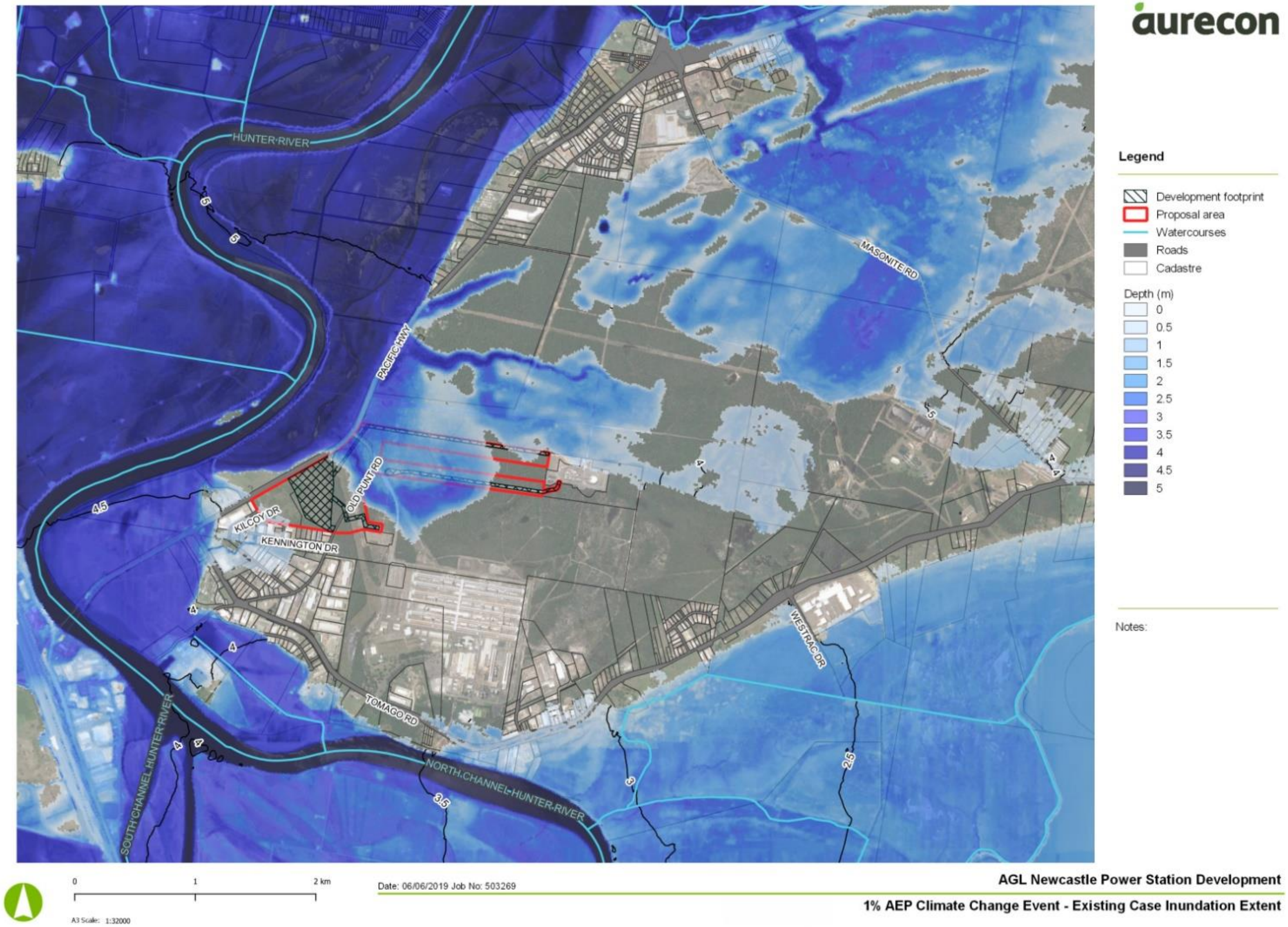

Figure 9 1% AEP with climate change inundation extent

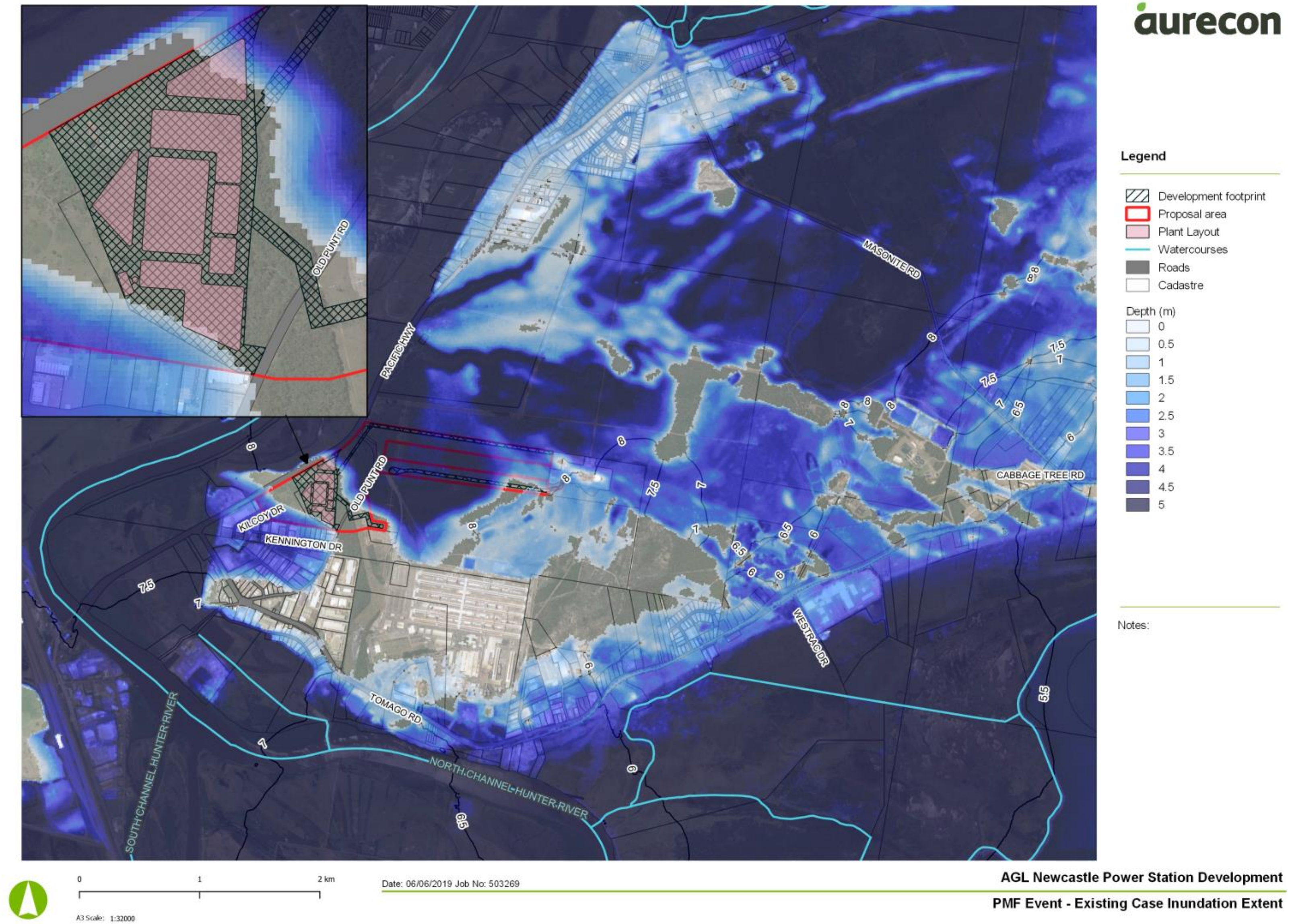

Figure 10 PMF inundation extent

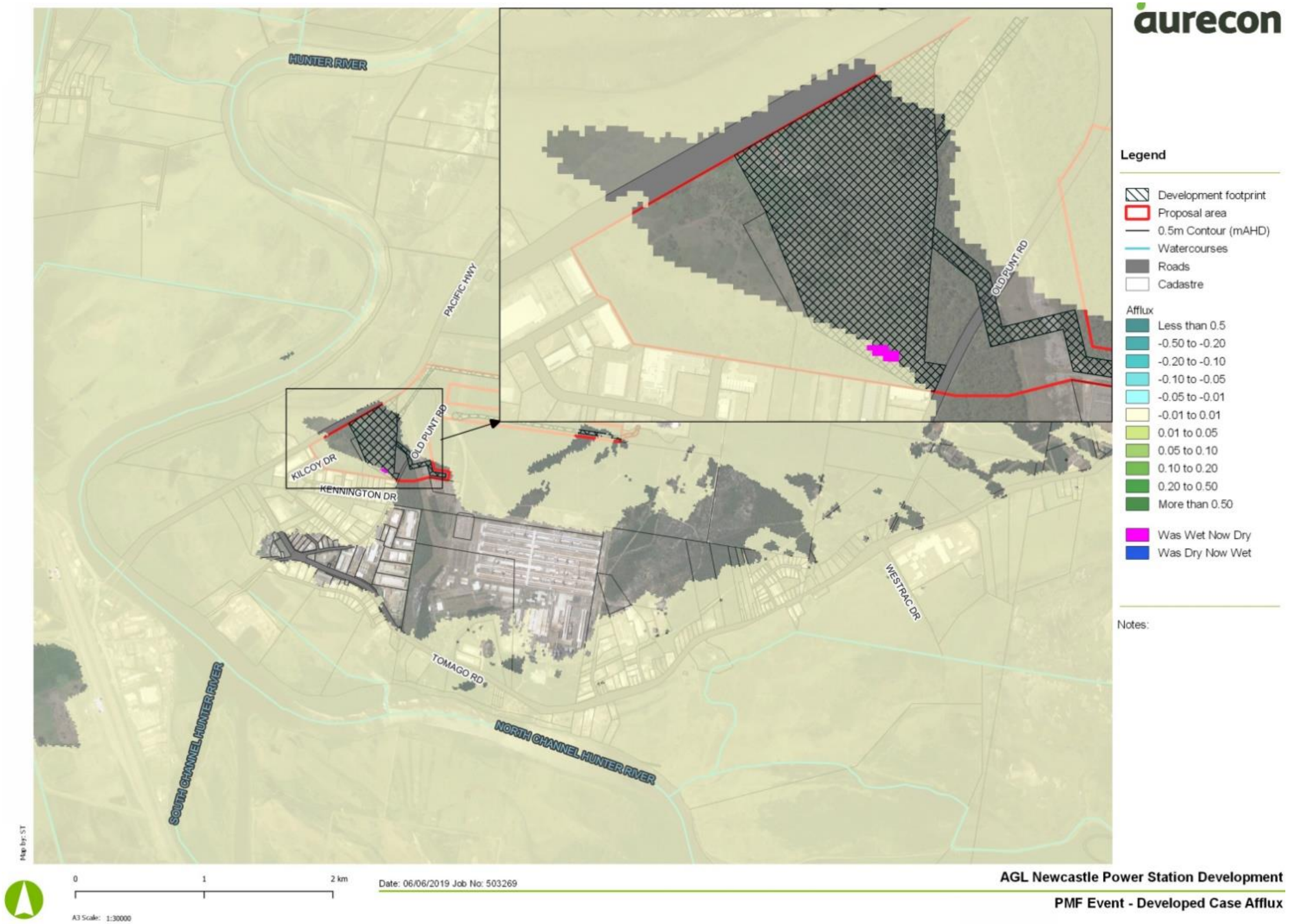

Figure 11 Afflux

5.2 Flood Levels and Impacts of the Proposal

Peak water levels at the Proposal area for the design events were determined from the flood modelling results. As the proposed site has been declared CSSI, these flood levels were used to determine the plinth level for the power station (being the significant component of above-ground infrastructure) to ensure it would not be affected by a 1% AEP design event. The site will need to be at least 5.1m AHD to remain immune from the 1% AEP event, including freeboard. As the proposed power station site topography is 7.2m AHD or higher, the development would be immune from the 1% AEP event. This is supported by the modelling in Figure 8.

The flood modelling also showed that the development of the power station site, using cut and fill construction methods, and being above the flood planning level, would not have any effect on the pattern of flood flows or on flood levels. The afflux results shown in Figure 11 show that the proposed development compared to the existing situation has near negligible difference. This is supported by the power station being above the flood planning level, and associated infrastructure (pipeline and transmission lines) being predominantly above or below ground with minimal features in the floodway or flood storage area. As the development for the Proposal would not impact flood behaviour, it would not result in any detrimental changes in potential flood affection of other developments or land.

The Proposal is outside of the Council flood hazard mapping area, and therefore development would not impact on the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the surrounding land (Figure 5). The proposal would not cause any redirection of flow, flow velocities, flood levels, hazards and hydraulic categories. There would be no adverse effect to beneficial inundation of the floodplain environment, on, adjacent to, or downstream of the site, as a consequence of developing the Proposal.

Whilst there would be some temporary impacts during construction of the Proposal, there would be no long-term direct or indirect increase in erosion or siltation as a consequence of the development. Areas disturbed during construction would most likely be revegetated, to reduce exposed soils and potentially remove sediment sources. During operation, the Proposal would have some sealed/impermeable surfaces and a stormwater management system in place. There would be no destruction of riparian vegetation or reduction in the stability of river banks or watercourses caused by construction or operation of the Proposal.

As the development would not impact on local flood behaviour, or impede access to existing road networks, the development is not expected to have any impacts on existing community emergency management arrangements for flooding. AGL would ensure that a meeting is held with the Lower Hunter Division of the SES and Council prior to construction of the Proposal to discuss proposed site evacuation routes and processes and ensure that these are compatible with or do not impede upon PSC and SES arrangements.

The flood modelling undertaken as part of this assessment suggests that the development would not have any detrimental social and economic impacts on the community as a consequence of flooding.

5.3 Evacuation Routes

Due to the proximity of the site to the Hunter River, the flooding fringe surrounds the Proposal and the access roads into the site would be affected by several of the design flood events. Consequently, evacuation routes would need to be considered for design events. It is proposed that the site would be accessed via Old Punt Road, which is supported by the flood modelling in this assessment as the safest site egress route.

During the 10% AEP event, the intersection of Tomago Road with the Pacific Highway would be affected by floodwater and would not be accessible to traffic. The safest and most direct evacuation route would be to exit the site by turning left onto Old Punt Road and then right onto the Pacific Highway. A secondary option (for use in the event of an unforeseen event or accident that prohibits turning left into Old Punt Road) would be to turn right onto Old Punt Road and then left on to Tomago Road, following it until it becomes Cabbage Tree Road, where vehicles could turn left onto Masonite Road which then leads to the Pacific Highway. These evacuation routes are illustrated in Figure 7. These appear to be the only roads that remain open during this event.

