Centennial Newstan Pty Ltd

Newstan Mine Extension Project
Environmental Impact Statement

September 2020

Executive summary

Newstan Colliery is an existing underground coal mine located in the Lake Macquarie Local Government Area (LGA), approximately 25 kilometres south west of Newcastle and 140 kilometres north of Sydney, NSW. It is owned and operated by Centennial Newstan Pty Ltd (Centennial Newstan).

Mining operations at Newstan Colliery began in 1887 and upon the introduction of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) operated pursuant to continuing use rights in accordance with Part 4, Division 10 of the EP&A Act (continuing use rights). On 14 May 1999 the (then) Minister for Urban Affairs and Planning granted Development Consent DA 73-11-98 under Part 4 of the EP&A Act for the Newstan Colliery Life Extension Area. This approval enabled mining to continue within the existing mining areas as well as the expansion of mining into areas that had not previously been mined. Development Consent DA 73-11-98 has been modified on eight occasions, with the most recent modification approved on 17 January 2019.

In August 2014, the underground operations at Newstan Colliery were placed onto care and maintenance due to poor market conditions. In recent years, Centennial Newstan has commenced feasibility investigations into the recommencement of mining at Newstan Colliery. Centennial Newstan is now seeking approval for the continuation of mining within the West Borehole seam. The Newstan Mine Extension Project (the project) proposes the extraction up to 25.9 million tonnes (Mt) of Run of Mine (ROM) coal over a fifteen year period. The proposed underground mining will be supported by operation of existing surface facilities at Newstan Colliery, and the augmentation and operation of surface facilities at the nearby Awaba Colliery (another existing Centennial Newstan underground mining operation, currently under care and maintenance).

This Environmental Impact Statement (EIS) has been prepared to assess the environmental, social and economic impacts of the project and will accompany a State Significant Development (SSD) application under Division 4.7 of Part 4 of the EP&A Act.

Project overview

Bord and pillar mining is proposed using continuous miner methods that will include areas of first workings, partial extraction and full extraction. A mix of metallurgical and thermal coal is proposed to be extracted at a maximum rate of 4 Mtpa. It will be delivered to the Newstan Colliery Surface Site via a series of existing underground conveyors. Once the coal reaches the Newstan Colliery Surface Site it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145), managed by Centennial Coal's Northern Coal Services business unit.

Other key features of the project include:

- Utilisation of the Newstan Colliery Surface Site to provide parking, bathhouse, administration and workshop facilities for the underground workforce. A small number of administrative, maintenance and monitoring personnel will also be located at Awaba Colliery Surface Site.
- Transportation of personnel and materials to and from the underground mining area via the existing men and materials drift at Newstan Colliery Surface Site.
- Continued operation of the two existing ventilation fans at Newstan Colliery Surface Site and the installation and operation of three new ventilation fans at the existing ventilation shaft at Awaba Colliery Surface Site.

- In-seam gas drainage, with gas transferred to a new gas flaring facility to be located within the existing disturbance footprint of Awaba Colliery Surface Site.
- Extraction of underground water via the existing Fassifern Pump Station at Newstan Colliery Surface Site and groundwater management in accordance with an approved Mining Operations Plan (MOP).
- Clearing of approximately 0.35 ha of remnant vegetation at the Awaba Colliery Surface Site for the construction of new ancillary facilities that could not be sited on pre-disturbed areas.

The project proposes the continuation of underground mining within an established mining precinct that has been operating for over 130 years. The project has been developed and refined in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the ‘avoid, minimise, offset’ hierarchy. In this regard, Centennial Newstan has worked through numerous iterations of the mine design to develop a project that responds to three key considerations:

- The coal resource is a public asset owned by the State of NSW and it is therefore in the public interest to optimise resource recovery.
- The project is constrained by a range of sensitive built and natural environmental features and their protection throughout all project phases must be a priority.
- Feedback from stakeholders must be considered and incorporated into the development of the project.

The project makes use of the existing surface facilities at the Newstan and Awaba Collieries and the coal handling and transportation operations already approved for the Northern Coal Logistics Project under SSD-5145. This represents a beneficial use of existing infrastructure and offers a substantial synergy with approved operations that will minimise further impacts beyond those already approved.

The low-impact and flexible bord and pillar mine design balances coal recovery with a need to limit mine subsidence. The utilisation of varying levels of extraction (first workings, partial and full extraction) will provide Centennial Newstan with the ability to limit the extent of subsidence in specific areas based on the need to protect certain important built assets or natural environmental features, which has been a key focus during development of the project. Conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and sensitive surface water features such Stockyard Creek, Kilaben Creek, and Stony Creek.

The potential impacts of the project have been minimised by maximising the use of existing surface infrastructure and equipment, developing a low-impact and flexible mine design, minimising surface disturbance for gas drainage and greenhouse gas abatement, and proposing a complementary suite of mitigation measures and management strategies to be implemented during construction, operation, and closure.

Benefits of the project

The project is aligned with the broader Centennial Coal business strategy in that it facilitates the development of a new semi-soft coking coal product stream and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets. Over time, the project can potentially replace the coal product currently supplied to the domestic market by other Centennial operations as these other resources become depleted. This will ensure ongoing security of supply for domestic electricity generation.

If approved, the project will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. The project will prevent the sterilisation of a substantial coal resource within the mining lease area, that would be unlikely to be extracted independently or as part of any other mining proposal, whilst balancing impacts to stakeholders and the environment.

In addition, the project will provide several positive flow-on effects to the local, regional and state economies through the continued employment of 320 full time equivalent (FTE) personnel and the generation of approximately $80 million in royalties to the State and $28 million in employee benefits.

Overview of stakeholder engagement

A comprehensive stakeholder engagement program was undertaken to identify, incorporate and address stakeholder concerns associated with the project. Key stakeholders were identified as those parties that are either directly impacted by the project or who have or will have an interest in the project as it progresses through the approval, construction, operational and closure phases. These include~~d~~ local, State and federal government agencies, industry, landholders, special interest groups, the broader community and Aboriginal stakeholders.

The engagement completed for the project builds on Centennial Newstan's existing relationships and engagement activities. The feedback received has allowed Centennial Newstan to identify issues of concern or interest, and to consider these issues during project planning and assessment. In particular, extensive consultation has been undertaken regarding the management of direct and indirect subsidence-related impacts to key infrastructure assets and environmental features. These consultations have formed an integral part of the mine design process and they will continue during the construction, operation, and closure phases of the project.

Overview of environmental, social and economic impacts

This EIS includes a detailed assessment of the potential environmental, social and economic impacts of the project and outlines a range of measures to manage, mitigate and offset these impacts, where necessary. It has been completed in accordance with relevant standards and guidelines to address State and Federal assessment requirements, as set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project. The key findings of the various impact assessments completed for the project are summarised in Table ES-1.

Table ES-1 Summary of key environmental, social, and economic impact assessment findings

Environmental/ social/ economic aspect	Summary of key findings
Subsidence	• Less than 20 mm of vertical subsidence is predicted in areas of first workings only. This includes under second and third order streams, the Main Northern Railway, a 132 kV substation, the Eraring Power Station, and the Eraring Ash Dam wall. • A maximum vertical subsidence of 1,100 mm is predicted in areas of partial extraction (single-seam conditions). This includes under the Ulan Rail Loop and under sections of an existing 132 kV transmission line that are subject to multi-seam conditions. • The greatest subsidence effects (with a maximum vertical subsidence of 3,250 mm) are predicted to occur in areas of full extraction where the proposed panels mine directly beneath the existing Awaba Colliery workings in the Great Northern Seam. • Long term subsidence impacts on steep slopes and rock outcrops is considered unlikely. • Subsidence impacts to residential areas is considered unlikely. • Subsidence monitoring, management and remediation will continue to be undertaken, including rail line and watercourse impact monitoring.
Hydro geotechnical	• First workings within the West Borehole seam in areas underlying Origin Energy's proposed grouting areas within the Western Emplacement Area are considered unlikely to cause or increase any direct or indirect hydraulic connectivity between the workings. • First workings are also not expected to impact the integrity of Origin Energy's proposed void filling in the former Awaba Colliery workings or increase flow paths between the Eraring ash dam and former Awaba Colliery workings. • The mine design incorporates strategies developed in consultation with Origin Energy to mitigate any interactions and risks. • A comprehensive monitoring program will be undertaken with an appropriate trigger action response plan developed and implemented if required.
Groundwater	• The project is predicted to result in an increase in groundwater inflow into the mine workings. A Water Access Licence (WAL) will be required for the Sydney Basin – North Coast Groundwater Source for the interception and extraction of groundwater from the proposed and existing workings. • There is no predicted impact on baseflow or Lake Macquarie due to the proposed mine workings. • Groundwater impacts due to the proposed mine workings do not extend up to the alluvium. Therefore, there will be no impact to the alluvial water table or baseflow to creeklines attributable to the proposed workings. This specifically includes Stockyard and Kilaben Creek catchments. • Modelled drawdown of private bores due to proposed workings is less than 1 m at all bores at the end of mining. • There are no high priority vegetation GDEs within the radius of drawdown. • All groundwater impacts attributable to the project have been assessed to be less than the Level 1 impact considerations in the NSW AIP. • The existing groundwater and flow monitoring program will be continued.

Environmental/ social/ economic aspect	Summary of key findings
Surface water	• The existing water management systems at Newstan Colliery and Awaba Colliery will be sufficient to accommodate the project, given some minor upgrades. • All water will continue to be treated at the Clean Water Plant prior to discharge at Newstan LDP001. The quality and quantity of discharge water will remain in accordance with the existing approved limits of EPL 395. • No additional surface water take is required due to the project. Therefore no additional surface water entitlements are required. • Any changes in the catchment areas due to the predicted subsidence are expected to be minor. As a result, it is considered that no appreciable changes to stream flows are likely to occur as a result of the project. • The existing flow monitoring program at Newstan Colliery and Awaba Colliery will be continued, in particular the continued monitoring of the discharges via Newstan LDP001 and LDP017 and extractions from the Fassifern underground storage.
Flooding	• Remnant ponding areas are predicted to increase (by approximately 2 ha due to subsidence) around existing waterbodies with minor areas within native bushland areas. • No material impacts to infrastructure, with respect to flooding, are expected to occur downstream of the study area. • Downstream of the subsidence impact areas, flood hazard is expected to decrease due to minor attenuation of peak flows within the Extension of Mining Area. Emergency management arrangements are not expected to change as a result of the project. • The majority of watercourse reaches were assessed as having negligible or low risk of impact from subsidence. • Monitoring and management plans will be implemented, including regular visual monitoring and development of appropriate stabilisation techniques.
Terrestrial ecology	• Approximately 0.35 ha of native vegetation will be cleared for construction of new ancillary facilities that could not be sited on pre-disturbed areas. This impact will be offset in accordance with the NSW Biodiversity Offset Scheme. • The project is unlikely to have a significant impact on threatened ecological communities and species listed under the EPBC Act as Matters of National Environmental Significance. • The project has the potential to lead to impacts to threatened plants and ecological communities from subsidence, cracking, sinkholes, plug-failures and ponding. LIDAR will be utilised to detect potential impacts. If impacts are detected, the extent of those impacts will be quantified and an offset liability report will be prepared to both quantify the impacts and outline the offset strategy that will be adopted to address those impacts.
Aquatic ecology	• Impacts on macroinvertebrate communities in LT Creek and Stony Creek due to a change in water quality from the project are considered unlikely. • Subsurface flow diversion and loss of surface flows may have a marginal impact on habitat availability, water, and sediment quality for macroinvertebrate communities in Stony Creek and Kilaben Creek. • The existing aquatic ecology monitoring program will continue for the project.

Environmental/ social/ economic aspect	Summary of key findings
Air quality and greenhouse gas	• The project is predicted to comply with all relevant air quality criteria, with the exception of the 24-hour average PM_{10} criterion and annual average $PM_{2.5}$ concentrations (which are due to pre-existing high background concentrations and the incremental impacts from the project are low and unlikely to cause an exceedance). • The annual Scope 1 and Scope 2 GHG emissions from the project are estimated to be 0.03 tonnes of CO_{2-e} per tonne of ROM coal produced. The introduction of flaring of the fugitive CH_4 emissions, rather than venting it direct to atmosphere ad part of the project significant reduces annual emissions. • The project would represent approximately 0.012% of Australia's national emissions. On this basis, it is concluded that the project will have a minimal impact on Australia's ability to meet its emission reduction target.
Noise and vibration	• The project is predicted to comply with the relevant operational noise criteria during standard weather conditions. During noise-enhancing weather conditions, a negligible exceedance of the noise criteria (up to 2 dB) is predicted during the night-time period at one assessment location. • Sleep disturbance impacts are considered unlikely to occur. • Construction noise emissions are predicted to comply with the relevant noise criteria at all assessment locations under both standard and noise-enhancing meteorological conditions. • A minor increase in road traffic noise (0.1 bB) is predicted for night-time construction traffic (ie early morning arrivals between 6:00 am and 7:00 am). There was no predicted increase in daytime traffic noise levels.
Traffic and transport	• The project is expected to have a negligible impact on the assessed road network and key intersections. Therefore, no road improvements or upgrades are proposed as part of the project. • The operation of the project is expected to have no impact on road safety, demand on public transport or pedestrian or cycling activities. • No cumulative impacts in regards to traffic and transport are expected over the operation of the project.
Soil and land resources	• The post-mining land use will be comparable with pre-mining land uses. The majority of predicted remnant ponding will occur in native bushland areas. • There will be negligible impact from the project on agricultural resources or enterprises.
Aboriginal heritage	• Seven Aboriginal heritage sites were identified within the study area and a further site was located within a 300m boundary of the study area. • These sites comprise three scarred trees and five isolated artefact/artefact scatter sites, with one site also containing shell material. • The project is unlikely to result in direct impacts to the Aboriginal archaeological sites present within the study area and the risk of indirect impacts to these sites is also low and can be mitigated. • In the event that a previously unrecorded Aboriginal object is identified within the study area, it will be managed in accordance with the Centennial Coal Northern Region Aboriginal Cultural Heritage Management Plan protocols.

Environmental/ social/ economic aspect	Summary of key findings
Historic heritage	• The assessment identified six listed and potential (unlisted) heritage items located within or in immediate proximity to the study area. • No significant impact to these heritage items was identified due to the project.
Visual amenity	• The project is expected to have a low to negligible impact on the visual amenity. • The capability of the landscape to screen views to the key components is considered to be high. The dense forested vegetation of the surrounding landscape is likely to reduce the potential magnitude of visual impact significance.
Social	• The project will have a minimal social impact, with changes to acoustic, air quality and visual amenity the key concern. • The project will not change how residents or visitors utilise the area or local community. • The project would create additional employment and commercial opportunities within the local area.
Economic	• The assessed net economic valuation of the project is a benefit of approximately $74.3 million (Net Present Value (NPV) over the project life). • The regional benefit relating to employee incomes was assessed as approximately $15 million over the life of the project. • The assessment indicated that a further $53 million a year in non-labour expenditure may be disbursed in the regional economy by Centennial Newstan. • Approximately $15 million of the regional sum would be spent in the local (LGA) economy annually. Total annual expenditure in NSW was estimated at approximately $82 million.
Hazard and risk	• No additional classes of hazardous chemicals or materials will be required for the project. • The project is not considered to comprise a "potentially hazardous industry" or a "potentially offensive industry" as per SEPP 33.
Bushfire	• The risk of a local bushfire adversely impacting persons on site is low. • Bushfire risk will continue to be actively managed in accordance with existing strategies.
Rehabilitation and closure	• The overall goal of closure of the Project Application Area is to maximise the retention of existing infrastructure at the Awaba Colliery Surface Site for reuse, rehabilitate remaining disturbed areas to be consistent with adjoining areas whilst not prohibiting potential future re-development of the site • There will be limited need for significant landform establishment during rehabilitation.

Conclusion and justification

The project proposes the continuation of underground mining within an established mining precinct that has been operating for over 130 years. The project is a logical continuation of the existing mining operations at Newstan Colliery, within existing mining tenements.

The potential impacts of the project have been minimised by maximising the use of existing surface infrastructure and equipment, developing a lower-impact and flexible mine design, minimising surface disturbance for gas drainage and greenhouse gas abatement, and proposing a complementary suite of mitigation measures and management strategies to be implemented during construction, operation, and closure. Centennial Newstan will continue to apply its leading practice environmental management and controls to mange environmental issues and respond to community concerns.

As outlined in Section 7.6, the project has been assessed against the principles of ESD in accordance with the EP&A Act and EP&A Regulations. This assessment has found that any environmental and social impacts associated with the project can be adequately avoided, mitigated and offset, whilst allowing the substantial economic and social benefits to the local region, State and Commonwealth be realised. The assessment therefore concludes that the project is consistent with the principles of ESD.

Newstan Colliery has provided substantial economic benefits to the Commonwealth, State, regional and local levels since it began operating in 1887. The project as proposed is a logical continuation of Newstan Colliery that would continue to provide economic benefits for the community. The project would generate approximately $80 million in royalties to the State and $28 million in employee benefits. Furthermore, the project would provide the continued employment of 320 FTEs.