For all other design events modelled, all potential evacuation routes appear to be inundated, and the Pacific Highway itself would be under at least 0.5m of water. Evacuation of the site prior to the access routes being inundated during these events would be required, in accordance with Government flood warnings and evacuation procedures

An alternative emergency egress point has been recommended as a critical emergency response factor in the Fire Safety Study (Bushfire) completed for the EIS, if the main access or Old Punt Road is closed or cut off. This would be via an unimproved track, between the north-western site boundary of the NPS and the Pacific Highway, mainly for pedestrian egress in the event of a fire. This egress from the NPS to the Pacific Highway would be unaffected by flooding for all flood events modelled, including the PMF.

Official flood warnings for the study area are issued by the Lower Hunter Division of the SES and are based on floodwater levels at upstream gauges including Maitland and Raymond Terrace. The Williamtown-Salt Ash Floodplain Risk Management Study and Plan (BMT WBM, 2017) has linked flood warning trigger levels and timings for the study area to the existing Raymond Terrace, Hexham Bridge and Stockton Bridge water level gauges. A Flood Preparedness Plan should be prepared for the Proposal based on the PMF design event, which would be incorporated into the Construction Environmental Management Plan or the Site Emergency Response Plan. This plan would include:

- Roles, responsibilities and communication procedures including emergency contacts
- Monitoring procedures for rainfall and flood warnings
- Site shut-down and flood preparedness procedures to minimise harm to persons, plant and the environment
  - Actions in the lead up to the flood (such as monitoring water levels, completing erosion and sediment controls, removing hazardous materials and waste from the site, barricading, sealing tanks and containers to prevent overflows, tying down loose items)
  - Actions at the time of the flood (may include further evacuation, rescue, pollution prevention, spill response, and contingency measures)
  - Actions post-flood (including clean up and rectification)
- Evacuation routes and procedures
- Rescue procedures
- Procedure for resuming operations
- Reporting requirements and corrective actions

During its development, this Flood Preparedness Plan would be discussed with the SES and Council to ensure alignment with community evacuation arrangements.

6 Conclusions

The flooding assessment of a range of events from frequent (10% AEP) to extreme (PMF) has been undertaken to determine the following:

- Flooding impacts of the Proposal
- Hydraulic classification of the site
- Design building platform level of the proposed power station site
- Evacuation routes for a range of events
- Alignment of this study in response to a series of NSW guidelines including Floodplain Development Manual, Floodplain Risk Management Guidelines, and Standard SEARs

The results from the 10% AEP, 1% AEP and the adopted 1% AEP with Climate Change scenarios flood modelling show that the proposed power station infrastructure will not experience any flood impacts as the site is out of the flood extent. In the PMF scenario, despite the maximum flood extent reaching the northern and southern boundaries of the proposed power station development, the site would be developed above the flood level and would remain dry. It was also determined that development of the power station has inconsequential impacts to both flood levels and changed flow patterns and velocities.

The proposed power station site is above the Council flood planning area and is not flood liable land, and therefore does not have a hydraulic categorisation. The nearest hydraulic classification to the proposed site is flood fringe (Figure 5). Flood fringe areas are the remaining areas of flood prone land after floodway and flood storage areas have been defined, where development on this land would not have any significant effect on the pattern of flood flows or on flood levels (DIPNR, 2005). As the power station site is not flood liable land, development on the land would not impact flood flows or levels. The proposed electricity transmission line crosses some minimal risk flood prone land and the proposed gas pipeline routes traverse high hazard floodway and high hazard flood storage areas which would be inundated in certain flood events, however, this flooding is not expected to have any impact on, above or below ground infrastructure associated with the Proposal.

As the proposal is CSSI, the design building platform level for the power station site has been assessed against the 1% AEP design flood levels. The flood levels near the site are approximately 4.5 m AHD, hence a level of least 5.1 m AHD for the building platform is recommended. As the proposed power station site is around 7.2 m AHD, the development is expected to be immune from the 1% AEP event. As the site is outside of the flood planning area, the power station building platform will have no impact on changing flood levels or flow patterns or velocities outside the property boundary. Associated infrastructure, including electricity and pipeline routes would have minimal above-ground presence and is expected to have a negligible effect on existing flooding conditions as shown by the afflux in Figure 11.

Whilst the power station itself would be immune from flooding impacts, associated infrastructure including the pipeline route would be partially affected by the 1% AEP event, 1% AEP with climate change and the PMF. During flood events, there would be temporary loss of access for construction or maintenance activities, and the pipeline route would most likely be inundated until flood waters subsided. This is not expected to cause any impact on the Proposal infrastructure.

Evacuation routes have been assessed for the various design events. The 10% AEP event has two available routes that lead to the Pacific Highway, a primary evacuation route and an alternate secondary route (refer to Figure 7). However, during the larger flood events these roads appear to be cut off, and the Pacific Highway itself would be under water. As the NPS site becomes isolated during extreme flood events, it is recommended that evacuation measures be taken before a predicated large flood event, in accordance with Government issued flood evacuation warnings and a Flood Preparedness Plan be prepared for the Proposal.

This flood assessment of the proposed power station site satisfies the criteria of the SEARs guidelines provided by the OEH as:

- It is consistent with Port Stephens Floodplain Risk Management Plan, which has been prepared to meet the NSW Floodplain Development Manual
- The existing flooding conditions do not change due to the development
- The proposed development will not cause flood impacts which would affect other properties, assets or infrastructure
- The proposed development has no effect on the flood hazard of the land. The proposed power station site is outside of the Council flood hazard mapping area
- The proposed development has no effect on the hydraulic functions of flow conveyance or flood storage
- The proposed development would have no adverse effect to beneficial inundation of the floodplain environment
- The proposed development would have no impact to the existing ground conditions, banks or water courses
- Existing community emergency management arrangements would not be impacted by the proposal, and this would be confirmed with Council and the SES
- The proposal does not create any additional risk to life from flood, which requires specific management measures, as the proposal does not impact on flood patterns or behaviour. The Flood Preparedness Plan would ensure there was no risk to life from flood to anyone working at the NPS.
- The proposed development would not affect existing emergency management, evacuation and access conditions
- Site evacuation routes have been recommended for the Proposal based on the flood assessment
- There would be no adverse flooding-related impacts as a consequence of developing the Proposal, and no social and economic costs to the community as a consequence of flooding.

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Appendix C
EIS Surface Water Quality Assessment

Newcastle Power Station

EIS Surface Water Quality Assessment

AGL Energy Limited

Reference: 503269

Revision: 2

2020-03-04

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1 INTRODUCTION

1.1 Background

Aurecon Australia (Aurecon) has been engaged by AGL Energy Limited (AGL) to undertake an Environmental Impact Statement (EIS) for the proposed Newcastle Power Station (NPS), located in Tomago, NSW. The proposal includes the power station, gas pipelines supplying gas to the facility, electricity transmission from the NPS, site access and associated ancillary facilities. The pipelines would supply the proposed NPS with gas from the eastern Australia gas transmission pipelines via the Jemena HPP network. A new electricity transmission line would transfer the electricity produced by the proposed NPS to the national electricity network via connection to the existing TransGrid 132kV switching station.

The proposal area is underlain by the Tomago Sandbeds Aquifer, which is a source of raw water for the potable water supply for the Newcastle region. Accordingly, surface water management controls are required to mitigate the potential for the development proposal to adversely impact the groundwater levels and groundwater quality of the Tomago Sandbeds Aquifer and other receiving waters.

Aurecon was engaged by AGL to complete a surface water quality assessment report outlining the key surface water quality management issues during operation of the proposal to inform the EIS, and to establish surface water quality management principles and concepts for the site. A water quality model (MUSIC) was used to estimate pollutant loads and assess design parameters and water quality treatment by proposed controls including a bio-retention system and wet sump oil/grease separator.

1.2 Location of the Proposal Area

The proposal area is located approximately 15km north-west of Newcastle CBD, south of the intersection of the Pacific Highway and Old Punt Road and 2.5 km north of the northern arm of the Hunter River Estuary (**Figure 1-1**).

The power station site is predominantly cleared and has been used for agricultural purposes with a single (unoccupied) residential dwelling remaining near the Pacific Highway. There are some isolated trees and stands of native vegetation which are generally confined to the lot boundaries. The area is relatively flat with dirt or gravel access pathways to the main lots.

The proposed site layout plan is provided in **Figure 1-2**. The current layout is an indicative one and will only be finalised once the engine technology type has been selected.