Not proceeding with the project would represent the loss of these economic and employment benefits and the loss of a secure coal supply to Eraring Power Station (provided through existing infrastructure of private haul roads and conveyors) to maintain reliable electricity for the State.

In weighing up the main environmental impacts (costs and benefits) associated with the project as assessed and described in this EIS, the Project is, on balance, considered to be in the public interest.

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Appendices

1. Introduction

This chapter provides an introduction to the document by:

- Explaining the background to the project.
- Presenting an overview of the key features of the project.
- Summarising the project history and the relationship of existing Centennial Coal operations to the project.
- Summarising the alternatives considered during development of the project design.
- Outlining the document's purpose and structure.

Further details are presented in the following subsections.

1.1 Background

Newstan Colliery is an existing underground coal mine located in the Lake Macquarie Local Government Area (LGA), approximately 25 kilometres south west of Newcastle and 140 kilometres north of Sydney, NSW (see Figure 2-1). It is owned and operated by Centennial Newstan Pty Ltd (Centennial Newstan).

Mining operations at Newstan Colliery began in 1887 and upon the introduction of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) operated pursuant to continuing use rights in accordance with Part 4, Division 10 of the EP&A Act (continuing use rights). On 14 May 1999 the (then) Minister for Urban Affairs and Planning granted Development Consent DA 73-11-98 under Part 4 of the EP&A Act for the Newstan Colliery Life Extension Area. This approval enabled mining to continue within the existing mining areas as well as the expansion of mining into areas that had not previously been mined. Development Consent DA 73-11-98 has been modified on eight occasions, with the most recent modification approved on 17 January 2019. Development Consent DA 73-11-98 lapses on 6 July 2021, at which point all mining operations at Newstan Colliery must cease. A new development consent will be required if mining operations are to continue beyond this date.

In August 2014, the underground operations at Newstan Colliery were placed onto care and maintenance due to poor market conditions. In recent years, Centennial Newstan has commenced feasibility investigations into the recommencement of mining at Newstan Colliery. Centennial Newstan (the proponent) is now seeking approval for the continuation of mining within the West Borehole seam and operation of associated surface facilities (the project).

The proposed underground mining will be supported by operation of existing surface facilities at Newstan Colliery, and the augmentation and operation of surface facilities at the nearby Awaba Colliery (another existing Centennial Newstan underground mining operation, currently under care and maintenance).

1.2 Project overview

The project seeks to extend underground mining operations at Newstan Colliery to the south. A low-impact and flexible mine design has been developed that proposes bord and pillar mining which includes areas of first workings, partial extraction and full extraction (see Figure 1-1) to balance coal recovery with a need to limit mine subsidence. The utilisation of varying levels of extraction (first workings, partial and full extraction) will provide Centennial Newstan with the ability to limit the extent of subsidence in specific areas based on the need to protect certain important built assets or natural environmental features. This approach has been adopted to avoid or minimise subsidence impacts where necessary, whilst also enabling economical extraction of the coal resource.

The project also proposes to, where possible, utilise existing surface facilities at Newstan and Awaba Collieries to further minimise environmental impacts that would otherwise occur if entirely new surface facilities were to be established for the project. Further, all proposed infrastructure will be situated at Awaba Colliery with the majority to be constructed on existing disturbed areas.

A mix of metallurgical and thermal coal is proposed to be extracted at a maximum rate of 4 million tonnes per annum (Mtpa). The project proposes the extraction of up to 25.9 million tonnes (Mt) of Run of Mine (ROM) coal over a fifteen year period.

Coal extracted by the project will be delivered to the Newstan Colliery Surface Site via a series of existing underground conveyors. Once the coal reaches the Newstan Colliery Surface Site it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145), managed by Centennial Coal's Northern Coal Services business unit.

Other key features of the project include:

- Utilisation of the Newstan Colliery Surface Site to provide parking, bathhouse, administration and workshop facilities for the underground workforce. A small number of administrative, maintenance and monitoring personnel will also be located at the nearby Awaba Colliery Surface Site.
- Transportation of personnel and materials to and from the underground mining area via the existing men and materials drift at Newstan Colliery Surface Site.
- Continued operation of the two existing ventilation fans at Newstan Colliery Surface Site and the installation and operation of three new ventilation fans at the existing ventilation shaft at Awaba Colliery Surface Site.
- In-seam gas drainage, with gas transferred to a new gas flaring facility to be located within the existing disturbance footprint of Awaba Colliery Surface Site.
- Extraction of underground water via the existing Fassifern Pump Station at Newstan Colliery Surface Site and groundwater management in accordance with an approved Mining Operations Plan (MOP).
- Clearing of approximately 0.35 ha of remnant vegetation at the Awaba Colliery Surface Site for the construction of new ancillary facilities that could not be sited on pre-disturbed areas.

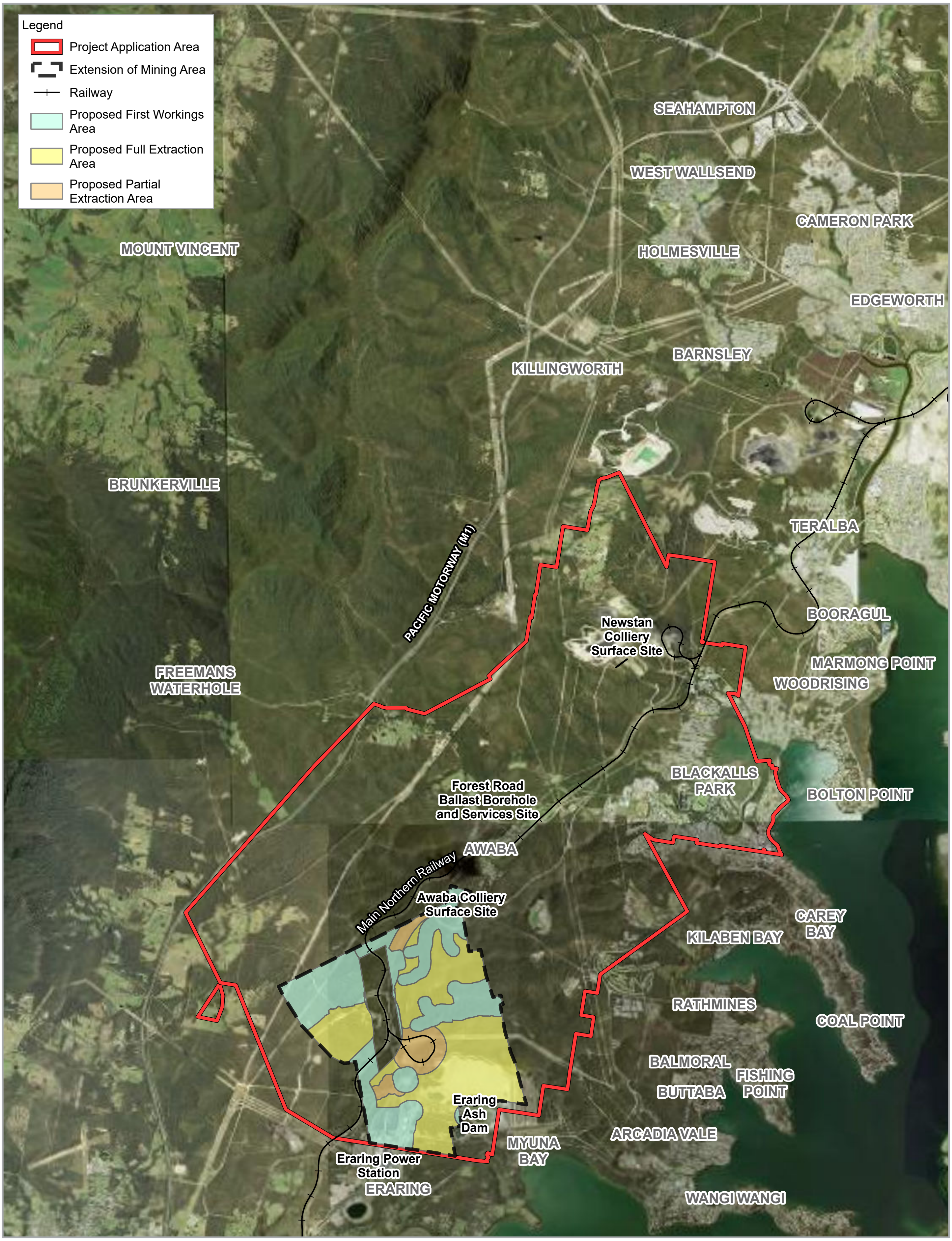
A detailed description of the project is presented in Chapter 2.

1.2.1 The proponent

The proponent for the project is Centennial Newstan Pty Limited (Centennial Newstan) (ABN 68 101 508 865), a wholly owned subsidiary of Centennial Coal Company Limited (Centennial Coal) (ABN 30 003 714 538). Centennial Coal is a wholly owned subsidiary of Banpu Public Company Limited (Banpu), which is listed on the Stock Exchange of Thailand.

The proponent's address is:

Centennial Newstan Pty Limited
PO Box 1000
Toronto NSW 2283



Paper Size ISO A4

0 0.6 1.2 1.8 2.4 3

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Conceptual project layout

Figure 1-1

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Print date: 09 Jun 2020 - 04:22

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

1.2.2 Project objectives

The key objectives of the project are to:

- Produce a semi-soft coking coal product for the export market and a thermal coal product for both the domestic and export markets.
- Help to ensure ongoing security of thermal coal supply for domestic electricity generation at the adjacent Eraring Power Station through the beneficial use of existing private infrastructure.
- Provide tangible social and economic benefits to the local community and positive flow-on effects to regional and State economies through additional wages and royalties.
- Design, construct, operate and close the project in an ecologically sustainable manner.
- Minimise the project's impacts on sensitive built and natural environmental features.
- Optimise resource recovery. The coal resource is a public asset owned by the State of NSW and it is therefore in the public interest to optimise resource recovery.
- Regularise the development consents for Newstan and Awaba Collieries into a single contemporary development consent, providing streamlined and enhanced environmental management.
- Provide for the continuation of mining at Newstan Colliery beyond 6 July 2021, the date at which Development Consent DA 73-11-98 lapses.

1.2.3 Project history

The project interrelates with three existing approved Centennial Coal operations:

- Newstan Colliery.
- Awaba Colliery.
- Northern Coal Logistics Project.

Descriptions of these operations, and explanations of the project's relationship to each, are presented in the following subsections. These approved operations are illustrated on Figure 1-2.

Newstan Colliery

Newstan Colliery comprises the underground workings and a number of associated surface facilities authorised under either DA 73-11-98 or continuing use rights. The primary activities currently authorised are as follows:

- Extraction of up to 4 Mtpa of ROM coal from within the consolidated development consent boundary, which includes the Main West mining area and first workings within the West Borehole seam.
- Pumping water from underground workings to Newstan Colliery Surface Site for recycling, reuse, treatment and discharge.
- Construction and operation of a ventilation shaft and fan at the Awaba Colliery Surface Site.
- Operation of ventilation shafts, boreholes and associated overhead power lines. This includes the operation of a small ballast borehole and services sites known as the Forest Road ballast borehole and services site, which is located approximately 4 km to the south-west of the drift entries at Newstan Colliery Surface Site.

- Operation of a men and materials drift to the underground workings from Newstan Colliery Surface Site.
- Personnel of up to 320 full time employees.
- Operating 24 hours per day, seven days a week.

The development consent for Newstan Colliery has been modified on eight occasions. The development consent lapses on 6 July 2021, at which point a new development consent will be required for the continuation of operations.

Awaba Colliery

Awaba Colliery is located south of the Awaba village on the western side of Lake Macquarie. Mining operations commenced in 1947. Awaba Colliery operates pursuant to continuing use rights and a project approval (Project Application 10_0038) that was granted in May 2011 under Part 3A of the EP&A Act.. The current project approval has since been declared a State Significant Development (SSD) under Clause 6 of Schedule 2 to the *Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017*, for the purposes of the EP&A Act. Accordingly, Awaba Colliery now operates as an SSD approval (MP 10_0038). Awaba Colliery's SSD approval provides approval for:

- Bord and pillar development and pillar extraction using continuous miners within the 'Main South' and 'East B' underground mining areas.
- Production and handling of up to 880,000 Mtpa of ROM coal using existing surface facilities at Awaba Colliery Surface Site.
- Use of existing ancillary surface facilities at Awaba Colliery Surface Site.
- Expansion of the existing Pollution Control Dam at Awaba Colliery Surface Site.
- Transfers of water from underground workings to Eraring Power Station and Eraring Ash Dam.

With coal reserves exhausted, Awaba Colliery ceased operating as a producing mine in March 2012. However, the surface facilities are still being used to service Newstan Colliery. The existing workings within the Great Northern seam also continue to be utilised post mining for the management of groundwater in accordance with the approved MOP.

In 2018, Centennial Newstan also received approval under Part 4 of the EP&A Act (DA/477/2018) to construct and operate a 200 kW prefabricated photovoltaic solar farm within the confines of the existing parking facilities at the Awaba Colliery Surface Site. This solar farm is approved separately and is not part of the approved operations for Awaba Colliery under MP 10_0038.

Relationship of Awaba Colliery to the project

The project proposes the ongoing use and upgrade of the surface infrastructure at Awaba Colliery Surface Site in addition to the construction and operation of a number of new facilities. Owing to the long history of activities at Awaba Colliery, the site contains a number of previously disturbed areas. To minimise environmental impacts, Centennial Newstan proposes to make use of these existing disturbance areas for the siting of new infrastructure as part of the project.

The following activities are proposed at Awaba Colliery Surface Site as part of the project:

- Ongoing use of the administration offices and parking facilities, excluding the footprint of the Awaba photovoltaic solar farm (DA/477/2018).
- The construction and operation of a gas flaring facility.

- Installation of three new ventilation fans. The fans would be installed at the site of the existing ventilation shaft.
- Upgrade and ongoing use of the underground water supply and communications infrastructure.
- Drilling of boreholes into the workings for the supply of bulk materials, gas drainage infrastructure, electricity, compressed air and water.

In addition to the proposed continued operation of the Awaba Colliery Surface Site, management of groundwater within the existing Awaba Colliery underground workings will be undertaken in accordance with an approved MOP.

It is proposed that Project Approval 10_0038 be surrendered subject to consent being granted for the project.

Further details regarding the relationship of the project to the Awaba Colliery are presented in Section 2.3.

Northern Coal Logistics Project

The Northern Coal Logistics Project provides the coal handling, processing and transport facilities to deliver coal from Mandalong Mine and Newstan Colliery to domestic and export markets. These activities are approved under Development Consent SSD-5145, with facilities comprised of the Newstan Colliery Surface Site, Cooranbong Entry Site, private haul roads and rail loading infrastructure.

Activities that occur at Newstan Colliery Surface Site, as approved under SSD-5145 for the Northern Coal Logistics Project, include:

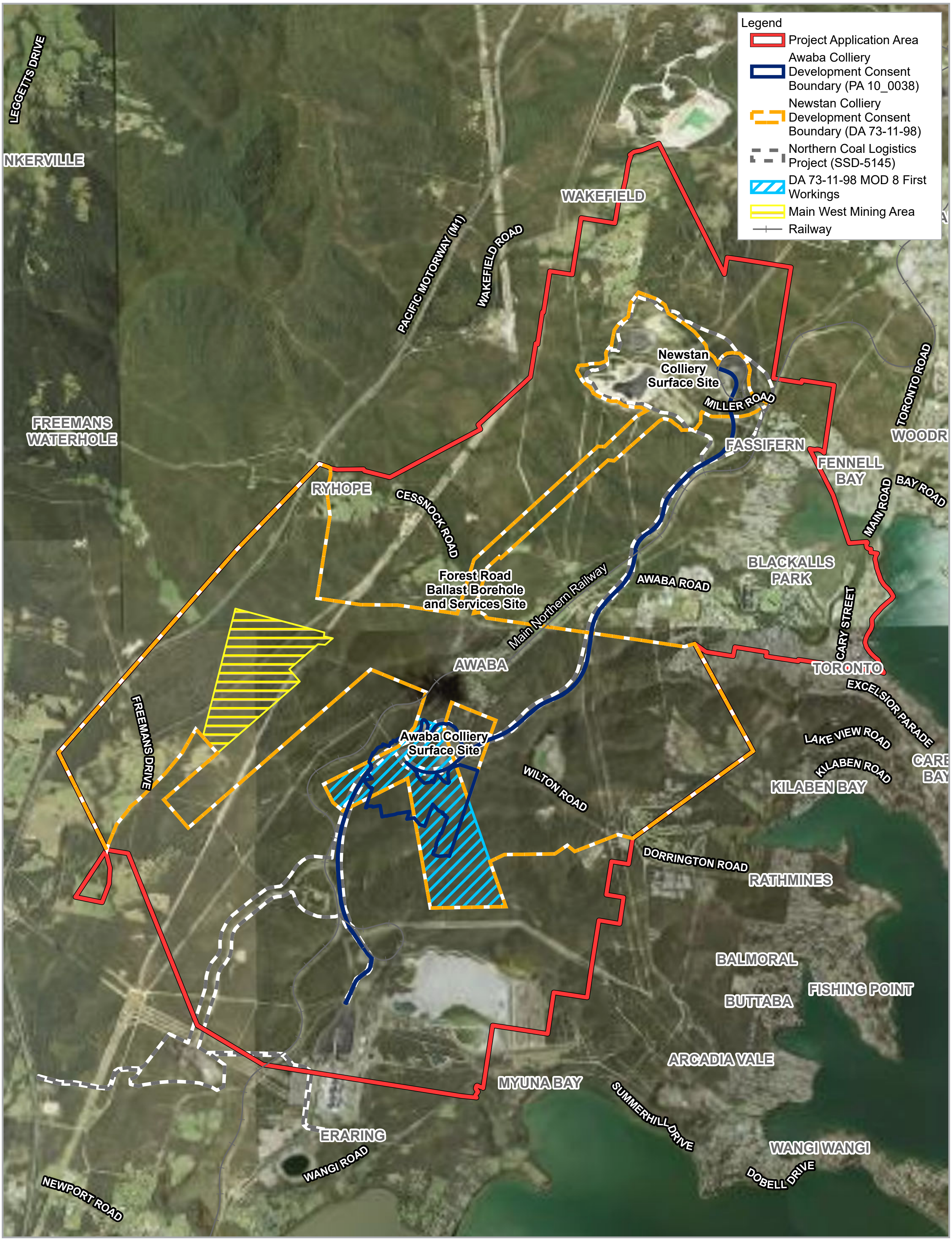
- Upgrades to coal handling and train loading infrastructure.
- Processing of up to 8 Mtpa ROM coal through the Newstan Coal Processing Plant, representing ROM coal supplied from Newstan Colliery (up to 4.5 Mtpa), Mandalong Mine (up to 6 Mtpa), and Awaba Colliery (up to 0.88 Mtpa).
- Transporting up to 8 Mtpa of product coal through the Newstan Colliery rail loading facilities by train to the Port of Newcastle.
- Transporting of up to 6 Mtpa of product coal via overland conveyor to Eraring Power Station.
- Transporting up to 4.5 Mtpa of product coal by truck to Eraring Power Station utilising the Newstan-Eraring private haul road.
- Receiving coal from Cooranbong Entry Site and coal and stone material from Awaba Colliery by truck utilising the Cooranbong and Newstan-Eraring private haul roads.
- Transporting reject material from the Newstan Colliery Coal Processing Plant to the Northern and Southern Reject Emplacement Areas and Hawkmount Quarry.
- Discharge of water from Licensed Discharge Points.
- Employment of up to 166 Full Time Equivalent (FTE) operational personnel of which 60 are permitted at the Cooronbong Entry Site and 106 at Newstan Colliery.