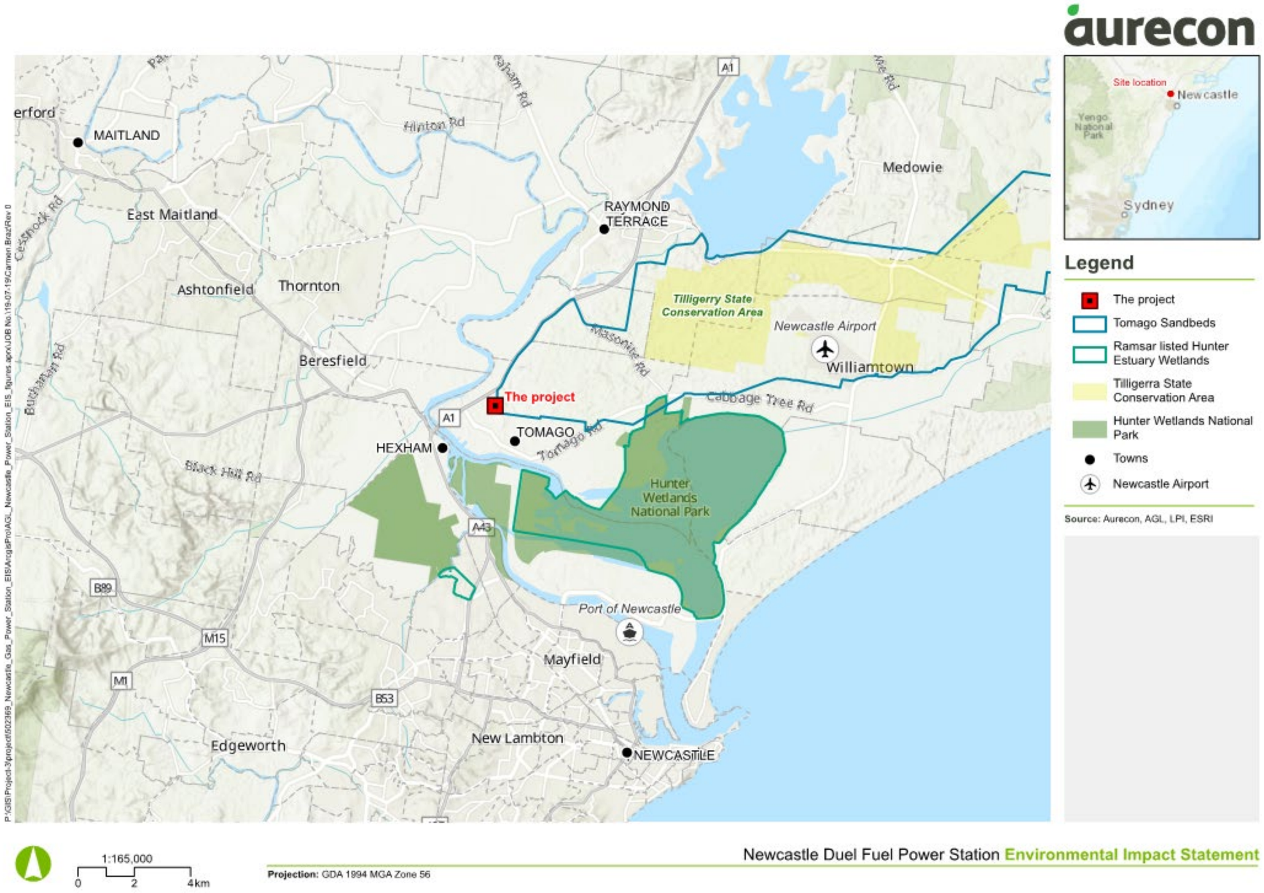

Figure 1-1 Proposal location

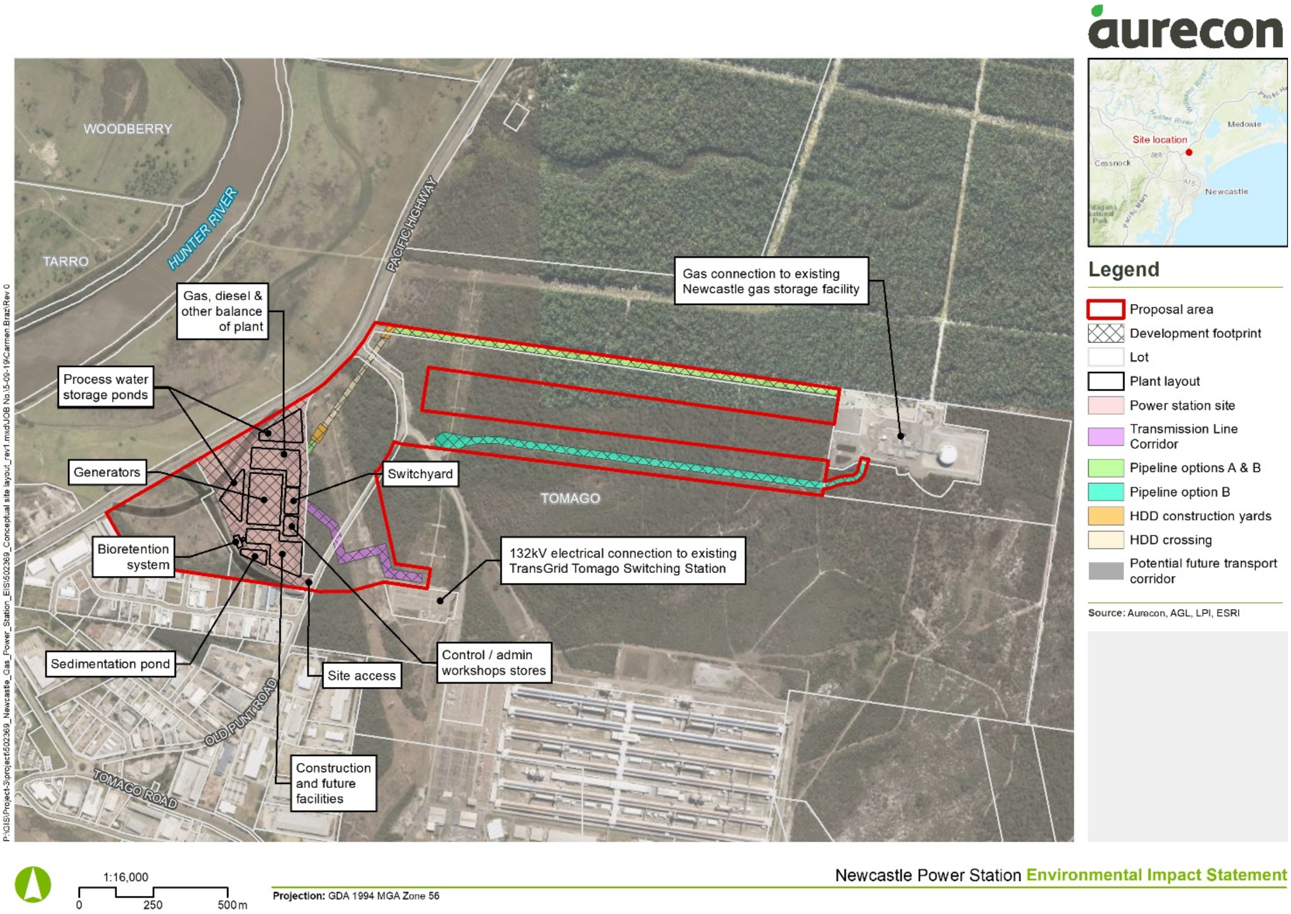

Figure 1-2 Site Layout

1.3 Available Data

The following data was used for this study:

- Lidar survey of the NGFPS site and surrounding land;
- Recent aerial photography of the site;
- Rainfall data and climatic statistics available from the BoM;
- A generic layout of the proposed plant;

2 Policies and Statutory Provisions

2.1 Hunter Water (Special Areas) Regulation

The proposal area is located within the Tomago Sandbeds Catchment Area (Figure 2-1). Hunter Water Corporation (HWC) extracts groundwater from the Tomago Sandbeds to supplement the potable water supply for the Newcastle region.

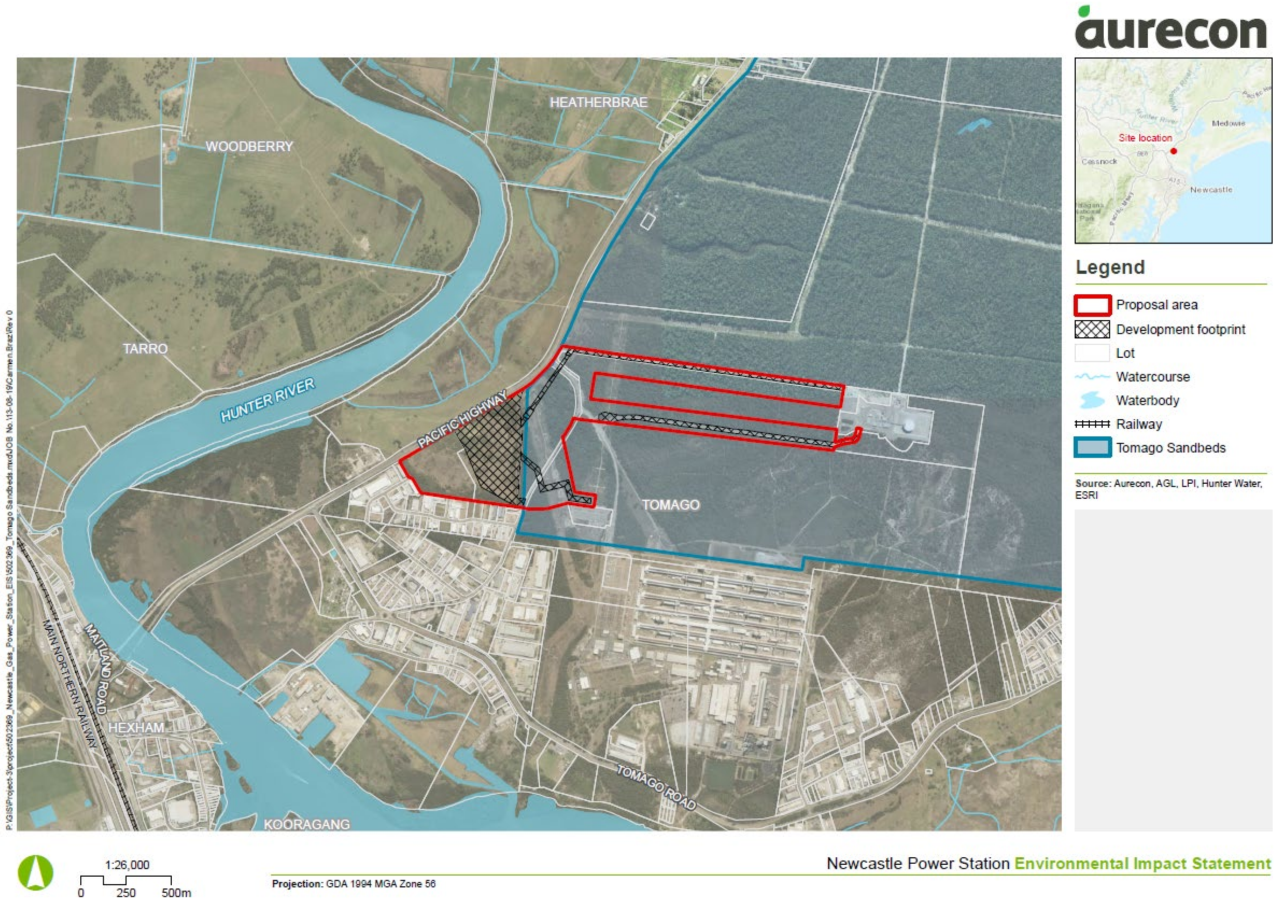

Figure 2-1 Extent of Tomago Sandbeds

The Tomago Sandbeds Catchment Area is declared a special area under the *Hunter Water Act 1991*. The Hunter Water (Special Areas) Regulation 2003 and Hunter Water Regulation (Public Exhibition Draft) 2010 - makes provision for HWC to regulate activities within areas of declared special areas under the above act.

Hunter Water Regulation 2010 - **Clause 10 … Tomago Sandbeds**

1. A person must not engage in any extractive industry in the … Tomago Sandbeds Catchment Area otherwise than in accordance with an approval given by the Minister.

Hunter Water Regulation 2010 - **Clause 12 Pollution of waters**

1. A person must not pollute any waters in a special area.

In this clause ***pollute***, in relation to waters, has the same meaning as ***pollution of waters*** has in the *Protection of the Environment Operations Act 1997*, but extends to include disturbing geological or other matter (whether natural or artificial) in such a manner as to change, or to be likely to change, the physical, chemical or biological condition of the waters. ***Waters*** has the same meaning as it has in the *Protection of the Environment Operations Act 1997*.

2.2 Water Management Act 2000

The objectives of the *Water Management Act* (*WMA) 2000* are to provide for the sustainable and integrated management of the water resources within NSW for the benefit of both present and future generations. In NSW, the regulator and policy maker for water resource management is the NSW Department of Industry – Water (DoI Water).

Specifically, the Act is used DoI Water to regulate the use of water resources through the provision of water quality and quantity controls on proposed and existing developments and the management of water sharing plans and water extraction licenses.

2.2.1 Water Sharing Plans

Water sharing plans set rules for sharing water between water users and the environment and bring water users into a single licensing system managed under the *Water Management Act 2000*.

A *Water Sharing Plan for the Tomago Tomaree Stockton Groundwater Sources 2003* was gazetted on 7 February 2003 and amended on 1 July 2004 (Coffey, 2011a). This plan was repealed in 2016 by the *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016*. The proposal site is located on land that lies above the south-western extent of the Tomago Groundwater Source which is subject to this water sharing plan.

2.3 Water Act 1912

The Water Act 1912 governs the issue of new water licences and the trade of water for water resources that are not regulated by the WMA.

2.4 Port Stephens Council Development Control Plan 2007

The proposal area is located within the Port Stephens Council local government area. Council guidelines should be considered when undertaking any civil / drainage engineering design, including the Development Control Plan (DCP) 2007, specifically general provision B4 Drainage and Water Quality, which includes the following requirements that are applicable to the proposal:

- A stormwater drainage plan must be prepared which
  - Details the proposed drainage system including a legal and physical point of discharge
  - Minimises impacts on water balance, surface water and ground water flow and volume regimes and flooding
  - Includes sustainable mitigation measures
- On-site detention or on-site infiltration may be required
  - Details of the concept design to be included in the stormwater drainage plan
  - Sized to ensure post-development flow rate and volume is equal to pre-development for all storm events up to and including the 1% AEP
  - Achieves neutral or Beneficial Effect (NorBE) on water quality for all storm events
- Water quality
  - Modelling to ensure the development does not detrimentally impact on water quality

- Water quality measures during construction to improve quality of stormwater runoff
- Erosion and sediment control measures during construction

3 Existing Surface Flow Environment

3.1 Topography and Catchments

Overall topography within the proposed power station site is relatively flat with an approximate north south grade of –1% and an east west grade of -1%, indicating a general inclination to the south west for the proposal area. A very minor rise appears to be present towards the centroid of power station site.

3.2 Surface Water Features – within the NPS Site

A small farm dam (<250 m²) appears to be present within the power station site area towards the north of Lot 3 DP1043561, the subject dam has no discernible streams or creeks upstream or downstream.

3.3 Other Surface Water Features

Surrounding the overall proposal area is the Hunter River which then flows through a wetland environment collectively called the Hunter Wetlands National Park.

4 Potential Surface Water Impacts - Operation

There is potential for surface water contaminants to be generated during the operational phase of the NPS from accidental leaks and spills, wash-off from impervious surfaces and corrosion of plant equipment and infrastructure. These contaminants could potentially be transported to the water environment (surface water or groundwater) in stormwater runoff. In the event of a fire at the NPS, fire-fighting water runoff would present a potential source of pollution. A Surface Water Management Plan, including several controls, has been recommended in **Section 5** to manage these impacts.

5 Surface Water Management Plan

5.1 Operation Phase Surface Water Management Plan

Once operational, the Proposal is unlikely to have a significant impact on the surrounding surface water features, other than a minor potential leaks/spills and a minor increase of pollutants due to the increase of impervious areas due to the power station development. However, the civil design of the power station will incorporate the principles outlined in Port Stephens Council DCP 2007 to ensure that the post-development flow rate and volume is equal to pre-development for all storm events, despite the increase in impervious area.

A suite of surface water quality controls will be implemented during the operational phase of the NPS. A conceptual Surface Water Management Plan (SWMP) for the operation of the NPS was developed for the various surface water management catchment characteristics that were identified within the NPS, summarised as follows:

- General pervious areas: This includes undeveloped pervious areas and general plan areas. No controls required, infiltration into the groundwater system as currently occurs.
- General hardstand areas: This includes general impervious areas such as handstand around equipment/building and car parks etc.
- Road areas: Also considered hardstand area.
- Roof areas: Building roof areas.
- Enclosed workshops: Runoff within enclosed workshops will be bunded and disposed to trade waste.
- Ponds: Runoff collected within the ponds will be contained within the ponds for evaporation, off-site disposal or treatment and on-site disposal.

5.1.1 Controls for General Pervious Areas

A significant portion of the proposal area will not be developed. This land would be maintained as pervious (undisturbed) surfaces and will not be exposed to potential spills, leaks or fire-fighting water runoff. Runoff from pervious areas is expected to be clean and therefore no treatment is required. Given the anticipated high infiltration rates of the on-site sandy soils, it is expected that the majority of rainfall will infiltrate at source. Excess flows from pervious areas will be directed to a standard pit/pipe stormwater network proposed for the Station.

5.1.2 Control for Hardstand and Road Areas

Runoff from roads, car-parks and hardstand areas may contain low to medium levels of hydrocarbons, metals, suspended sediments and nutrients resulting from the operation of vehicles and machinery as would typically be expected from roads in the Tomago area.

It is proposed to capture all runoff from roads, car-park and hardstand areas in a ‘pit and pipe’ stormwater system. The pit and pipe stormwater system will be provided along the roads within the project site and would eventually discharge to the natural depression at the south-west corner of the proposal site (Attachment 1). Design surface levels of the proposal site will be regraded to facilitate the stormwater system. To minimise the impact to the downstream environment, the captured stormwater will be treated through the following stormwater controls prior to discharge:

- **Wet sump oil and grease separator**: This would facilitate the removal of the majority of entrained oils and greases, suspended solids and associated attached metals from stormwater runoff. Wet sump oil and grease separator will also capture any small to medium spill that occurs on the hardstand area and should be selected to provide a design treatment rate equivalent to a 1 in 3 month Average Recurrence Interval (*ARI*) peak flow. The oil and grease separator is to be adequate to remove all oil/grease to <5 mg/L, and coarse sediment.
- **Bio-Retention System**: Treated discharge from the wet sump oil and grease separator would be discharged into a bio-retention system. Bio-retention systems consist of selectively vegetated areas with enhanced filter media. Stormwater runoff is slowly filtered through the enhanced filter media, where physical and bio-chemical processes facilitate the removal and breakdown of common stormwater contaminants. Refer Figure 6-1 for an example of a bio- retention system. Filtered stormwater would be collected and discharged to the natural depression downstream. The base of the bio-retention filter media would be lined such that it will be separated from the groundwater system.

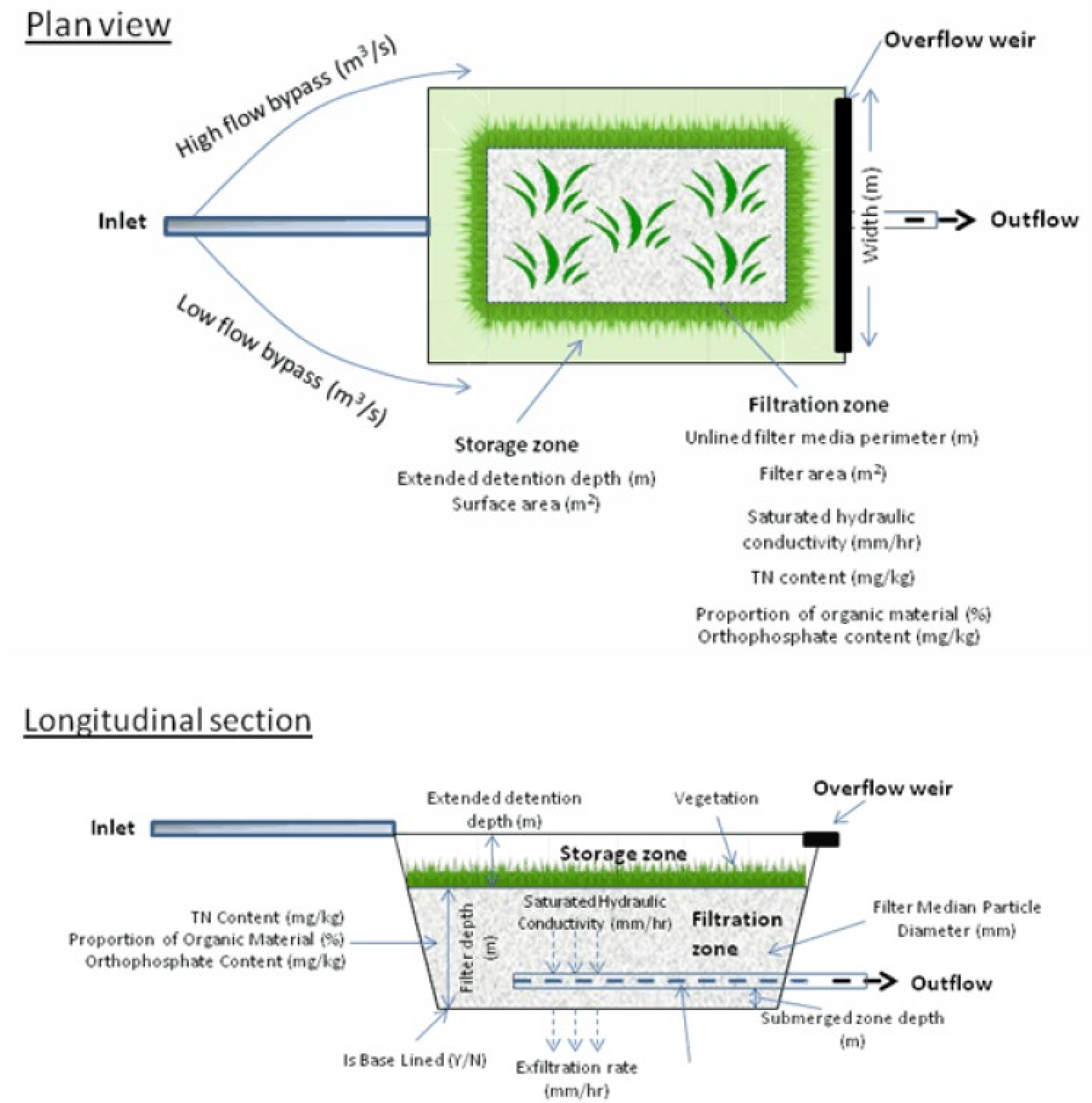

Figure 5-1-1: Concept of bio-retention system.