Relationship of Northern Coal Logistics Project to the project

Once ROM coal from the Newstan Colliery underground workings reaches the surface at the Newstan Colliery Surface Site, it forms part of the Northern Coal Logistics Project. The Northern Coal Logistics Project is approved to receive, handle and process up to 8 Mtpa of ROM coal, of which up to 4.5 Mtpa may be received from Newstan Colliery. The Northern Coal Logistics Project is approved to operate until 31 December 2045. The 4 Mtpa of ROM coal proposed to be extracted as part of the project would be received, handled and processed at the Newstan Colliery Surface Site in accordance with the approved operations under SSD-5145. At this production rate, the project would not exceed the approved processing capacity of the Northern Coal Logistics Project.

All surface water management at Newstan Colliery Surface Site, including operation of licenced discharge points, form part of the Northern Coal Logistics Project (SSD-5145). Transfers of water between the Newstan Colliery underground workings and the Newstan Colliery Surface Site were considered as part of the Northern Coal Logistics Project. These transfers and associated volumes have also been considered in this EIS to confirm that all predicted flows are within the limits approved under SSD-5145.

Further details regarding the relationship of the project to the Northern Coal Logistics Project are presented in Section 2.3.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Approved operations

Figure 1-2

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Print date: 09 Jun 2020 - 04:21

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

1.2.4 Relationship to Eraring Power Station and Eraring Ash Dam

The Eraring Power Station is a coal fired electricity power station constructed in 1977, which is located on Rocky Point Road at Eraring. The infrastructure associated with the Eraring Power Station includes the Eraring Ash Dam (a fly ash emplacement dam), a number of buildings, water and fuel storage tanks, and coal stockpiles and associated infrastructure. The area within which underground mining is proposed for the project, termed the Extension of Mining Area (refer to Section 2.2.1), is partially overlaid by the Eraring Power Station and Eraring Ash Dam. Origin Energy own and operate these assets.

Origin Energy received approval to augment the Eraring Ash Dam in December 2019 under Project Approval 07_0084 Mod 1. The modification involves the placement of ash in a series of upstream raises or terraces, or through placement from a pipe (or pipes) from the edges of the dam to form a 'beach' extending across the length of the ash dam operational area to achieve ash deposition to Reduced Level (RL) 140 m. The design shares similarities with the existing project approval in terms of the overall landform profile and ash placement techniques. However the augmented landform requires construction of a new saddle embankment (termed the Western Saddle Embankment), improved stormwater diversion system and the filling of mine voids underlying the Eraring Ash Dam (AECOM, 2018).

The interaction of the project with the Eraring Power Station and Eraring Ash Dam has been a key consideration during development and refinement of the project design. Centennial Newstan understands there is significant community and government agency interest regarding:

- The potential for leachate from Eraring Ash Dam to enter the historic Awaba workings and then mobilise via groundwater aquifers into Lake Macquarie.
- The potential for underground mining to compromise the structural integrity of the Eraring Ash Dam wall and Eraring Power Station.

Centennial Newstan has placed considerable effort into understanding these risks as part of the mine planning process in consultation with Origin Energy and in response has developed a mine design and complementary suite of mitigation measures to mitigate the identified risks.. Further detail is provided throughout this EIS.

1.2.5 Project justification and alternatives considered

The long history of mining at the Newstan and Awaba Collieries, and the associated environmental monitoring and management activities that have been undertaken over many years, has provided Centennial Newstan with a large amount of baseline information to help guide the development of the project. Centennial Newstan has also undertaken extensive detailed project-specific geological, engineering, environmental, financial and other technical investigations over several years to develop and refine the project.

The project has been designed in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the 'avoid, minimise, offset' hierarchy. A review of feasible alternatives to the proposed development has been undertaken to demonstrate that the preferred option constitutes the most appropriate scenario to meet the identified project needs. The following alternatives have been considered by Centennial Newstan during the preliminary planning for the project:

- Not proceeding with the project.
- Alternative methods for extraction of the resource.
- Alternative locations and designs for various infrastructure components of the project.

The combination of first workings only, partial extraction, and full extraction using bord and pillar mining has been adopted as the preferred resource extraction option to minimise subsidence impacts to sensitive built and natural surface features and to mitigate multi-seam subsidence impacts associated with the Awaba Colliery workings in the overlying Great Northern seam. This mining method, along with the combined utilisation of surface infrastructure at Newstan Colliery Surface Site and Awaba Colliery Surface Site, constitutes the preferred option for the project.

The potential impacts of the project have been minimised by maximising the use of existing surface infrastructure and equipment, developing a low-impact and flexible mine design, minimising surface disturbance for gas drainage and greenhouse gas abatement, and proposing a complementary suite of mitigation measures and management strategies to be implemented during construction, operation, and closure.

Conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and sensitive surface water features such Stockyard Creek, Kilaben Creek, and Stony Creek.

1.3 Purpose of this document

The project is SSD pursuant to Schedule 1 of the *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP). Accordingly, Centennial Newstan is seeking approval for the project under Part 4, Division 4.7 of the EP&A Act. An Environmental Impact Statement (EIS) is a requirement of the approval process. This EIS document has been prepared to accompany Centennial Newstan's application for approval of the project. It has been prepared to the form and content requirements outlined in Clauses 6 and 7 of the NSW *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) and generally in accordance with the draft guideline titled *Preparing an Environmental Impact Statement* (NSW Government, 2019a).

The purpose of this document is to inform government agencies and other stakeholders about the project, its potential environmental, social and economic impacts, and the measures that will be implemented to manage, mitigate and offset those impacts. It addresses the specific requirements set out in the Secretary's environmental assessment requirements (SEARs) for the project, which were issued by the NSW Department of Planning, Industry and Environment – Planning and Assessment Division (DPIE – Planning and Assessment) (formerly Department of Planning, Industry and Environment (DPIE)) on 3 September 2019.

In addition to State matters, supplementary assessment requirements for Matters of National Environmental Significance (MNES), as required under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were provided to Centennial Newstan (to be incorporated into the SEARs) on 12 February 2020.

The SEARs, together with references to where each of the requirements have been addressed within this EIS, are presented in tabular format in Appendix A. This document therefore addresses both State and Commonwealth assessment requirements and would be assessed under an accredited assessment process.

2. Project description

This chapter presents a summary and detailed description of the project, and the rationale and alternatives considered during development of the project design. Further details are presented in the following subsections.

2.1 Project summary

An overview of the project is presented in Table 2-1. The project is described in detail in Section 2.2.

Table 2-1 Project overview

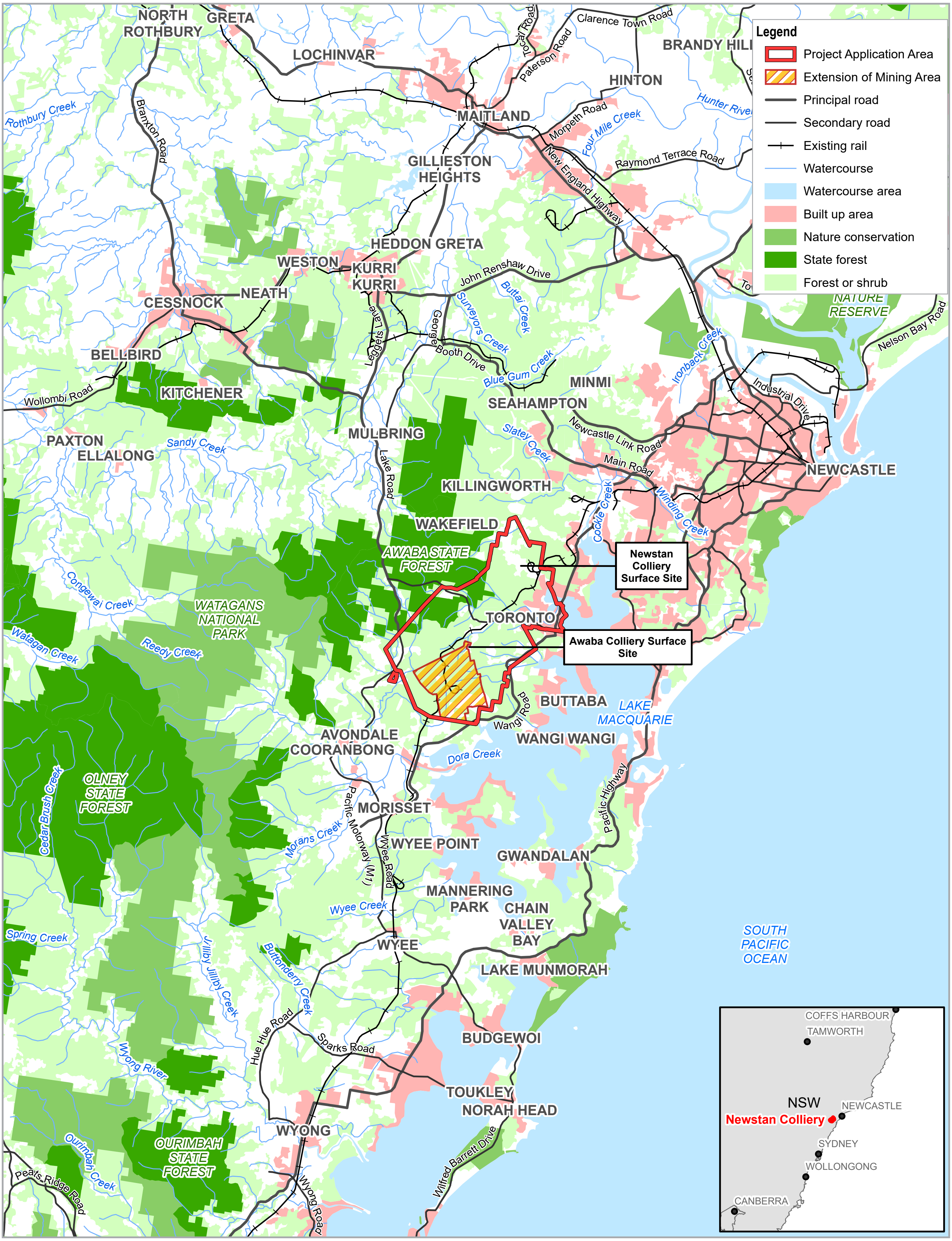
Aspect	Description
Proponent	Centennial Newstan
Project duration	15 years[1]
Project schedule	2021 - 2035
Resource	Estimated 25.9 Mt of recoverable ROM coal within the West Borehole seam
Mining method	Bord and pillar mining using a combination of first workings, partial extraction and full extraction.
Annual production rate	Up to 4 Mtpa ROM coal
Mine design	A combination of first workings only, partial extraction, and full extraction using bord and pillar mining methods has been adopted to minimise subsidence impacts to sensitive built and natural surface features and to mitigate multi-seam subsidence impacts associated with the Awaba workings in the overlying Great Northern seam. Conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and sensitive surface water features such Stockyard Creek, Kilaben Creek, and Stony Creek.
Mine infrastructure area and access	The project will utilise the existing surface facilities at the Newstan and Awaba Collieries and the Forest Road ballast and borehole services site. Awaba Colliery Surface Site will be upgraded as part of the project and be utilised for: • Power supply. • Compressed air and nitrogen inertisation. • Greenhouse gas capture and abatement. • Ventilation. • Communications. • Parking. • Administration. Newstan Colliery Surface Site will be utilised for: • Access to underground workings (as approved under DA 73-11-98). • Parking, offices, bathhouse facilities and workshop (as approved under SSD-5145). • Ventilation (prior to the commencement of secondary extraction) as approved under DA 73-11-98.

[1]Closure and rehabilitation would extent beyond the 15 year project operational life until mining lease relinquishment has occurred.

Aspect	Description
Coal handling, processing and transport	ROM coal will be transported via underground conveyor to the Newstan Colliery Surface Site at a rate of up to 4 Mtpa. Once it reaches the surface it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145). No coal handling operations at Awaba Colliery Surface Site are proposed as part of the project. Product coal transport does not form part of the project. The project proposes the transportation of ROM coal via underground conveyor to the Northern Coal Logistics Project, at which point the processing and product coal transportation will be undertaken as approved under SSD-5145.
Coal reject management	The project is expected to generate 4.77 Mt of reject over the mine life, of which 3.2 Mt is expected to be coarse reject and 1.57 Mt is expected to be fine reject (tailings). Reject management for the coal to be extracted during operation of the project is already approved under SSD-5145. The Northern Coal Logistics Project has sufficient capacity to accommodate the 4.77 Mt of reject from the project over the mine life. Centennial Newstan estimates that the coarse and fine reject emplacement areas approved under SSD-5145 have a remaining capacity of 7.3 Mt (coarse reject) and 5.9 Mt (fine reject) respectively, which is sufficient to accommodate the coal reject to be produced from the project.
Ventilation and gas drainage	Operation of existing ventilation fans at Newstan Colliery Surface Site prior to the commencement of secondary extraction. Construction of three new fans at the existing ventilation shaft at Awaba Colliery Surface Site and operation of those fans during extraction. Decommissioning of the existing ventilation fans at Newstan Colliery Surface Site once the three new fans at Awaba Colliery Surface Site are operational. Construction and operation of a gas flaring facility within previously disturbed areas at Awaba Colliery Surface Site.
Water supply	Upgrade existing reticulated water system at Awaba Colliery Surface Site. Use of recycled wastewater for mining and dust suppression.
Water and wastewater management	Extraction of underground water via the Fassifern Pump Station. Underground water management including transfers between coal seams. Transfer of water to the Newstan Colliery Surface Site is approved under SSD-5145. Continued receipt of decanted water into underground workings from the Southern Reject Emplacement Area at Newstan Colliery Surface Site. Surface water management at the Newstan Colliery Surface Site will continue as approved under SSD-5145 and does not form part of the project. Surface water management at the Awaba Colliery including the utilisation of existing and approved licensed water discharge points.
Communications and electrical supply	Upgrades to 33 kV switchyard and 11 kV switch room at Awaba Colliery Surface Site. Upgrades to underground electrical equipment. Upgrades to the communications network.
Exploration and other investigations	Exploration will be ongoing throughout Centennial Newstan's lease areas for the life of the project.
Disturbance area	Extension of Mining Area (area within which underground mining is proposed) extends over 1,153 ha. Direct vegetation clearing of 0.35 ha at Awaba Colliery Surface Site.

Aspect	Description
Construction	Construction of new and upgraded surface facilities at Awaba Colliery Surface Site. Key works will include drilling and construction of services and gas drainage boreholes, enlargement of the existing Pollution Control Dam, and construction of the gas flaring facility and ventilation fan site.
Construction duration	Approximately 11 months if undertaken concurrently however this may be longer if construction is staged
Construction hours	Monday to Friday: 7.00 am to 6.00 pm Saturday: 8.00 am to 1.00 pm Sundays and public holidays: no work
Operating hours	24 hours a day, seven days a week
Peak operational workforce	320 FTE personnel
Peak construction workforce	50 FTE personnel (indicative)
Temporary construction facilities	If required, they will be located within previously disturbed areas at Awaba Colliery Surface Site.
Rehabilitation and closure	The rehabilitation and closure strategy for the project will include: • Progressively rehabilitating minor surface disturbance areas (e.g. drill pads, access tracks, surface cracking, and sinkholes) to their previous land use. • Removing underground plant and equipment at the completion of mining. • Filling and sealing mine accesses (drifts and shafts) in accordance with relevant guidelines and standards. • Removing or finding a beneficial reuse for mine infrastructure at Awaba Colliery Surface Site and rehabilitating surface disturbance areas. Rehabilitation of the Newstan Colliery Surface Site will be in accordance with SSD-5145 and does not form part of the project.
Project capital cost	$130 Million

The local setting of the project is illustrated on Figure 2-1. The regional setting of the project is illustrated on Figure 2-2.



Paper Size ISO A4

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Kilometres

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Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Local setting

Figure 2-1

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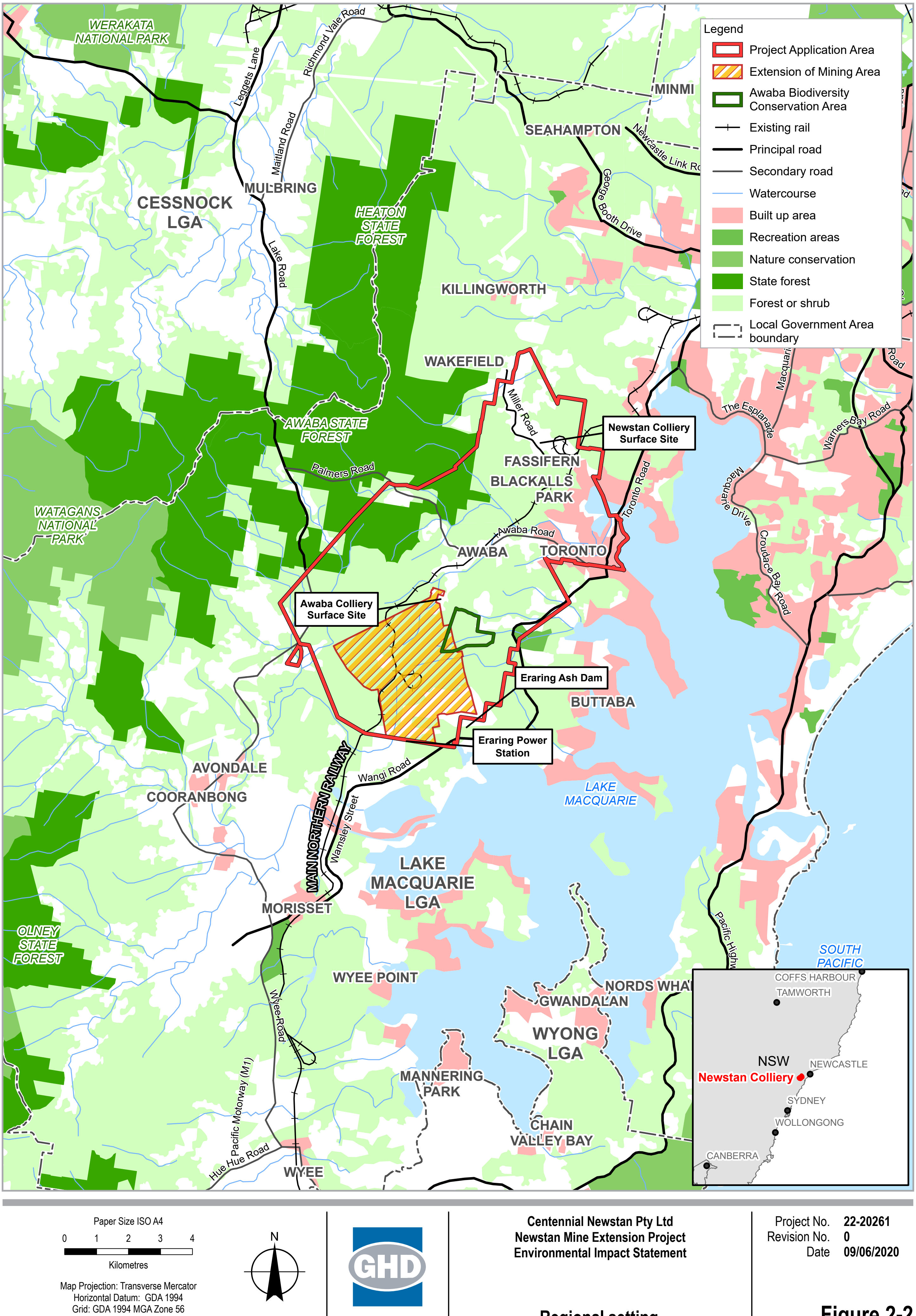
Data source: Centennial: Consent boundary, 2016; Geoscience Australia: 250k Topographic Data Series 3, 2006. . Created by: fmackay



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Environmental Impact Statement

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Regional setting

Figure 2-2

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Data source: Centennial: Consent boundary, 2016; Geoscience Australia: 250k Topographic Data Series 3, 2006. . Created by: fmackay

2.2 Description of the project

2.2.1 Project Application Area

The project is located in the Lake Macquarie LGA, approximately 100 kilometres north of Sydney and 25 kilometres south-west of Newcastle. Lake Macquarie and the surrounding residential suburbs of Toronto and Rathmines border the project to the east. To the south lie the suburbs of Dora Creek and Myuna Bay. To the west lies the M1 Pacific Motorway.

The Project Application Area (i.e. project boundary) is based on the total mining lease area for Newstan Colliery (the Colliery Holding Boundary). It encompasses three distinct areas; Newstan Colliery, the Extension of Mining Area, and Awaba Colliery. These areas are described in the following subsections and illustrated on Figure 1-1 and Figure 1-2.

The Project Application Area covers an area of approximately 6,762 hectares. A schedule of the land that applies to the Project Application Area is provided in Appendix B.

Newstan Colliery

The nearest major population settlements to Newstan Colliery are Toronto, Blackalls Park and Fassifern to the east, Wakefield to the north, and Dora Creek to the south. Newstan Colliery is also bordered to the east by Wangi Road. Newstan Colliery pit top and surface infrastructure (Newstan Colliery Surface Site) is located at Fassifern, approximately four kilometres north of Toronto. Access is via Miller Road, Fassifern. These features are shown in Figure 1-2.

Parts of the Newstan Colliery Surface Site also operate under SSD-5145 for the Northern Coal Logistics Project.

Newstan Colliery also incorporates the Forest Road ballast and borehole services site and existing underground mining areas within Great Northern, Fassifern, West Borehole, Borehole, Young Wallsend and Yard seams. The existing workings within the Fassifern, Great Northern and Borehole seams are utilised as underground water storages (refer to Figure 6-5).

Extension of Mining Area

The portion of the Project Application Area within which mining is proposed is termed the Extension of Mining Area. It covers an area of approximately 1,153 hectares. The majority of the proposed Extension of Mining Area is located under undulating, unpopulated bushland. Wangi Road is located to the east of the area. To the south lies the Eraring Power Station and associated infrastructure including the Eraring Ash Dam. To the west lies the M1 Pacific Motorway. The Main Northern Railway traverses the area in a north-south direction. These features are shown in Figure 1-1.

The Extension of Mining Area is bordered by previous Newstan Colliery mine workings to the north and northwest, while the western portion of the proposed mining area is overlain with the Awaba Colliery mine workings in the Great Northern seam.

The Extension of Mining Area is also partially overlain by a biodiversity offset site known as the Awaba Biodiversity Conservation Area. The site is owned by Lake Macquarie City Council and managed for biodiversity conservation in accordance with the terms of an agreement established under the EPBC Act. The Awaba Biodiversity Conservation Area is shown in Figure 1-1.

Awaba Colliery

The Awaba Colliery Surface Site is located approximately one kilometre south of the Awaba village and 5.5 kilometres south-west of Toronto, adjacent to the Newstan-Eraring private haul road. The site is accessed via Wilton Road, Awaba. Awaba Colliery also incorporates the flooded former workings within the Great Northern seam. These features are shown in Figure 1-2 and Figure 6-5.

2.2.2 Proposed mining

Mining method

Bord and pillar mining is proposed to be undertaken using continuous miners and will include first workings, partial extraction and full extraction. Mining will be designed to extract up to 4 Mtpa of ROM coal from within the Extension of Mining Area and a total of 25.9 Mt over a fifteen-year mine life.

Mining will target the West Borehole seam, which is an agglomeration of the Borehole seam, the Young Wallsend seam and the Yard seam. A mix of metallurgical and thermal coal will be extracted. The depth of cover within the Extension of Mining Area ranges from 140 m in the north west to 320 m in the south east. The target seam is overlain by the previous Awaba Colliery mine workings in parts of the Extension of Mining Area with the interburden between the two seams ranging from 100 m to 210 m.

The project proposes to extend the existing mains in the West Borehole seam and then turn to the west, with panels developed from the mains to the south. The panels will be developed in a 'super panel' layout using two continuous miners per development section, shuttle cars and feeder breakers. The panels will be between approximately 665 m and 4,485 m in length, and 168.5 m in width. Each panel will comprise four rows of pillars with angled cut throughs and with pillar dimensions of 35 m by 35 m. These pillar dimensions provide for a Factor of Safety[2] of greater than 2.11, or 'long term stable', prior to extraction. The mine design also includes 45 m barrier pillars to improve regional stability and separate the panels for improved gas and water management. Roadways will be mined at widths of 5.5 m and heights of 3.2 - 3.4 m.

Following the development phase, some pillars will be extracted using continuous miners paired with a flexible conveyor train or similar type equipment. The extraction panels will extract close to the full seam outside of the previously supported development roadways to maximise resource recovery and manage potential future spontaneous combustion risks arising from coal left behind in the goaf. ROM coal will be delivered to the Newstan Colliery Surface Site via a series of underground conveyors.

The combination of first workings, partial and full extraction (refer to Figure 1-1) has been adopted to mitigate impacts on sensitive surface features. Full extraction, where all pillars in a panel are removed, is proposed to the south of the existing Awaba workings in areas that have not been subject to mining previously (i.e. single-seam conditions) and in some areas beneath the existing workings (multi-seam conditions) where sensitive surface features are not present. The full extraction in the multi-seam areas will provide the additional benefit of reducing the long-term liability of pillar failure in the overlying Awaba workings in the Great Northern seam.

[2] Factor of Safety refers to the ratio of a structure's absolute strength (structural capability) to actual applied load.

The proposed partial extraction will mine three of the four rows of pillars, leaving a spine pillar (i.e. one row of pillars) within each panel. This spine pillar will reduce the maximum mining span to 86 m, which will reduce subsidence effects. Partial extraction is proposed under the Ulan Rail Loop and under the sections of an existing 132 kV transmission line that are subject to multi-seam conditions.

The development of first workings only (i.e. no secondary extraction) will occur beneath certain sensitive surface features in both single-seam and multi-seam conditions. This includes under second and third order streams, the Main Northern Railway, a 132 kV substation, the Eraring Power Station, the Eraring Ash Dam wall and Western Saddle Embankment.

With the presence of the overlying Awaba Colliery workings and a larger than previously encountered volume of gas within the West Borehole seam and overlying seams, which will be released by the mining process, the proposed mining system allows for greater control of subsidence, particularly with regard to minimising multi-seam subsidence, improved gas management, and superior flexibility to deal with geological anomalies.

Mining schedule

First workings will commence in the north-eastern portion of the Extension of Mining Area by developing the mains in a south-west orientation. Each panel will be developed south from the mains, with the mains and associated panels being extended progressively from east to west through the Extension of Mining Area. Partial and full extraction of the panels will generally be undertaken in a sequential manner from east to west, excluding areas where only first workings are proposed. This will be followed by the partial and full extraction of the mains from west to east, again, excluding areas where only first workings are proposed.

Gas drainage

Historically gas levels have been low at Newstan Colliery, with gas emissions of approximately 1 cubic metre per tonne (m^3/t) of coal extracted. Within the Extension of Mining Area the predicted gas emissions have increased within both the West Borehole seam and overlying seams.

The majority of the gas within the Extension of Mining Area is contained in the Australasian and Fern Valley seams, which overlie the target West Borehole seam. The gas from these seams will be released into the workings through the de-pressurisation of the overlying seams during the formation of the goaf. Gas emissions are expected to vary between 13.3 m^3/t and 17.1 m^3/t within the Extension of Mining Area.

Historically all gas emissions at Newstan Colliery have been free vented to atmosphere through boreholes to the surface, in line with accepted practice at the time. However, Centennial Newstan proposes to use in-seam gas drainage methods to manage gas to within acceptable statutory safety limits for the protection of workers the Extension of Mining Area.

This method will involve undertaking horizontal directional drilling between 15 m and 20 m above the West Borehole seam following the orientation of the panels and roadways within the Extension of Mining Area. Gas captured during the in-seam drainage system will be transferred to a gas flaring facility to be constructed at the Awaba Colliery Surface Site via underground pipelines. The gas flaring facility will be constructed and operational prior to the commencement of secondary extraction.

The proposed gas drainage approach minimises surface disturbance and associated environmental impacts whilst also providing a safe solution to managing gas emissions in line with current industry practice.

Underground access and egress

Personnel and materials will be transported down the existing men and materials drift at Newstan Colliery Surface Site. The project proposes to use specialised underground vehicles for both personnel and material transport.

2.2.3 Coal handling, processing and transportation

ROM coal will be transported from the underground workings to the Newstan Colliery Surface Site by a conveyor system at a rate of up to 4 Mtpa. Once the coal reaches the Newstan Colliery Surface Site it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145), managed by Centennial Coal's Northern Coal Services business unit.

The coal recovered from the Project Application Area can produce both a semi-soft coking coal product for the export market and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets.

All surface coal handling, processing and transportation operations undertaken at Newstan Colliery will form part of SSD-5145 and as such do not form part of the project. The Northern Coal Logistics Project has sufficient coal processing and transportation capacity to accommodate the project's maximum production rate (4 Mtpa) and total production over the mine life (25.9 Mt) without exceeding the throughput limits imposed under SSD-5145.

No coal handling operations at Awaba Colliery Surface Site are proposed as part of the project.

2.2.4 Coal reject management

The project is expected to generate 4.77 Mt of reject over the mine life, of which 3.2 Mt is expected to be coarse reject and 1.57 Mt is expected to be fine reject (tailings). However, reject management does not form part of the project.

Reject management for the coal to be extracted during operation of the project is already approved under SSD-5145. The Northern Coal Logistics Project has sufficient capacity to accommodate the 4.77 Mt of reject from the project over the mine life without exceeding the limits imposed under SSD-5145. Centennial Newstan estimates that the coarse and fine reject emplacement areas approved under SSD-5145 have a remaining capacity of 7.3 Mt (coarse reject) and 5.9 Mt (fine reject) respectively, which is sufficient to accommodate the coal reject to be produced from the project.

2.2.5 Surface facilities

The project will utilise the existing surface facilities of the Newstan and Awaba Collieries, excluding the use of the Newstan Colliery Surface Site facilities for the activities approved under SSD-5145. The additional works described in the following subsections will also be undertaken as part of the project. The surface facilities that will be utilised for the project at Newstan and Awaba Collieries are illustrated in Figure 2-3 and Figure 2-4 respectively.

Parking, administration, bathhouse and workshop facilities

Upgrades to the existing administration buildings at the Awaba Colliery Surface Site will be undertaken to support the project's administrative workforce. The existing parking, offices, bathhouse facilities and workshop at the Newstan Colliery Surface Site will continue to be utilised as approved under SSD-5145 for the Northern Coal Logistics Project.