The wet sump oil and grease separator and bio-retention system will be implemented at the outlets of the stormwater system prior to discharging into the natural depression downstream (**Attachment 1**).

Bio-retention systems will be sized to achieve 90% Total Suspended Solids (*TSS*), 60% Total Phosphorus (*TP*) and 45% Total Nitrogen (*TN*) pollutant removal efficiencies as per Port Stephens DCP guideline.

Preliminary water quality modelling indicates that approximately 500 m^2 of bio-retention filter area will be required. **Attachment 1** indicates potential location and sizes for the proposed bio-retention systems. **Section 5.1.6** details modelling methods, assumptions and results.

5.1.3 Controls for Roof Areas

Runoff from roof areas is expected to be relatively clean and therefore will not require treatment. However, where practical (e.g. for the office/administration building), runoff from roof areas will be captured in rainwater tanks for re-use in toilet flushing and other non-potable uses. Excess roof water will be directed into the pit and pipe stormwater system.

5.1.4 Controls for Enclosed Workshops

Internal runoff within enclosed workshop areas is likely to be the lowest quality runoff generated on- site. However, since workshop areas are roofed and generally are fully enclosed, only relatively minor volumes of runoff will be generated from internal water uses such as hosing down workshop floors. It is therefore proposed to collect all internal runoff in a designated drainage system for disposal to trade waste or an appropriate contaminated liquid disposal facility. 'Clean' runoff from the roofed areas is described above.

5.1.5 Controls for Ponds

Runoff collected within ponds will be contained within the ponds for off-site disposal or treatment and on-site disposal (i.e., testing, treatment or flocculation and discharge in accordance with the *Managing Urban Stormwater: Soils and Construction (The Blue Book)* (Landcom 2004) and *ANZECC Guidelines for Fresh and Marine Water Quality (2000))*.

5.1.6 Preliminary Sizing of SWMP Components

Preliminary sizing of several stormwater components was undertaken using a water quality model (MUSIC). MUSIC is a continual-run conceptual water quality assessment model and can be used to estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. MUSIC can conceptually simulate the performance of a group of stormwater treatment measures (treatment train) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

The proposed area is underlain by the Tomago Sandbeds aquifer, which is a source of raw water for the portable water supply for the Newcastle region. According to Figure Bf of Port Stephens DCP 2014, before water is released into public drainage, the water quality outcome shall achieve NorBe or Council's water quality pollutant retention targets, whichever achieves the better water quality outcome. Therefore, assessment was undertaken for both the Norbe requirements and the pollutant retention targets to determine the required treatment measures.

Councils pollutant retention targets:

- *Total Suspended Solids (TSS) 90% retention of developed average annual load;*
- *Total Phosphorus (TP) 60% retention of developed average annual load;*
- *Total Nitrogen (TN) 45% retention of developed average annual load;*
- *Gross Pollutants (GP) 90% retention of developed average annual load*
- *Oils and Grease No visible oils for flows up to the 3-month ARI (i.e<5mg/L).*

The above targets were adopted when determining the indicative design parameters of the proposed treatment measures. **Table 6-4 & Table 6-5** detail these design parameters as well as key design parameters for the other components of the SWMP.

To ensure NorBE is achieved, the modelled pollutants loads for the developed case should aim to achieve 10% less than the pre-development case for total suspended solids (TSS), total phosphorous (TP) and total nitrogen (TN). For gross pollutants, the modelled post development load only needs to be equal to or less than pre-development load, refer to **Table 6-4 & Table 6-5**.

Moreover, to meet NorBE requirements, the concentration of pollutants for the post-development case should always be equal to or less than the concentration for the pre-development case. This is impractical for a risk-based approach and the natural variability of rainfall events. As a result, NorBE will be deemed to be met if the post development case pollutant concentrations are equal to or less than the pre-development case concentrations between the 50^{th} and 98^{th} frequency percentiles when run-off occurs, refer to **Table 6-6.**

Table 5-1 summaries the recommended water quality controls to achieve the associated design criteria.

Attachment 1 indicates preliminary location and sizes for the proposed water quality controls.

Table 5-1: Operational Phase Stormwater Controls

Catchment area category	Recommended control	Design Criteria (Preliminary)
Pervious areas	None	Infiltrate at source
Roof areas	Rainwater tank	Typically sized for 5 m3 / 200 m2 roof area Indicative tank volume ≈ 250 m3 / ha roof
	Pit/pipe stormwater system	20 year ARI storm event
Hardstand and road areas	Pit/pipe stormwater system	20 year ARI capacity, critical storm duration for each sub-catchment.
	Wet sump oil and grease separator	1 in 3 month ARI peak flow. Oil and grease separator to be adequate to remove all oil and grease to<5mg/L
	Bioretention system	1 in 3 month ARI peak flow, plus 90% TSS, 60% TP & 45% TN removal sizing criteria. Preliminary surface area ≈ 735 m2 (calculated from MUSIC).
Enclosed Workshops	Trade waste will be fully captured in the trade waste system and does not form part of the stormwater system	
Ponds	Storage ponds for power generation purposes do not form part of the stormwater system. Sedimentation ponds would be designed in accordance with the Blue Book	

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6 Modelling

6.1 MUSIC Model Setup

This section details the methodologies and assumptions adopted for the MUSIC modelling that was undertaken to determine indicative design parameters for the proposed bio-retention systems and the wet sump oil/grease separator.

The MUSIC model was used to estimate the likely pollutant loads and assess the water quality treatment provided by proposed water quality controls. The model was used to define the minimum design parameters (i.e. areas and volumes) required for water quality control devices to meet the targets as outlined in Section Error! Reference source not found.. The following sections describe the modelling methodologies and report the estimated performance and minimum design parameters for the proposed water quality controls.

6.1.1 Rainfall and Evaporation Inputs

Similar to many councils in Australia, Port Stephens has developed the MUSIC LINK with eWATER to specify the modelling parameters, rainfall and evaporation data for water quality performance assessment as per Council Guideline. MUSIC link is imbedded in the MUSIC programme to streamlins the process of achieving a match between an assessing authority's specific guidelines and urban development water sensitive designs. Therefore, as specified in Port Stephens DCP, Port Stephens MUSIC link was used to set up the MUSIC model for the project catchment.

In order to develop a model that could comprehensively assess the performance of the proposed SWMP, 6 minute pluviograph data was used as specified by Port Stephens Council MUSIC link. Utilizing MUSIC-link with the Port Stephens Council, Williamtown Sensitive Catchment – Sandy Soils configuration file, data within the configuration file is from the Williamtown RAAF - Station 061078 - Zone B. The rainfall data from Williamtown RAAF has 10 years of historical rainfall data with 6 minute intervals, and therefore is utilized by Port Stephens Council for MUSIC modelling within the Proposal catchment area.

A review of the historical data from the Williamtown RAAF rain guage found that the annual average rainfall depth at Williamtown RAAF is approximately 949mm. A selected 10-year period generating an annual rainfall depth of approximately 950mm was adopted for the purposes of determining the effectiveness of the proposed stormwater quality controls.

Table 6-1: Rainfall data for MUSIC modelling

Purpose	Time step required	Rainfall station	Modelling Period
Water quality	6 minutes	WILLIAMTOWN RAAF - Station 061078 - Zone B	1998-2007

The monthly average evapotranspiration data from the Williamtown RAAF was used in the MUSIC model and applied to the adopted modelling period (1998 to 2007) as shown in **Table 6-2**.

Table 6-2: **Monthly Evapotranspiration for Music Modelling**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PET (mm)	182	146	146	94	65	53	55	72	98	141	160	181

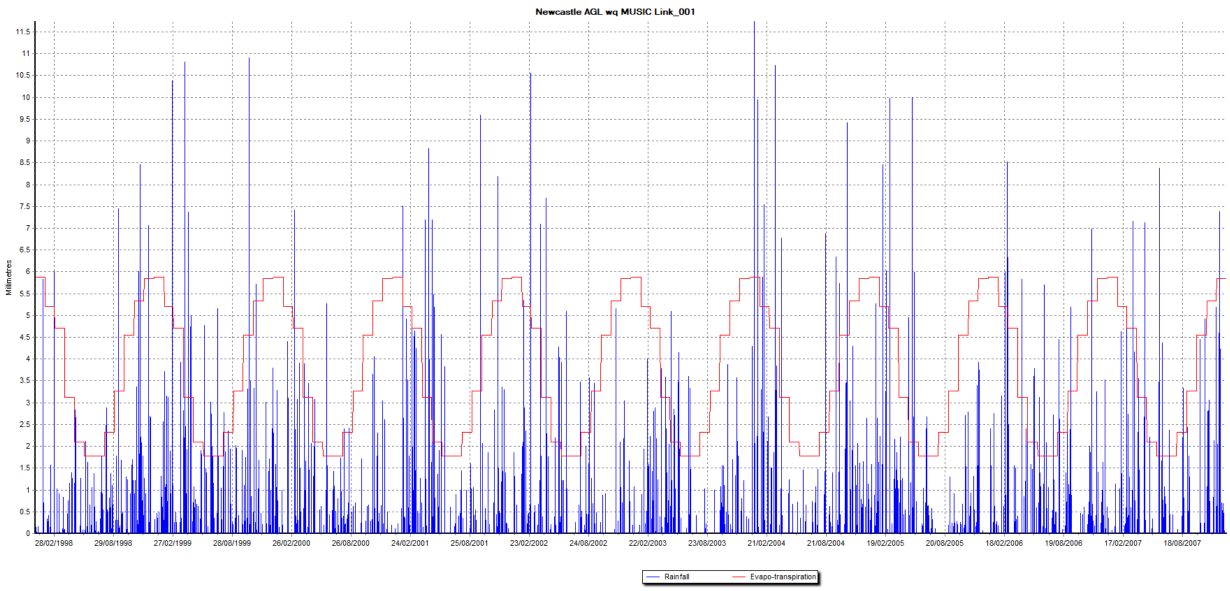


Figure 6-1: Adopted rainfall and evapotranspiration data for MUSIC modelling

6.1.2 Catchment inputs

The proposed Proposal site was divided into smaller subcatchments, based on the proposed facilities within the site (Attachment 1). Impervious percentage for each subcatchment was assumed, based on the concept layout for the power station, as shown in Table 6-3.