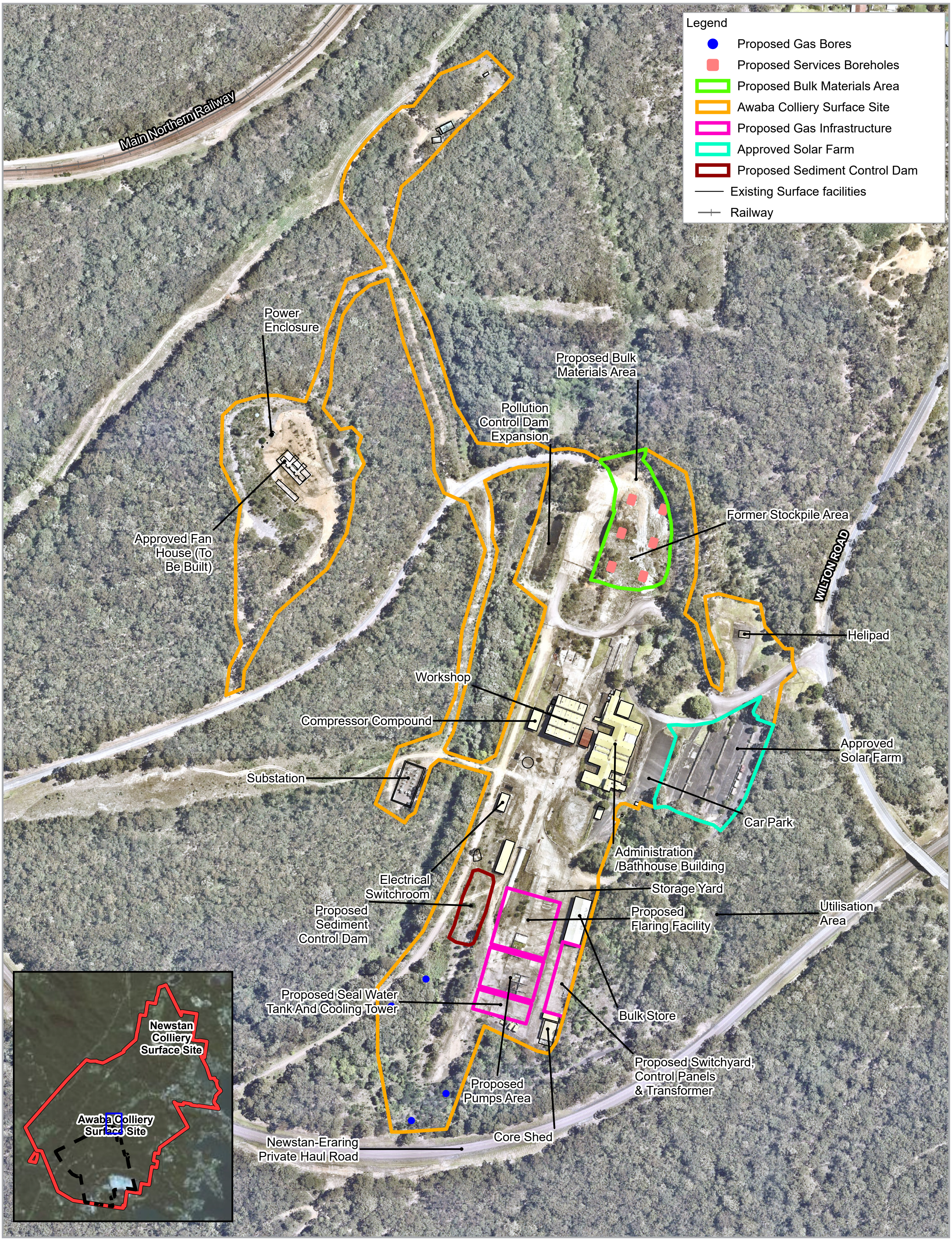
Ventilation

Existing ventilation shafts at the Newstan Colliery Surface Site and Awaba Colliery Surface Site will continue to be used for the project. The two existing ventilation fans at the Newstan Colliery Surface Site will be utilised during initial development of the first workings prior to the commencement of secondary extraction. During this development phase, three new fans will be constructed at the existing ventilation shaft at the Awaba Colliery Surface Site. Once these fans become operational, the existing fans at Newstan Colliery Surface Site will be decommissioned.

Gas flaring facility

A gas flaring facility will be established within the confines of the current disturbance area at the Awaba Colliery Surface Site. This will involve the installation of one or multiple vertical enclosed elevated flare stacks. The gas captured from the in-seam drainage system, approximately 90% of which will be methane, will be burned and converted to carbon dioxide in the flare stacks.

The global warming potential of methane is estimated to be 28 times greater than that of carbon dioxide. Through the conversion of the pre-drained gas to carbon dioxide during the flaring process, the project’s greenhouse gas emissions will be substantially reduced.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Conceptual surface facilities layout
Awaba Colliery Surface Site

Project No. **22-20261**
Revision No. **0**
Date **09/06/2020**

Figure 2-3

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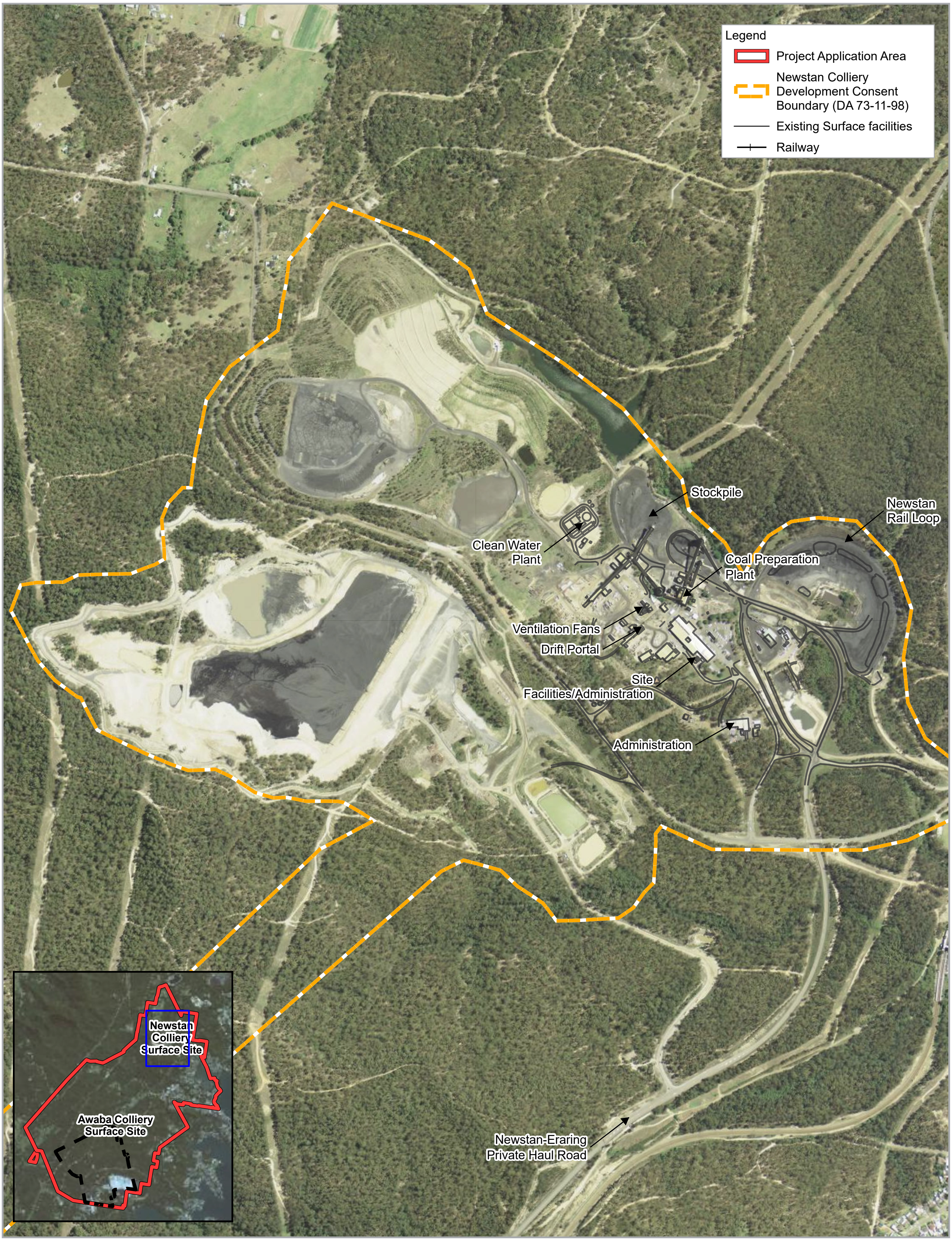
Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: kpsroba



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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No.	**22-20261**
Revision No.	**0**
Date	**09/06/2020**

Conceptual surface facilities layout
Newstan Colliery Surface Site

Figure 2-4

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2.2.6 Utilities and services

The following utilities and services will be required for the project:

- Upgrade of the existing 33 / 11 kV Substation at Newstan Colliery Surface Site.
- Upgrade of the existing 33 kV switchyard and 11 kV switch room at Awaba Colliery Surface Site.
- Upgrade and replacement of a number of existing pumps and compressors at Newstan Colliery Surface Site.
- Upgrade of the existing drift conveyor drives at Newstan Colliery Surface Site.
- Installation of new or replacement underground electrical equipment (pumps, substations, control panels, drives, etc.).
- Provision of electrical supply to the underground workings via cables run from the Awaba Colliery Surface Site through boreholes into the workings.
- Extension of the existing intrinsically safe (IS) mine automatic telephone system.
- Installation of a Personal Emergency Device (PED) emergency messaging and control system.
- Installation of a Supervisory Control and Data Acquisition (SCADA) system.
- Operation of the Forest Road ballast borehole and services site.
- Installation of boreholes at Awaba Colliery Surface Site for the supply of bulk materials, compressed air, gas drainage infrastructure and electricity. Once the bulk materials handling area at Awaba Colliery Surface Site is established and operational, the Forest Road borehole and ballast site will be decommissioned and rehabilitated.

Utility and infrastructure relocations are not proposed as part of the project. However, subsidence mitigation works to existing surface infrastructure are expected to be required.

2.2.7 Water management

The water demands of the project will be for underground operations, surface facilities (including machinery operation and wash-down), dust suppression, fire-fighting, and staff amenities.

The key functions of the project’s water management systems will be to:

- Separate clean and dirty water sources, and allow for diversion, collection and treatment as appropriate.
- Facilitate water recycling and water sharing to support the mining operation.
- Minimise discharges by maximising, where practicable, available water storages.
- Manage water discharge, in terms of volume and quality, to a level that is acceptable for environmental management.

No changes to the water management system at Newstan Colliery Surface Site are proposed as part of the project.

Minor upgrades to the water management system at the Awaba Colliery Surface Site are proposed to support the underground mine operations for the project. Surface water management at the Awaba Colliery will also include the utilisation of existing and approved licensed water discharge points.

Further details regarding the proposed water management systems for the project, with respect to the Newstan and Awaba Collieries, are presented in the following subsections and in Sections 6.3 (groundwater) and 6.4 (surface water).

The project-wide water management system is presented conceptually in Figure 2-5.

Newstan Colliery

Groundwater inflows to the underground workings in the West Borehole seam will continue to be dewatered to the Fassifern underground storage and discharge to LT Creek through Newstan LDP001 via the Clean Water Plant at Newstan Colliery Surface Site. Overall, no changes to the interaction between Newstan Colliery and the Newstan Colliery Surface Site are proposed as part of the project.

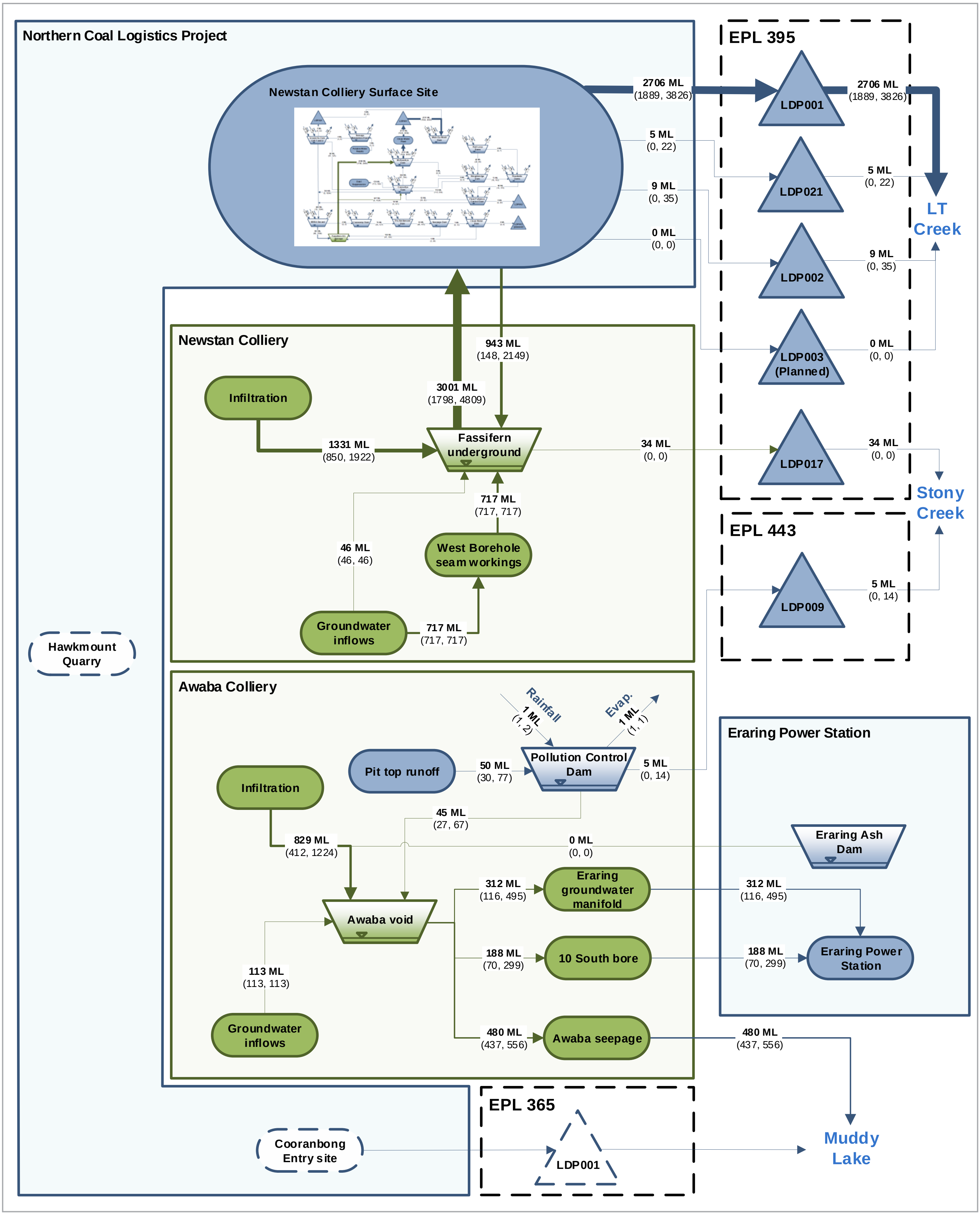
All surface water management at the Newstan Colliery Surface Site, including the operation of licensed discharge points, will continue to be managed by the Northern Coal Services business unit, and operate as approved under the Northern Coal Logistics Project (SSD-5145).

Awaba Colliery

The existing Pollution Control Dam at the Awaba Colliery Surface Site will be upgraded and transfers of dirty water to the Awaba underground void will cease. A new sediment control dam will also be constructed. The Awaba underground void will continue to be managed by pumping water to Eraring Power Station, via the 10 South Bore, to the Eraring Ash Dam and from the Eraring groundwater manifold to the Eraring Discharge Canal.

Potable water will continue to be supplied by Hunter Water Corporation. Effluent generated by on-site staff amenities will be serviced via a new connection to Hunter Water Corporation’s reticulated sewer system or a self-contained pump out system.

The proposed water management system at the Awaba Colliery surface site is shown in Figure 2-6.



Legend

- Underground storage
- Underground process
- Surface storage
- Surface process
- Licensed discharge point
- Groundwater flow
- Surface water flow

Centennial Newstan Pty Ltd
Newstan Mine Extension Project EIS

Conceptual water management system
Annual water transfers

Project No. 2220261
Revision No. 0
Date 07/02/2020

FIGURE 2-5

Created by: Tyler Tinkler

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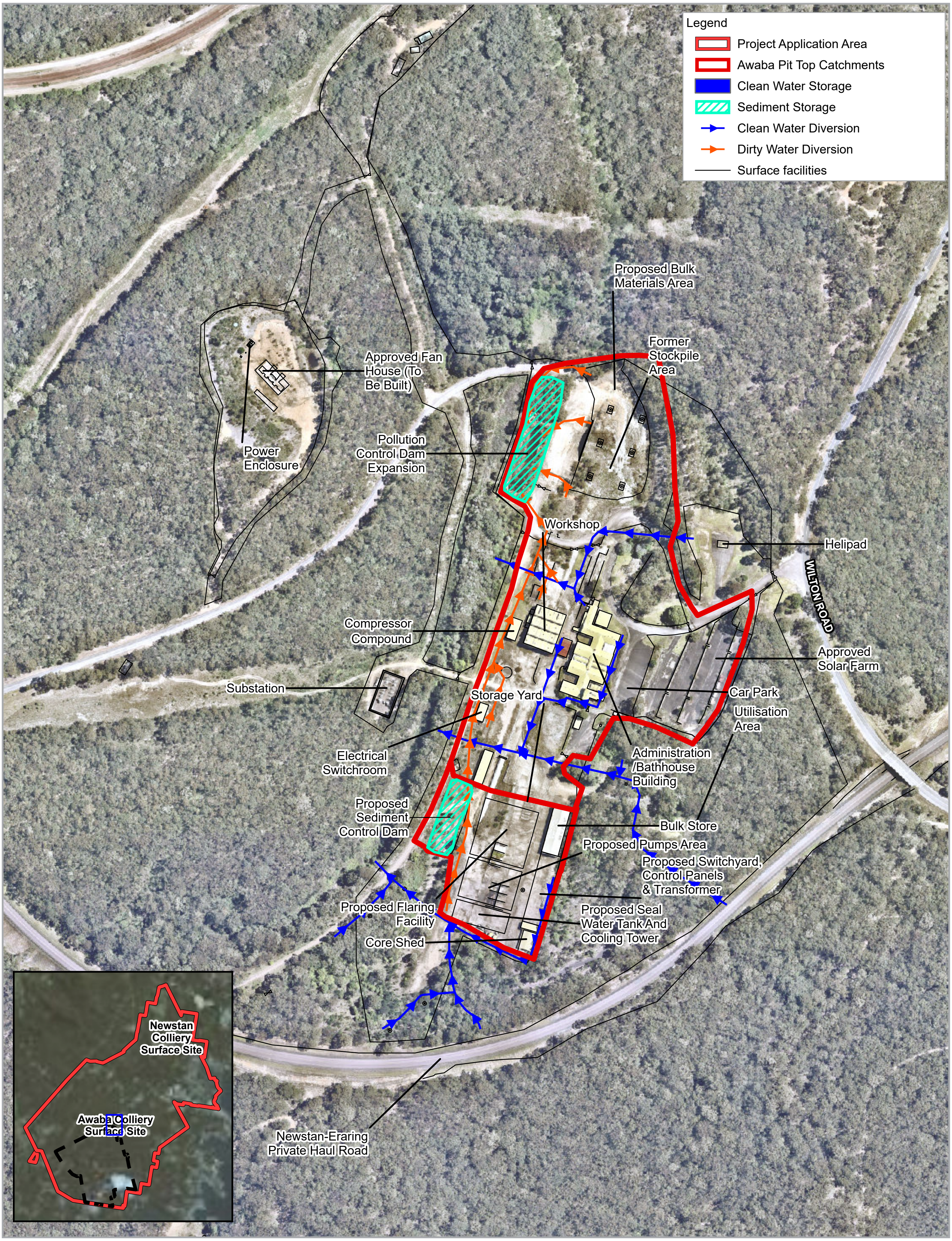

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No. 22-20237
Revision No. 0
Date 09/06/2020

Proposed water management at Awaba Colliery Surface Site

Figure 2-6

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Print date: 09 Jun 2020 - 04:21

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

2.2.8 Site access and parking

Access and parking will remain consistent with the current approved arrangements for the Newstan and Awaba Collieries. Awaba Colliery Surface Site will continue to be accessed via Wilton Road, Awaba. Newstan Colliery Surface Site will continue to be accessed via Miller Road, Fassifern. The existing parking facilities at both sites will also continue to be utilised as currently approved. All underground access will continue to be via the Newstan Colliery Surface Site.

During construction, the majority of the workforce will require access to the Awaba Colliery Surface Site. The majority of project-related operations traffic will access the Newstan Colliery Surface Site.

2.2.9 Construction activities and facilities

Construction activities will be undertaken within previously disturbed areas. Existing surface facilities will be utilised where practicable to minimise the need for additional construction. Should additional facilities, such as construction offices, parking areas, stores and laydown areas, equipment assembly areas, fuel facilities, power, communications or water services be required, they will be sited within previously disturbed areas.

Aggregate and other road building material may be imported to site for use in road and access upgrades, as required. Any excess or unsuitable material will be removed from site for beneficial reuse or disposal at an approved facility.

Construction activities will be guided by a Construction Environmental Management Plan (CEMP) to ensure work is carried out in accordance with the project's environmental management obligations. Detailed work methodologies will be determined during detailed design and construction planning.

Construction phases

Construction will be undertaken in four main phases and take approximately eleven months to complete. The four construction phases are:

- Mobilisation of construction plant and equipment and materials to site.
- Site establishment.
- Construction.
- De-mobilisation.

Each phase is described in further detail in the following subsections.

Mobilisation

Mobilisation will involve the delivery of the construction plant, equipment and materials to the Awaba Colliery Surface Site and the erection of temporary sheds to be utilised during construction. Deliveries will be placed within previously disturbed areas in preparation for site establishment and construction.

Mobilisation is expected to take approximately two weeks to complete.

Site establishment

Site establishment will involve removing vegetation and topsoil, constructing internal roads and accesses, installing site services and establishing temporary erosion and sediment controls for any disturbance activities proposed outside of the existing dirty water management system. All removed vegetation and topsoil will be stockpiled on site for later use in site rehabilitation.

Site establishment is expected to take approximately six weeks to complete.

Construction

This phase will involve the construction of the new and upgraded surface facilities at Awaba Colliery Surface Site. Key works will include drilling and construction of services and gas drainage boreholes, enlargement of the existing Pollution Control Dam, construction of a new sediment control dam, and construction of the gas flaring facility and ventilation fan site.

Construction is expected to take approximately ten months complete. Some construction works will occur concurrently with the mobilisation and site establishment phases.

De-mobilisation

De-mobilisation will involve the de-construction of any temporary structures and erosion and sediment controls and the removal of construction plant and equipment from site.

De-mobilisation is expected to take approximately two weeks to complete.

Construction plant and equipment

A range of plant and equipment will be used during construction. The construction contractor will determine the final equipment and plant requirements.

2.2.10 Workforce

The construction workforce is expected to peak at approximately 50 FTE personnel. The operational workforce is expected to peak at approximately 320 FTE personnel, which is consistent with the current Newstan Colliery workforce approved under DA 73-11-98 and assessed as part of the Northern Coal Logistics Project.

The majority of operational personnel, including the underground workforce, will be located at the Newstan Colliery Surface Site. A small number of administrative and maintenance personnel (less than 10) will be located at Awaba Colliery Surface Site.

It is expected that the construction and operational workforce will be able to the sourced from the local and regional labour market. Project-specific accommodation facilities are not expected to be required for the workforce.

2.2.11 Construction and operating hours

It is anticipated that construction will be largely carried out during the following hours:

- Monday to Friday: 7.00 am to 6.00 pm.
- Saturday: 8.00 am to 1.00 pm.
- Sundays and public holidays: no work.

Operation activities will occur 24 hours a day, seven days a week.

2.2.12 Exploration and resource definition

Exploration drilling will continue to be undertaken throughout Centennial Newstan's lease areas for the life of the project to obtain specific geological information and to assist in mine planning.

Centennial Newstan has an ongoing exploration programme to obtain specific geological information in terms of geotechnical conditions, coal seam quality and thickness, through core sampling. Information obtained is used for the ongoing refinement of the site's existing geological model which then allows detailed mine planning.

Exploration boreholes are drilled vertically to the target coal seams, some 200-400 metres below the surface.

Some minor surface clearance is often required to establish drilling sites (drill site footprint) and for the clearing and maintenance of small access tracks to reach drilling locations in cases where access does not already exist. Where possible, drill sites are selected as close as possible to existing access roads or tracks to minimise clearing requirements. Each drilling site will require a disturbance area of approximately 25m x 25m. Where practicable, sites are located in existing cleared areas.

Following vegetation clearing, appropriate erosion and sediment controls are installed and maintained around disturbed areas in accordance with the Blue Book (Landcom, 2004). Felled trees are stockpiled for use in rehabilitation.

Drilling activities require the construction of sumps to collect drill cuttings and to control and recycle drilling fluids down the borehole. One or two sumps, approximately 2m x 2m x 2m in dimension, will be excavated at each drill site. Topsoil will be removed and stockpiled separately. The remaining material excavated from the sumps will be used to construct a bund adjacent to, and down slope from the sumps to control any excess drilling water. Silt fence will be installed along the down slope perimeter of the drill site as a further control for any surface water runoff from the site. A temporary security fence will be placed around the drill site if required. A typical layout for an exploration drill site is shown below.

Centennial Newstan has developed area-based assessment procedures for the management of exploration activities to ensure that they are conducted in an environmentally responsible manner and with due consideration to the community. This includes a risk-based process for the selection of proposed drillhole sites and access tracks based on environmental, geological, logistical and other operational constraints. This risk-based process includes the completion of due-diligence field inspections and targeted surveys of the proposed drill sites and associated access tracks by appropriate qualified ecologist and heritage specialists prior to commencement of works to ensure the potential for localised impacts and risks are avoided, minimised and, where necessary, appropriately managed.

Drill sites and associated access tracks will be located wherever possible to:

- Avoid threatened flora species.
- Avoid hollow bearing trees.
- Avoid endangered ecological communities.
- Minimise clearing.
- Avoid identified Aboriginal heritage sites.

Mitigation measures and management strategies will be implemented as appropriate.

If impacts to threatened species can not be avoided, the appropriate approvals will be obtained prior to any impacts occurring.

At the completion of drilling activities, all drilling fluid recovered is vacuum pumped and removed from site for disposal the Newstan Colliery Southern Reject Emplacement Area and the exploration drill hole and site rehabilitated in accordance with the appropriate guidelines and legislation at the time.

Exploration activities will continue throughout the life of the project within the Project Application Area with a view of refining the site's existing geological model used for detailed mine planning. The exploration programme will be undertaken throughout the life of the project and approval for these activities is sought as part of the project.

2.2.13 Waste management

Production waste

The project is expected to generate 4.77 Mt of reject over the mine life, of which 3.2 Mt is expected to be coarse reject and 1.57 Mt is expected to be fine reject (tailings). As described in Section 2.2.4, reject management for the coal to be extracted during operation of the project is approved under SSD-5145 and will be managed in accordance with the provisions of that development consent.

General waste

The key non-production waste streams to be generated during operation of the project, and an estimate of the annual quantities of each, are presented in Table 2-2. The estimated waste quantities are based on the recorded annual average waste quantities generated from an existing underground coal mine (Centennial Coal's Mandalong Mine) whilst operating at an annual production rate (approximately 5 Mtpa) that is comparable to the maximum annual production rate proposed for the project (4 Mtpa).

Table 2-2 Waste streams and quantities during operation of the project

Classification*	Waste stream	Estimated annual quantity (tonnes)
General waste	Mixed solid waste	590
	Subtotal – General waste	**590**
Liquid waste disposal	Washbay sludge	1.7
	Subtotal – Liquid disposal	**1.7**
Liquid waste recycling	Coolant	9
	Effluent	874
	Oily water	375
	Used oil	25
	Subtotal – Liquid recycling	**1,280**
Paper and cardboard recycling	Paper and cardboard	7.4
	Subtotal – paper and cardboard recycling	**7.4**
Other recycling	Grease	1.6
	Oil filters	1.3
	Oily rages/absorbents	3.2
	Chemical anchors	2.4
	Scrap steel	168
	Subtotal – other recycling	**176.5**
	Total (tonnes)	**2,055.6**
	Total waste (tonnes)	**591.7**
	Total recycling (tonnes)	**1,463.9**
	Recycling percentage (%)	**71.2**

Descriptions of the sources and proposed management strategies for key project waste streams are presented Table 2-3.

Table 2-3 Waste stream sources and management strategies

Waste stream	Source and management strategy
General waste and routine maintenance consumables	All general wastes and routine maintenance consumables from the daily servicing of equipment will be collected on a regular basis from the Newstan Colliery Surface Site and Awaba Colliery Surface Site by an appropriately licensed contractor for either recycling or off-site disposal within a waste facility approved to accept such waste. The waste contractor is charged with sorting comingled general waste in a designated waste sortation facility on-site in order to remove any recyclable items, such as oil filters, cartridges and scrap metal.
Waste oil and grease	The generation of waste oils and grease will be primarily limited to the routine maintenance of plant and equipment. Waste oils and greases stored at the Newstan Colliery Surface Site and Awaba Colliery Surface Site, along with parts and packaging (for example, filters and waste oil drums), will be collected by a licensed waste contractor on a regular basis for recycling and/or off-site disposal within a waste facility approved to accept such waste. Oily water from the workshop, equipment storage and washdown bay areas at Newstan Colliery Surface Site will continue to be drained to the on-site oil-water separator. A licensed contractor will continue to regularly service and maintain the separator and remove all waste hydrocarbons for recycling.
Effluent	Sewage effluent generated by on-site staff amenities at Awaba Colliery Surface Site will be serviced via a new connection to Hunter Water Corporation's reticulated sewer system. Sewage effluent generated by on-site staff amenities at the Newstan Colliery Surface Site will continue to be managed in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145). Effluent management at Newstan Colliery Surface Site does not form part of the project.

2.2.14 Dangerous goods management

The transportation, handling and storage of all dangerous goods for the project will be undertaken in accordance with the requirements of the NSW *Work Health and Safety Act* (WHS Act), NSW *Work Health and Safety Regulation 2017* (WHS Regulation), NSW *Dangerous Goods (Road and Rail Transport) Act 2008*, and NSW *Dangerous Goods (Road and Rail Transport) Regulation 2014*.

The dangerous goods stored for the project will typically include compressed gases, flammable and combustible liquids, and corrosive substances. Based on the quantities proposed to be stored, it is not anticipated that a Dangerous Goods Licence will be required for the project.

The management of hydrocarbons will be undertaken in accordance with the requirements of *Australian Standard (AS) 1940 The Storage and Handling of Flammable and Combustible Liquid.*

2.2.15 Rehabilitation and closure

Following the completion of mining, the Awaba Colliery Surface Site will be decommissioned and the area rehabilitated such that it can support land uses similar to those that occurred prior to mining or be repurposed for light industrial use. It is expected that the Newstan Colliery Surface Site will be decommissioned and rehabilitated as part of closure activities for the Northern Coal Logistics Project in accordance with the requirements of SSD-5145. As such, decommissing and rehabilitation of the Newstan Colliery Surface Site does not form part of the project.

A conceptual rehabilitation strategy for the project (refer to Section 6.19) has been developed in consultation with stakeholders and with consideration of the detailed environmental investigations undertaken as part of the EIS.

The purpose of the rehabilitation strategy is to establish preliminary objectives for the decommissioning and rehabilitation of disturbed land as part of the project. The strategy identifies potential final land use options, defines the preferred final land use option, and sets out rehabilitation objectives and preliminary rehabilitation success criteria that can be used to demonstrate that the desired final land use outcome has been achieved.

Conceptually, the rehabilitation strategy for the project will include:

- Progressively rehabilitating minor surface disturbance areas (e.g. drill pads, access tracks, surface cracking) to their previous land use.
- Removing underground plant and equipment at the completion of mining.
- Filling and sealing mine accesses (drifts and shafts) in accordance with relevant guidelines and standards.
- Establishing a final landform that is safe, stable, non-polluting and free draining.
- Not precluding other potential post mining land use options that may be considered feasible in the future as part of the detailed mine closure planning process.
- Removing all infrastructure that does not have any post mining beneficial use.
- If required, preserving surface infrastructure or features that are heritage listed or have high heritage value.

Decommissioning and rehabilitation activities for the project will be undertaken in accordance with an approved Mining Operations Plan (MOP) to be developed following approval of the project. The MOP will function as the primary rehabilitation and decommissioning management plan for the project and will document both long term rehabilitation principles for the life of the operation, including specific construction, operation and rehabilitation activities for the term of the MOP (a period of up to seven years).

The rehabilitation strategy set out in this EIS is intended to provide the conceptual rehabilitation and closure objectives that provide the framework for more detailed rehabilitation planning to be developed and documented in the project MOP. It is expected that within 5 years of planned closure, a detailed Rehabilitation and Closure MOP will need to be prepared by Centennial Newstan and approved by the Resources Regulator.

Subsidence monitoring, management and remediation

Subsidence monitoring, management and remediation will be undertaken throughout the life of the project in consultation with DPIE – Planning and Assessment, land and infrastructure owners, and other relevant stakeholders. Further details regarding proposed monitoring, management and remediation of subsidence impacts from the project are presented in Section 6.1.

2.3 Relationship of the project to existing approved Centennial Coal operations

As described in Section 1.2.3, the project interrelates with three existing approved Centennial Coal operations; Newstan Colliery, Awaba Colliery, Northern Coal Logistics Project. A breakdown of how key elements of each of these existing approved Centennial Coal operations interrelate with the project is presented in Table 2-4.

Table 2-4 Summary of project relationship to existing approved Centennial Coal operations

Aspect	Existing approved Centennial Coal operation: Newstan Colliery (DA 73—11-98 and continuing use rights)	Existing approved Centennial Coal operation: Awaba Colliery (MP 10_0038)	Existing approved Centennial Coal operation: Northern Coal Logistics Project[3] (SSD-5145)	The project
Project life	Mining operations may be carried out within the DA Area until 6 July 2021.	The Proponent may carry out mining operations on site until 31 December 2015	Development consent expires on 31 December 2045	Seeking approval for continuation of operations for 15 years. Northern Coal Logistics Project will continue to operate as approved until 31 December 2045.
ROM coal extraction from underground workings	Extraction of up to 4 Mtpa of ROM coal from first workings within DA-73-98 MOD 8 first workings area in West Borehole seam and delivery of the mined coal to Newstan Colliery Surface Site.	Extraction of up to 0.88 Mtpa of ROM coal from the Main South and East B mining areas and delivery of the mined coal to the Awaba Colliery Surface Site.	N/a	Extraction of up to 4 Mtpa from the Extension of Mining Area within the West Borehole seam and delivery of the mined coal to Newstan Colliery Surface Site via the existing men and materials drift at Newstan Colliery Surface Site.
Coal handling, processing and transportation	N/a	Handling of up to 880,000 Mtpa of ROM coal using existing surface facilities and transportation of the coal to Newstan Colliery Surface Site via the Awaba Private Haul Road and Newstan-Eraring Private Haul Road.	Upgrades to coal handling and train loading infrastructure. Processing of up to 8 Mtpa ROM coal through the Newstan Coal Processing Plant, representing ROM coal supplied from Newstan Colliery (up to 4.5 Mtpa), Mandalong Mine (up to 6 Mtpa), and Awaba Colliery (up to 0.88 Mtpa). Transporting up to 8 Mtpa of product coal through the Newstan Colliery rail loading facilities by train to the Port of Newcastle.	All surface coal handling, processing and transportation operations are approved under SSD-5145 and as such do not form part of the project.