Table 6-3: Catchment delineation

Catchment Name	Facility	Catchment area					
		Total (ha)	Hardstand (ha)	Road (ha)	Pervious (ha)	Roof (ha)	Impervious percentage (%)
PL01	Gas, Diesel & Other balance of plant	1.65	0.50	0	1.16	0	30
PL02	Generators	2.15	0.86	0	1.29	0	40
PL03	Switchyard	0.49	0.20	0	0.29	0	40
PL04	Admin Workshops/Stores	0.39	0	0	0.08	0.31	80
PL05	Construction and Future Facilities	0.86	0.26	0	0.34	0.26	60
PL06	-	0.72	0.36	0	0.36	0	50
RD01	Road	0.99	0	0.99	0	0	100
		7.25	**2.17**	**0.99**	**3.52**	**0.57**	**51%**

6.1.3 Treatment Node Inputs

Bioretention System

The proposed bioretention system is modelled as Bioretention in the MUSIC model. The following modelling parameters were adopted for the MUSIC modelling as specified by Port Stephens Council MUSIC link

- High flow bypass: 3 month ARI flow
- Saturated hydraulic conductivity: 100 mm/hr
- Filter depth: 0.5 m
- TN content of filter media: 800 mg/kg
- Orthophosphate content of filter media: 50 mg/kg
- Exfiltration rate: as per geotechnical design or 0 mm/hr if ground condition is unknown

6.2 MUSIC Modelling Results

The MUSIC model was validated using the Port Stephens Council MUSIC-link from the Port Stephens Council. The modelling results are tabulated below outlining the water quality performance to achieve the NorBE requirements and the Water Quality Stripping (WQS) targets.

Table 6-4: Water quality performance with a proposed 500sqm Bio-retention pond and a wet sump oil/grease separator

MUSIC water treatment results for 500sqm Bio-retention								
	PRE - DEVELOPMENT RESIDUAL LOAD	POST - DEVELOPMENT RESIDUAL LOAD	UNIT	WATER QUALITY STRIPPING TARGET (MIN)	WATER QUALITY STRIPPING RESULTS	MINIMUM REDUCTION as per NorBE	ACHIEVED REDUCTION as per NorBE	SATISFACTORY
Total Suspended Solids	1.08E+04	1.11E+03	kg/yr	90%	90.60%	10%	89.70%	**Y**
Total Phosphorous	6.79	5.78	kg/yr	60%	71.10%	10%	14.90%	**Y**
Total Nitorgen	36.3	39	kg/yr	45%	57.30%	10%	0.00%	**N**
Gross Pollutants	0	0.133	kg/yr	90%	100%	0%	0.00%	**Y**

This design did meet the Water Quality Stripping (WQS) targets but did not reduce the Total Nitrogen (TN) in the post development to below that of the pre-development, highlighted above in red.

Table 6-5: Water Treatment Results for 735sqm Bio-retention pond and a wet sump oil/grease separator

MUSIC water treatment results for 735sqm Bio-retention								
	PRE - DEVELOPMENT RESIDUAL LOAD	POST - DEVELOPMENT RESIDUAL LOAD	UNIT	WATER QUALITY STRIPPING TARGET (MIN)	WATER QUALITY STRIPPING RESULTS	NorBE MINIMUM REDUCTION	NorBE ACHIEVED REDUCTION	SATISFACTORY
Total Suspended Solids	1.08E+04	675	kg/yr	90%	94.50%	10%	93.70%	**Y**
Total Phosphorous	6.79	4.95	kg/yr	60%	75.70%	10%	27.10%	**Y**
Total Nitorgen	36.3	32.5	kg/yr	45%	64.50%	10%	10.40%	**Y**
Gross Pollutants	0	0.133	kg/yr	90%	100%	0%	0.00%	**Y**

In attempt to reduce the Total Nitrogen (TN) to 10% below the pre-development value, the bio-retention pond was increased in size from 500sqm to 735sqm achieving the results tabulated above. These results complement the Water Quality Stripping target and the NorBE requirements set in Port Stephens DCP Part B4, *Drainage and Water Quality.*

Further, since the proposed power station is located within Tomago Sandbeds aquifer, which is a source of raw water for the portable water supply for the Newcastle region, the pollutants concentration for Total Phosphorous and Total Nitrogen for the post development must equal or better compared to the pre-development for the 50th and 98th percentile respectively as per the NorBe requirements. These requirements were achieved utilising a 735sqm Bio-retention in oppose to the 500sqm, refer to the results tabulated below.

Table 6-6: Total Phosphorous & Nitrogen Concentration for 735sqm Bio-retention

Total Phosphorous Concentration (mg/L)			Total Nitrogen Concentration (mg/L)		
	PRE - DEVELOPMENT RESIDUAL LOAD	POST - DEVELOPMENT RESIDUAL LOAD		PRE - DEVELOPMENT RESIDUAL LOAD	POST - DEVELOPMENT RESIDUAL LOAD
50th percentile	0.135	0.1	**50th percentile**	1.25	0.6
98th percentile	0.4	0.14	**98th percentile**	2.4	0.6

Refer to **Attachment 2** for the details of the MUSIC modelling and validation results.

The MUSIC model was used to estimate future stormwater discharge rates, volumes and qualities. The resultant simulated flow rates for daily and 6-minute timesteps, along with their predicted volumes are shown in **Table 6-7** and the cumulative distribution functions for the site discharge flowrates for the two timesteps are shown in **Figure 6-2** and **Figure 6-3** respectively.

Table 6-7 Storm water discharge flow rates as simulated by the MUSIC model

Frequency / Time Step	Median	90th Percentile	Maximum
6-minute Flow Rate (m^3/s)	$2.40X10^{-6}$	$418x10^{-6}$	0.794
Daily Flow Rate (m^3/s)	$4.28x10^{-6}$	0.003	0.054
Daily volume (m^3)	0.37	259	4 666

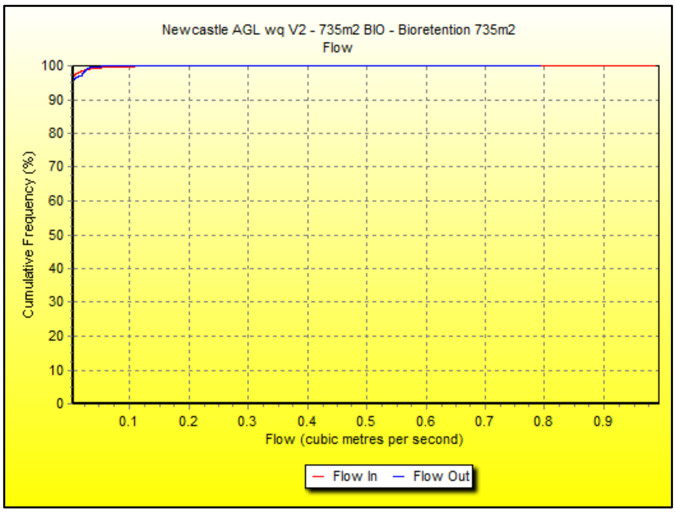


Figure 6-2 Simulate 6-minute time step cumulative distribution function

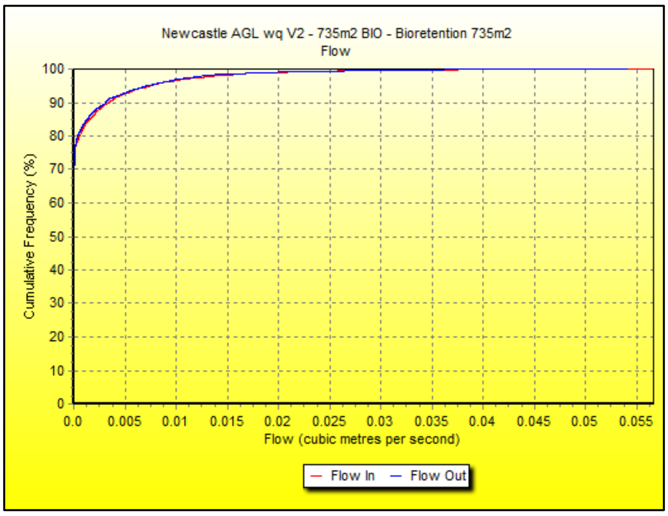


Figure 6-3 Simulated daily time step cumulative distribution function

Whilst soil erosion and scour could occur after wind and rain events, the preparation and development of an Erosion and Sediment Control Plan (ESCP) for the operational phase will reduce water flow velocities at discharge points and ensure discharge rates are moderated to eliminate downstream erosion.