[3] Refers to elements of the Northern Coal Logistics Project applicable to Newstan Colliery Surface Site, not those applicable to Cooranbong Entry Site, which are also approved under SSD-5145.

Aspect	Existing approved Centennial Coal operation			The project
	Newstan Colliery (DA 73—11-98 and continuing use rights)	Awaba Colliery (MP 10_0038)	Northern Coal Logistics Project[3] (SSD-5145)	
			Transporting of up to 6 Mtpa of product coal via overland conveyor to Eraring Power Station. Transporting up to 4.5 Mtpa of product coal by truck to Eraring Power Station utilising the Newstan-Eraring private haul road. Receiving coal from Cooranbong Entry Site and coal and stone material from Awaba Colliery by truck utilising the Cooranbong and Newstan-Eraring private haul roads.	
Coal reject management	N/a	N/a	Management of coarse and fine reject from the processing of up to 8 Mtpa ROM coal through Newstan Coal Processing Plant. Transporting reject material from the Newstan Colliery Coal Processing Plant to the Northern and Southern Reject Emplacement Areas and Hawkmount Quarry.	All coal reject handling activities are approved under SSD-5145 and as such do not form part of the project.

Aspect	Existing approved Centennial Coal operation			The project
	Newstan Colliery (DA 73—11-98 and continuing use rights)	Awaba Colliery (MP 10_0038)	Northern Coal Logistics Project[3] (SSD-5145)	
Ventilation and gas drainage	Operation of existing ventilation fans at Newstan Colliery Surface Site Construction and operation of ventilation fans at the existing ventilation shaft at Awaba Colliery Surface Site	N/a	N/a	Operation of existing ventilation fans at Newstan Colliery Surface Site prior to the commencement of secondary extraction. Construction of three new fans at the existing ventilation shaft at Awaba Colliery Surface Site and operation of those fans during extraction. Decommissioning of the existing ventilation fans at Newstan Colliery Surface Site once the three new fans at Awaba Colliery Surface Site are operational. Construction and operation of a gas flaring facility within previously disturbed areas at Awaba Colliery Surface Site.
Water supply	Use of recycled water for mining. Use of potable water at Bathhouse.	Operation of the existing reticulated water system at Awaba Colliery Surface Site and use of that water for mining and dust suppression	Operation of the existing reticulated water system at Newstan Colliery Surface Site and use of that water for potable purposes, coal processing and dust suppression.	Upgrading the existing reticulated water system at Awaba Colliery Surface Site. Use of recycled wastewater for mining, and for dust suppression at Awaba Colliery Surface Site.

Aspect	Existing approved Centennial Coal operation			The project
	Newstan Colliery (DA 73—11-98 and continuing use rights)	Awaba Colliery (MP 10_0038)	Northern Coal Logistics Project[3] (SSD-5145)	
Groundwater management	Transfers of water from underground workings in West Borehole seam to the Fassifern Underground Storage (the void formed by previous mining activity in the Fassifern and Great Northern seam at Newstan Colliery).	Transfer of groundwater from the flooded Awaba Colliery workings in the Great Northern seam to the surface via the 10 South Bore to the Eraring Ash Dam and via a series of boreholes (the Eraring Groundwater Manifold) to Eraring Power Station.	Transfers of water from the Fassifern Underground Storage to Newstan Colliery Surface Site and recycling, reuse, treatment and licensed discharge of that water in accordance with the Northern Operations Water Management Plan. Transfers of water from Southern Rejects Emplacement Area to Newstan Colliery underground workings.	Transfers of water from underground workings in West Borehole seam to the Fassifern Underground Storage (the void formed by previous mining activity in the Fassifern and Great Northern seam at Newstan Colliery). Receipt of water from Southern Rejects Emplacement Area.
Surface water management	N/a	Management of surface water at Awaba Colliery Surface Site in accordance with the Northern Operations Water Management Plan Expansion of the Pollution Control Dam at Awaba Colliery Surface Site Licensed discharge of surface water to Stony Creek.	Management of surface water, including recycling, reuse, treatment, and licensed discharge of surface water at Newstan Colliery Surface Site in accordance with the Northern Coal Services Water Management Plan and EPL 395.	Upgrading the surface water management system at Awaba Colliery Surface Site and cessation of underground transfers.

Aspect	Existing approved Centennial Coal operation			The project
	Newstan Colliery (DA 73—11-98 and continuing use rights)	Awaba Colliery (MP 10_0038)	Northern Coal Logistics Project[3] (SSD-5145)	
Ancillary facilities	Operation of the Forest Road ballast borehole and services site, located approximately 4 km to the south-west of the drift entries at Newstan Colliery Surface Site. Operation of a men and materials drift to the underground workings from Newstan Colliery Surface Site.	Operation of existing ancillary surface facilities.	Operation of surface facilities at Newstan Colliery Surface Site, excluding the existing ventilation shaft and fans and men and materials drift at Newstan Colliery Surface Site.	Operation, decommissioning and rehabilitation of the Forest Road ballast borehole and services site. Operation of the existing men and materials drift to the underground workings from Newstan Colliery Surface Site. Upgrade and utilisation of Awaba Colliery Surface Site for: Power supply. Compressed air and nitrogen inertisation. Communications. Administration.
Workforce	Operational workforce of 320 FTE personnel	Operational workforce of 100 FTE personnel	Operational workforce of 166 FTE personnel.	Construction workforce of up to 50 FTE personnel Operational workforce of 320 FTE personnel
Operating hours	24 hours per day, seven days a week	24 hours per day, seven days a week	24 hours per day, seven days a week	24 hours per day, seven days a week

2.4 Project rationale and alternatives considered

2.4.1 Project rationale

The project proposes the continuation of underground mining within an established mining precinct that has been operating for over 130 years. The potential impacts of the project have been minimised by maximising the use of existing surface infrastructure and equipment, developing a lower-impact and flexible mine design, minimising surface disturbance for gas drainage and greenhouse gas abatement, and proposing a complementary suite of mitigation measures and management strategies to be implemented during construction, operation, and closure.

The combination of first workings only, partial extraction, and full extraction using bord and pillar mining methods has been adopted to minimise subsidence impacts to sensitive built and natural surface features and to mitigate multi-seam subsidence impacts associated with the Awaba workings in the overlying Great Northern seam.

Conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and sensitive surface water features such Stockyard Creek, Kilaben Creek, and Stony Creek.

There is also inherent flexibility in the proposed bord and pillar mining method as it provides Centennial Newstan with the ability to vary mining activities as required in response to unforeseen geological or environmental constraints.

The coal recovered from the Project Application Area can produce both a semi-soft coking coal product for the export market and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets. Over time, the project can potentially replace the coal product currently supplied to the domestic market by other Centennial Coal operations as these other resources become depleted. This will ensure ongoing security of supply for domestic electricity generation.

The project, if approved, will allow for the optimisation of resource recovery from within the Project Application Area while provide ongoing direct and indirect employment opportunities. In addition, the project will provide a number of positive flow-on effects to the local, regional and state economies through additional wages and royalties.

2.4.2 Project constraints and opportunities

The long history of mining at the Newstan and Awaba Collieries, and the associated environmental monitoring and management activities that have been undertaken over many years, has provided Centennial Newstan with a large amount of baseline information to help guide the development of the project. Centennial Newstan has also undertaken extensive detailed project-specific geological, engineering, environmental, financial and other technical investigations over several years to develop and refine the project.

Key constraints and opportunities that were considered by Centennial Newstan when evaluating project alternatives and refining the project design included:

- The potential for additional subsidence due to the reactivation of the existing Awaba Colliery workings in the Great Northern seam. This includes the potential for multi-seam subsidence, the development of sinkholes, and rapid subsidence events due to the failure of the Teralba Conglomerate spanning areas.

- Potential impacts to Eraring Power Station and Eraring Ash Dam, including subsidence-related structural impacts to the power station and dam wall, and the potential for the mobilisation of leachate from the dam into underlying aquifers.
- Potential impacts to second and third order streams and watercourses, including the potential for ponding, loss of stream base flow, erosion, and flooding due to subsidence.
- Potential direct and indirect impacts to the biodiversity values of the area, including threatened species, populations and ecological communities and groundwater dependent ecosystems.
- Potential subsidence-related impacts to public infrastructure such as the Main Northern Railway, M1 Pacific Motorway, local roads, and potable water, sewage, electrical and communications infrastructure.
- Potential impacts to the Awaba Biodiversity Conservation Area, a biodiversity offset site managed by Lake Macquarie City Council for biodiversity conservation under the EPBC Act.
- Potential impacts to the amenity of the residents and businesses in proximity to the project.
- Geological constraints, including the presence, throw and strike of faulting, and variable seam thickness and coal quality within the West Borehole seam.
- Potential human health, safety and greenhouse gas emission impacts associated with the release of methane gas from the West Borehole seam and overlying coal seams as part of the mining process.
- The need to optimise resource recovery within the mining lease area.
- Opportunities to utilise existing Centennial Coal mining infrastructure to generate project efficiencies and create synergies with existing approved operations.

Further discussion regarding how these constraints and opportunities were considered during the selection and refinement of project alternatives is provided below.

2.4.3 Alternatives considered

The project has been developed and refined in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the ‘avoid, minimise, offset’ hierarchy.

A review of feasible alternatives to the proposed development has been undertaken to demonstrate that the preferred option constitutes the most appropriate scenario to meet the identified project needs. The following alternatives have been considered by Centennial Newstan during the preliminary planning for the project:

- Not proceeding with the project.
- Alternative methods for extraction of the resource.
- Alternative locations and designs for various infrastructure components of the project.

Consideration of each of these alternatives is discussed in further detail in the following subsections.

The alternative of not proceeding with the project

If the project were not to proceed, there would be the following implications:

- Mining of the coal resources within the approved mining areas would need to cease by 6 July 2021 upon expiry of the development consent for Newstan Colliery (DA 73-11-98). This would result in the sterilisation of a substantial coal resource within the mining lease area, as it is unlikely that this area would be extracted independently or as part of any other mining proposal.
- Upon cessation of mining, Newstan Colliery would close and all economic and associated social benefits would cease to be realised beyond this time (see Sections 6.15 and 6.16). This would include the loss of approximately $80 million in royalties to the State and $28 million in employee benefits. The exception would be the benefits associated with a relatively brief period of decommissioning and rehabilitation activity.
- The proposed employment of the 320 FTE personnel associated with Newstan Colliery operations would be placed in jeopardy.
- An opportunity for the beneficial use of existing infrastructure at Newstan and Awaba Collierys would not be realised.
- Not proceeding with the project would eliminate Newstan Colliery as a secure and strategically located coal supply option for the Eraring Power Station.

One of the objects of the EP&A Act is to:

'…promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources.'

If the project were not to proceed, 25.9 Mt of coal would remain unrecovered, and the economic benefits that flow from the recovery of this resource would not be realised. The impact assessments provided in Chapter 6 of this EIS demonstrate that the resource can be recovered in an environmentally and socially responsible manner, whilst still providing economic benefits to the people of NSW. Not proceeding with the project would conflict with the objects of the EP&A Act.

Alternative methods for extraction of the resource

Centennial Newstan has worked through numerous iterations of the mine design in order to develop a mine plan that responds to two key considerations:

- The coal resource is a public asset owned by the State of NSW and it is therefore in the public interest to optimise resource recovery.
- The project is constrained by a range of sensitive built and natural environmental features and their protection throughout all project phases must be a priority.

Two mining methodologies, longwall mining and bord and pillar mining, were considered during the project planning process before the preferred resource extraction option was identified by means of options analysis.

An overview of how each of these mining methods were considered, and the justification for the selection of the preferred bord and pillar mining option, are presented in the following subsections.

The longwall mining alternative

Longwall mining is undertaken using a shearer to extract large rectangular panels of coal in a series of passes that run perpendicular to the direction of the advancing coal face. The longwall is supported by hydraulic roof supports that gradually move forward with the advancing coal face, allowing the overlying strata behind to collapse and form the goaf. The collapse of the overlying strata results in subsidence above the panel. After the completion of each panel, the mining equipment is relocated to a new pre-developed panel to re-commence extraction. Each panel is separated by a chain pillar, comprised of coal and interbedded strata that is left in-situ. The subsidence impacts of longwall mining are heavily influenced by the depth and dimensions of the panels and pillars.

Longwall mining generally allows resource recovery to be maximised when compared with other underground mining methods. It minimises the amount of development roadways that need to be excavated to access the coal, which, in turn, increases the resource recovery and provides a better financial outcome. However, it also causes subsidence impacts with the potential to damage natural and built surface features, as well as potentially increasing water inflow to underground workings due to increased hydraulic connectivity in the rock strata above the goaf. Longwall mining is also less flexible in being able to avoid sensitive surface features and geological constraints. Whilst it would have maximised resource recovery, the environmental impacts were considered unacceptable and the longwall mining option was therefore rejected as a viable method for extraction of the resource.

Centennial Newstan did consider reduced longwall widths and lengths as a means of minimising subsidence impacts, however it was determined that there would not be any significant reduction in surface impacts and it was not a financially viable option. Reduced longwalls widths would require additional development gateroads and longwall moves, which would reduce the coal available for extraction and reduce mining efficiencies. Reduced longwall lengths would also reduce the coal available for extraction.

The proposed bord and pillar mining method

Bord and pillar mining uses a grid of tunnels and involves progressively cutting panels into the coal seam whilst leaving behind pillars of coal to support the roof. The bord and pilling mining alternative was selected as the preferred option as it allowed for greater control of subsidence (particularly with regard to minimising multi-seam subsidence), improved gas management, and superior flexibility to deal with geological anomalies. If greater than predicted subsidence is found to occur on the surface, the bord and pillar mining design also allows for mining to be adapted quickly to reduce impacts, which is not possible with longwall mining.

Once the bord and pillar mining method was confirmed as the preferred resource extraction option, the mine plan was further developed and assessed in response to geological, geotechnical, environmental, surface infrastructure and mining constraints.

The current proposed bord and pillar mine plan aims to strike a balance between optimising resource recovery and protecting sensitive environmental features. It has been developed based on extensive modelling of subsidence impacts and through consultation with key government agencies and infrastructure owners.

Centennial Newstan proposes to vary the coal recovery within the West Borehole seam depending on the natural and built features located directly above these workings and the potential for compound subsidence impacts associated with the overlying Awaba Colliery workings in the Great Northern seam.

Modelling of the proposed interaction between the seams has indicated that by the application of a spine pillar type layout, the risk for compound subsidence can be managed. The combination of first workings only, partial extraction, and full extraction mining methods (refer to Figure 1-1) will reduce multi-seam subsidence impacts associated with the overlying Awaba Colliery workings.

This combination of first workings, partial and full extraction has also been adopted to mitigate impacts on sensitive surface features. The development of first workings only (i.e. no secondary extraction) is proposed beneath certain sensitive surface features in both single-seam and multi-seam conditions. This includes under second and third order streams, the Main Northern Railway, a 132 kV substation, the Eraring Power Station, and the Eraring Ash Dam wall and Western Saddle Embankment.

The proposed partial extraction will mine three of the four rows of pillars, leaving a spine pillar (i.e. one row of pillars) within each panel. Partial extraction is proposed under the Ulan Rail Loop and under the sections of an existing 132 kV transmission line that are subject to multi-seam conditions.

Full extraction, where all pillars within each panel are removed, is only proposed to the south of the existing Awaba Colliery workings (i.e. single-seam conditions) and in some areas beneath the existing workings (multi-seam conditions) where sensitive surface features are not present.

Surface infrastructure alternatives

A number of alternatives were considered during the project planning process before the preferred surface infrastructure option was identified. Broadly, the surface infrastructure alternatives included:

- Utilisation of Awaba Colliery Surface Site exclusively.
- Utilisation of Newstan Colliery Surface Site exclusively.
- Utilisation of Newstan Colliery Surface Site in combination with Awaba Colliery Surface Site.

An overview of how each of these alternatives were considered, and the justification for the selection of the preferred surface infrastructure option, are presented in the following subsections.

Utilisation of Awaba Colliery Surface Site exclusively

The existing Awaba Colliery Surface Site was operational until 2012, when it was placed into care and maintenance. The existing facilities at Awaba Colliery Surface Site generally comprise:

- Mine access and associated infrastructure, including a portal and drift to the Great Northern seam.
- Coal handling, preparation and transport infrastructure, including access to the NSW rail network and Newstan-Eraring private haul road.
- Workshop, services and administration infrastructure.
- Parking and access to the NSW road network.
- Water management and pollution control infrastructure.