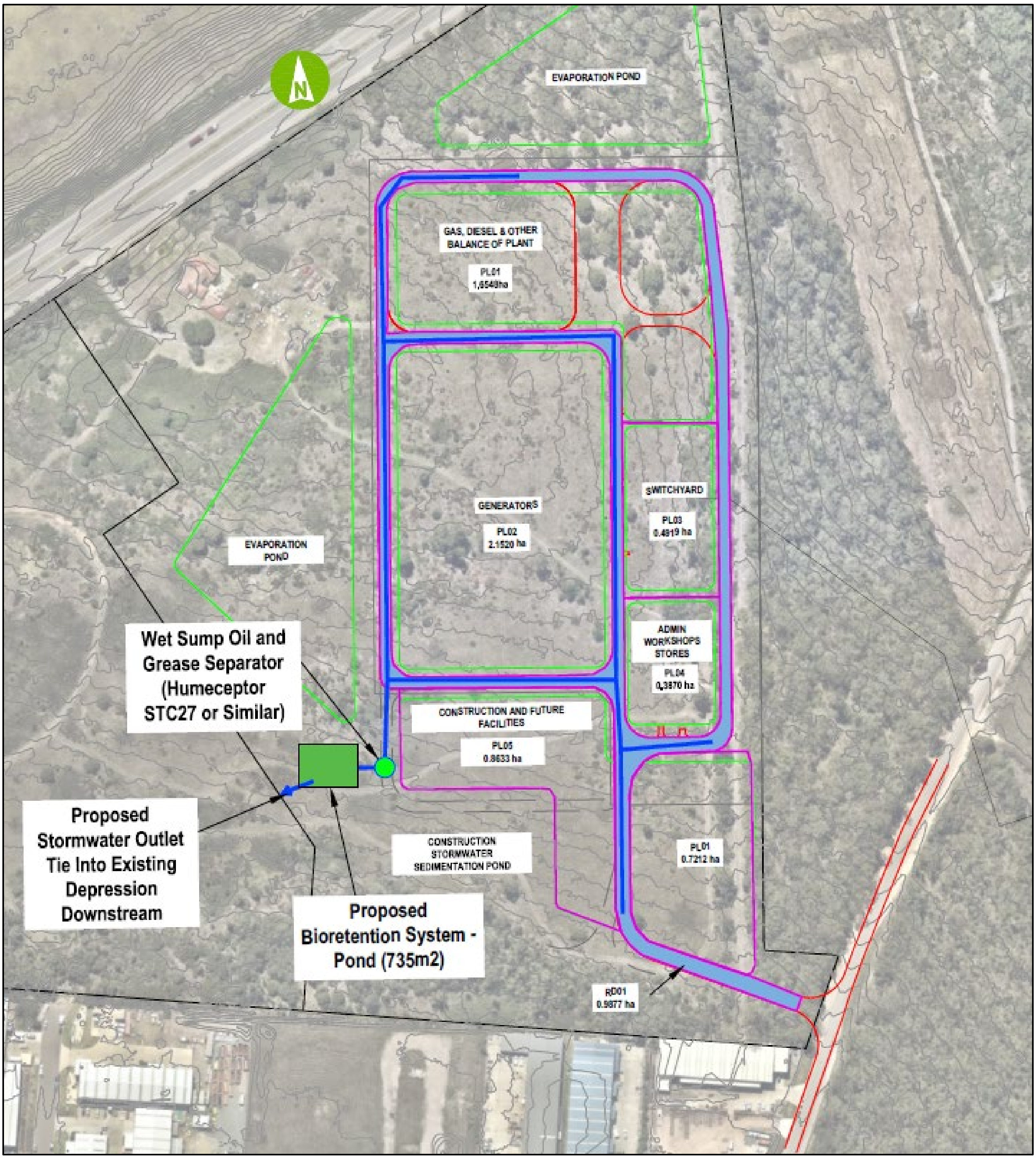
7 Conclusion

Based on the tabulated results in **Table 6-4, Table 6-5** & **Table 6-6**, two models were completed for a 500m^2 bio-retention and 735m^2 respectively. Both designs satisfied the water quality stripping targets but only the 735m^2 bio-retention model satisfied the NorBE criteria**.** Since this development falls within a water drinking catchment area, the targets for both water quality stripping and NorBE need to be satisfied as per Port Stephens Council Development Control Plan (*DCP*) 2014.

8 References

- Water By Design, 2014. Bioretention Technical Design Guidelines. Version 1.1, October 2014
- BMT WBM Pty Ltd, 2010. NSW Draft MUSIC Modelling Guidelines. Prepared for Greater Sydney Local Land Services by BT WBM Pty Ltd, August 2010
- BMT WBM, 2015. NSW MUSIC Modelling Guidelines. Prepared for Greater Sydney Local Land Services by BT WBM Pty Ltd, August 2015
- Port Stephens Council, 2015. Port Stephens Council Development Control Plan 2014. Accessed 5 August 2019 at **http://www.portstephens.nsw.gov.au/grow/development-controls-plans-and-strategies/dcp**
- NSW Government, 2019. Water Sharing Plan for the Tomago Tomaree Stockton Groundwater Sources 2003. Accessed 5 August 2019 at https://www.legislation.nsw.gov.au/#/view/regulation/2003/118
- Using MUSIC in Sydney Drinking Water Catchment, WaterNSW, June 2019.

Attachment 1 Surface Water Management Plan



Attachment 2 MUSIC Modelling Results

MUSIC-*link* Report

Project Details		Company Details	
Project:		**Company:**	
Report Export Date:	13/08/2019	**Contact:**	
Catchment Name:	Newcastle AGL wq MUSIC Link_001	**Address:**	
Catchment Area:	3.737ha	**Phone:**	
Impervious Area*:	100%	**Email:**	
Rainfall Station:	WILLIAMTOWN RAAF - Station 061078 - Zone B		
Modelling Time-step:	6 Minutes		
Modelling Period:	1/01/1998 - 31/12/2007 11:54:00 PM		
Mean Annual Rainfall:	1125mm		
Evapotranspiration:	1394mm		
MUSIC Version:	6.2.1		
MUSIC-link data Version:	6.22		
Study Area:	Williamtown		
Scenario:	Sensitive Catchment - Sandy soils		

* takes into account area from all source nodes that link to the chosen reporting node, excluding Import Data Nodes

Treatment Train Effectiveness		Treatment Nodes		Source Nodes	
Node: Receiving Node	**Reduction**	**Node Type**	**Number**	**Node Type**	**Number**
Flow	4.58%	Bio Retention Node	1	Urban Source Node	8
TSS	94.5%	GPT Node	1		
TP	75.7%				
TN	64.5%				
GP	100%				

Passing Parameters

Node Type	Node Name	Parameter	Min	Max	Actual
Bio	Bioretention 735m2	Hi-flow bypass rate (cum/sec)	None	None	0.867
Bio	Bioretention 735m2	PET Scaling Factor	2.1	2.1	2.1
GPT	Gross Pollutant Trap	Hi-flow bypass rate (cum/sec)	None	99	0.07
Receiving	Receiving Node	% Load Reduction	None	None	4.58
Receiving	Receiving Node	GP % Load Reduction	90	None	100
Receiving	Receiving Node	TN % Load Reduction	45	None	64.5
Receiving	Receiving Node	TP % Load Reduction	60	None	75.7
Receiving	Receiving Node	TSS % Load Reduction	90	None	94.5
Urban	PL01 imp	Area Impervious (ha)	None	None	0.5
Urban	PL01 imp	Area Pervious (ha)	None	None	0
Urban	PL01 imp	Total Area (ha)	None	None	0.5
Urban	PL02 imp	Area Impervious (ha)	None	None	0.86
Urban	PL02 imp	Area Pervious (ha)	None	None	0
Urban	PL02 imp	Total Area (ha)	None	None	0.86
Urban	PL03 imp	Area Impervious (ha)	None	None	0.2
Urban	PL03 imp	Area Pervious (ha)	None	None	0
Urban	PL03 imp	Total Area (ha)	None	None	0.2
Urban	PL04 Roof	Area Impervious (ha)	None	None	0.31
Urban	PL04 Roof	Area Pervious (ha)	None	None	0
Urban	PL04 Roof	Total Area (ha)	None	None	0.31
Urban	PL05 imp	Area Impervious (ha)	None	None	0.26
Urban	PL05 imp	Area Pervious (ha)	None	None	0
Urban	PL05 imp	Total Area (ha)	None	None	0.26
Urban	PL05 Roof	Area Impervious (ha)	None	None	0.26
Urban	PL05 Roof	Area Pervious (ha)	None	None	0
Urban	PL05 Roof	Total Area (ha)	None	None	0.26
Urban	PL06 imp	Area Impervious (ha)	None	None	0.36
Urban	PL06 imp	Area Pervious (ha)	None	None	0
Urban	PL06 imp	Total Area (ha)	None	None	0.36
Urban	RD01	Area Impervious (ha)	None	None	0.987
Urban	RD01	Area Pervious (ha)	None	None	0
Urban	RD01	Total Area (ha)	None	None	0.987

Only certain parameters are reported when they pass validation

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