The existing surface facilities would continue to be accessed via Wilton Road and Wangi Road, which would require minimal upgrades, if any. The existing parking facilities could also readily accommodate the operational workforce.

New ventilation and gas drainage facilities would also need to be constructed to adequately service the proposed mining within the West Borehole seam in the Extension of Mining Area. There are a number of existing hardstand areas within Awaba Colliery Surface Site on which new supporting infrastructure, such as the required ventilation fans and gas drainage infrastructure, could be constructed. This would minimise the need for additional ground disturbance.

To support the proposed mining a new portal and drift would be required connecting the surface facilities with the West Borehole seam within the Extension of Mining Area. Utilisation of a new portal and drift at Awaba Colliery Surface Site would offer a number of benefits due to the shorter distance required for the transportation of personnel and materials to and from the West Borehole seam, when compared the Newstan Colliery Surface Site. These would include reduce shift times, labour cost and fuel savings, and allowance for increased production time at working faces, enabling more coal to be produced per annum. The shorter travel distances would also reduce road maintenance costs and minimise the time it would take to reach the surface in the case of an emergency. However, there would also be additional costs and time required to establish the new portal and drift.

The aging infrastructure at Awaba Colliery Surface Site would also require refurbishment to make it suitable for ongoing project operations. The considerable refurbishment costs rendered this option unfeasible.

Utilisation of Newstan Colliery Surface Site exclusively

This option would involve utilisation of the existing Newstan Colliery Surface Site as currently approved under SSD-5145 for the Northern Coal Logistics Project, and the utilisation of the existing ventilation fans at Newstan Colliery Surface Site as approved under DA 73-11-98 for Newstan Colliery. The Newstan Colliery Surface Site contains the following key features that would be utilised for the project:

- Mine access and associated infrastructure, including a portal and drift to the West Borehole seam.
- Administration and bathhouse infrastructure.
- Parking and access to the NSW road network.
- Ventilation fans, which would only be suitable for operation during first workings.
- Coal handling, preparation and transportation infrastructure, including access to the NSW rail network and the Newstan-Eraring private haul road.
- Water management and pollution control infrastructure.

New ventilation and gas drainage facilities would also need to be constructed to adequately service the proposed mining within the West Borehole seam in the Extension of Mining Area. Constructing these additional facilities at the Newstan Colliery Surface Site would not be the most feasible approach due to the large distance between the Newstan Colliery Surface Site and the Extension of Mining Area (approximately 6 km). Locating them closer to the Extension of Mining Area would reduce the extent of horizontal directional drilling required for gas drainage and minimise the size of the ventilation fans required to safely ventilate the underground mining area.

Utilisation of Newstan Colliery Surface Site in combination with Awaba Colliery Surface Site

The preferred surface infrastructure option is the utilisation of Newstan Colliery Surface Site in combination with Awaba Colliery Surface Site. This option involves the utilisation of the Newstan Colliery Surface Site as approved under SSD-5145, the existing ventilation fans at Newstan Colliery Surface Site as approved under DA 73-11-98, and utilisation of the Awaba Colliery Surface Site as follows:

- Upgrading the existing administration buildings to support the project's administrative workforce and then ongoing utilisation of those buildings during operations.
- Constructing and operating three new ventilation fans at the site of the existing ventilation shaft. Once these fans become operational, the existing fans at Newstan Colliery Surface Site will be decommissioned.
- Constructing and operating a gas flaring facility within the confines of the current disturbance area at the site.
- Expanding the existing Pollution Control Dam to improve dirty water management at the site.

There are a number of benefits to this option. Firstly, it makes use of the existing drift and portal to the West Borehole seam at Newstan Colliery Surface Site, eliminating the need to construct a new drift and portal for the project to access the Extension of Mining Area. Secondly, locating the new ventilation fans and gas drainage infrastructure within previously disturbed areas at Awaba Colliery Surface Site minimises surface disturbance requirements, and any associated environmental impacts (e.g. biodiversity, surface water, Aboriginal heritage, etc.). It also allows these facilities to be located in relatively close proximity to the Extension of Mining Area (when compared to Newstan Colliery Surface Site), which minimises the extent of horizontal directional drilling required for gas drainage, and enables more efficient mine ventilation.

Consolidating the Awaba Colliery Surface Site into a contemporary SSD project approval will also facilitate a more holistic approach to the ongoing management of existing infrastructure and project closure planning.

The project will supply ROM coal to the existing approved Newstan Coal Logistics Project (SSD-5145) at Newstan Colliery Surface Site. As such, additional impacts associated with the construction and operation of new coal handling, processing and transportation infrastructure have been avoided.

Centennial Newstan's proposed use of the existing surface infrastructure facilities at Newstan and Awaba Collieries has minimised the area of land required to develop the project.

2.4.4 The preferred option

The preferred option for the project represents of a combination of the preferred resource extraction option and the preferred surface infrastructure option, comprising:

- Bord and pillar mining within the West Borehole seam using a combination of first workings, partial and full extraction to mitigate impacts on sensitive surface features.
- Utilisation of Newstan Colliery Surface Site in combination with Awaba Colliery Surface Site.

The ways in which Centennial Newstan has further refined the preferred option to minimise subsidence impacts and optimise the surface infrastructure design are summarised in the following subsections.

Minimising subsidence impacts

Protection of the Main Northern Railway

In 2017 and 2018, as part of the mine planning process, Centennial Newstan consulted with the Resources Regulator's Principal Subsidence Engineer (PSE) regarding the proposed workings in the West Borehole seam. The Resources Regulator's PSE requested that there be no subsidence from the proposed West Borehole seam mining within this enlarged barrier in the Great Northern seam surrounding the Main Northern Railway[4].

As a result of this consultation, the proposed workings have been designed to incorporate a 165 m protection barrier, with a 26.5 degree angle of draw projected from the Awaba Great Northern seam workings to the West Borehole seam. This barrier is significantly larger than the 20 m offset and 35 degree angle of draw from the rails to the West Borehole seam that has been historically maintained around the Main Northern Railway and as prescribed in Centennial Newstan's mining lease conditions. Only long-term stable first workings, with a Factor of Safety in excess of 2.5, are proposed in the West Borehole seam within the barrier area. The partial and full extraction areas within the proposed panels are located at a minimum distance of 250 m from the centreline of the Main Northern Railway.

As part of the mine design process, Centennial Newstan engaged specialist subsidence consultants (MSEC, 2018; 2019a) to complete a review of the risk of pillar run due to historical and proposed workings.

The existing and overlying Awaba workings in the Great Northern seam contain areas of first workings only, partial extraction, full extraction and areas where the 'Teralba Conglomerate' has been spanned. The Teralba Conglomerate 'spanning areas' in the Great Northern seam are not considered to be long-term stable by design and have failed in other areas.

Following a review of pillar run risks, Centennial Newstan engaged a suitably qualified and experienced civil engineer to develop a series of strategies to mitigate and manage potential impacts to the Main Northern Railway. The use of a Track Expansion System and Track Monitoring System, coupled with regular inspections and monitoring of the track and surrounding ground surface, have been proposed as feasible strategies. These strategies have been successfully implemented at other locations throughout NSW where railways have been impacted by mine subsidence.

The mine plan for the project and the suite of proposed mitigation and management strategies have been developed to take into consideration the pillar run risks identified during the risk review and those risks are considered to be manageable.

Extensive modelling of both the vertical and horizontal displacement in the worst-case pillar run scenario has indicated that the effects on the railway can be safely managed. Taking into account the worst-case modelling results and the pre-emptive installation of track expansion gauges, which are able to cope with more than doubled the modelled movement, it is feasible to say that the risk to the railway line can be successfully managed within acceptable tolerances.

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[4] The management of subsidence-related safety and serviceability risks to the Main Northern Railway has been undertaken successfully as part of previous operations at Awaba Colliery. During the latter stages of production in the Great Northern seam at Awaba Colliery, secondary extraction was not permitted within a barrier of nominally 165 m from the railway tracks of the Main Northern Railway. This barrier far exceeded Awaba Colliery's mining lease condition requirements and was imposed to mitigate the risk of a pillar run that may affect the railway.

Mining in proximity to Eraring Ash Dam

The Eraring Ash Dam is located above the southern ends of the proposed workings in the West Borehole seam. The depth of cover above the West Borehole Seam, within the extents of the Eraring Ash Dam and the proposed panels, varies between 250 m and 320 m.

Origin Energy is proposing to establish a new emplacement area for ash deposition (the Western Emplacement Area) within the Eraring Ash Dam. The proposed emplacement area (as approved in December 2019 under MP 07_0084, Mod 1) includes construction of a saddle embankment (the Western Saddle Embankment) along the western perimeter of the Western Emplacement Area. The Western Embankment Area is also partially located above the former Awaba workings in the Great Northern seam. Origin Energy is proposing to undertake filling (with cement-stabilised fly ash) of some areas within these former workings to mitigate the risk of leachate from the deposited ash entering the former workings.

Centennial Newstan proposes a number of strategies to mitigate the risk of subsidence-related impacts to the Western Saddle Embankment, the proposed grouting areas within the Western Emplacement Area, and the Eraring Ash Dam wall. Firstly, no secondary extraction will be carried out within a 35 degree angle of draw of the Western Saddle Embankment. The area of any first workings within a 35 degree angle of draw of the Western Saddle Embankment will be determined following the completion of detailed designs by Origin Energy and subject to approval from Dams Safety NSW (formerly NSW Dam Safety Committee).

Furthermore, no secondary extraction will be carried out within a 26.5 degree angle of draw of any areas where grouting of the former Awaba workings in the Great Northern seam is proposed by Origin Energy. The area of any first workings within a 26.5 degree angle of draw of any proposed grouting areas will be determined following the completion of detailed designs by Origin Energy and subject to approval from Dams Safety NSW.

Finally, to protect its structural integrity, only first workings are proposed within a 35 degree angle of draw of the Eraring Ash Dam wall. The area of any first workings within a 35 degree angle of draw of the Eraring Ash Dam wall will also be subject to approval from Dams Safety NSW.

Mining in proximity to Eraring Power Station

First workings only are planned within a 35 degree angle of draw from Eraring Power Station, in accordance with mining lease conditions. These workings are designed to be long term stable and consultation with Eraring is underway to develop strategies to allow for safe and continuous operations for both entities.

Mining in proximity to Awaba Biodiversity Conservation Area

Centennial Newstan understands that Lake Macquarie City Council has established a biodiversity offset area (the Awaba Biodiversity Conservation Area) on Lot 463 DP 1138964, which is located within the Extension of Mining Area. Potential impacts to this offset area have been considered by proposing first workings only within the 2nd and 3rd order watercourses within this area. Extraction of the coal resource is proposed outside these watercourses in accordance with the mine plan.

Minimising impacts to watercourses

There are four named streams within the Extension of Mining Area; Stony Creek, Stockyard Creek, Kilaben Creek and Crooked Creek. First workings only are proposed directly beneath the second order sections of Stony and Stockyard Creeks where they are located above the Extension of Mining Area. The partial and full extraction areas within the proposed panels have been set back from Stony, Kilaben, and Stockyard Creeks and some of their tributaries based on a 26.5 degree angle of draw. The secondary extraction areas within the proposed panels are therefore located at minimum distances ranging between 100 m and 150 m from these named creeks.

Optimisation of the surface infrastructure design

The surface infrastructure design has been developed to provide a number of operational, economic and environmental benefits. The ways in which it has been optimised and the associated benefits are summarised in Table 2-5.

Table 2-5 Surface facilities optimisation

Aspect	Description and benefits
Minimising surface disturbance	Where possible the project has sought to make use of the existing surface infrastructure facilities at Newstan and Awaba Collieries. All new major surface infrastructure is proposed within the existing approved disturbance footprint and existing disturbed land at Awaba Colliery Surface Site. The proposed adoption of in-seam gas drainage methods, with underground piping of the gas, has further reduced surface disturbance requirements by minimising the number of drill pads and gas pipelines required on the surface.
Access to key infrastructure	Traffic and transport impacts have also been minimised through the project's proposed use of the existing access and parking facilities at the Newstan and Awaba Collieries.
Proximity to sensitive receptors and sensitive environments	The proposed use of the existing surface infrastructure facilities as Newstan and Awaba Collieries has minimised the project's potential for intrusions on the amenity of sensitive receptors and sensitive environments not already impacted to some extent by mining operations.
Proximity to underground mining areas	The proposed underground mining areas are located immediately to the south of the existing Awaba Colliery Surface Site. They are also a continuation of the existing Newstan workings within the West Borehole Seam, which are accessed via a men and materials drift at Newstan Colliery Surface Site. The proposed workings will be accessed via this existing drift portal, thus eliminating the need for construction of a new drift portal. Similarly, the underground mining areas will be ventilated through the utilisation of the existing ventilation fans at Newstan Colliery Surface Site and the site of the approved ventilation fans at Awaba Colliery Surface Site. Surface disturbance and amenity impacts associated with the construction and operation of a new ventilation fan site have consequently been minimised, if not avoided.

3. Strategic context

The strategic context for the project is established in this chapter by describing:

- Relevant strategic planning and policy documents and their relationship to the project.
- Land use and land ownership within and surrounding the Project Application Area.
- Any protected areas relevant to the project.
- Geology relevant to the project, including the coal resource.

Further details are presented in the following subsections. Elements of the built and biophysical environment potentially affected by the project are described as relevant in the assessment of impacts in Chapter 6.

Whilst environmental planning instruments (including State Environmental Planning Policies (SEPPs)) may be considered strategic planning and policy documents, they are also statutory planning instruments. As such, they have instead been described in Chapter 4, having regard to their relationship to the project.

3.1 Strategic planning and policy context

3.1.1 Strategic Statement on NSW Coal

The Strategic Statement on NSW Coal (NSW Government, 2014) is a high-level policy document developed by the NSW Government to:

- Acknowledge the valuable contribution that the coal mining industry makes to the NSW economy.
- Outline a series of objectives to guide the growth and performance of coal mining within NSW.

The objectives outlined in the Strategic Statement on NSW Coal (NSW Government, 2014) include:

- Co-existence – Land use decisions do not exclude other potential uses without considering the benefits and consequences for other land users and all residents of NSW.
- Transparency – Coal release, exploration and production decisions are open, transparent and evidence-based to minimise corruption risks.
- Sustainability – Coal release, exploration and production decisions are government by triple bottom line considerations to promote comprehensive and balanced decision making.
- Safety – Coal exploration and production risks are managed through consultation and safe systems to achieve zero fatalities in the mining industry.
- Best practice and leading technologies – The regulation of the coal sector promotes the adoption of best practices and world leading technologies.
- Achieving value for the economy and adequate returns for taxpayers – Coal development prioritises the highest value resources, and generates financial returns for the Government by capturing an appropriate share of that value. The provision of infrastructure will be integrated into the decisions to develop particular resources.
- Regional economic development – Coal release should support opportunities and economic development in the region of a resource.

Relationship of the Strategic Statement on NSW Coal to the project

The project is well aligned with the objectives of the Strategic Statement on NSW Coal (NSW Government, 2014) for the following reasons:

- The project will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. It will also provide a number of positive flow-on effects to the local, regional and State economies through additional wages and royalties.
- The project is located within an existing coal mining precinct. The existing land use is therefore appropriate for the development.
- The project has been designed to consider the benefits and consequences of the development for other land uses, including coexistence with urban and semi-urban areas on the western side of Lake Macquarie, existing biodiversity conservation areas (e.g. Awaba Biodiversity Conservation Area), nearby infrastructure such as the Main Northern Railway, and industrial development such as the Eraring Power Station and Eraring Ash Dam.
- The project has been developed and refined in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the 'avoid, minimise, offset' hierarchy.
- A review of feasible alternatives to the proposed development has been undertaken to demonstrate that the preferred option constitutes the most appropriate scenario to meet the identified project needs. Centennial Newstan has undertaken extensive detailed project-specific geological, engineering, environmental, financial and other technical investigations over several years to develop and refine the project.
- Where possible, the project has sought to make use of the existing surface infrastructure facilities at Newstan and Awaba Collieries which minimises surface disturbance and the use of natural resources required to develop the project.
- The project will be undertaken in accordance with Centennial Coal's safety management system and relevant NSW legislation to minimise the risk of safety-related incidents during construction, operation and closure.
- The project does not conflict with any strategic land use proposals identified in relevant regional planning documents (e.g. Lower Hunter Regional Strategy 2006-2031).

3.1.2 Lower Hunter Regional Strategy 2006 - 2031

The Lower Hunter Regional Strategy (Regional Strategy) (DoP, 2006) applies to the five local government areas of Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock. The document represents an agreed NSW government position on the future of the Lower Hunter. It is the pre-eminent planning document for the Lower Hunter Region and has been prepared to complement and inform other relevant State planning instruments.

The primary purpose of the Regional Strategy is to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing and employment needs of the Region's population between 2006 and 2031. The Regional Strategy plans for the provision of sufficient new urban and employment lands to meet expected strong demands for growth. The Regional Strategy also refocuses development in the Lower Hunter towards the strengthening of vibrant centres that support the role of Newcastle City Centre as the regional city.

Relationship of the Regional Strategy to the project

The project represents a proposed land use that is compatible with the existing and proposed future land uses identified in the Regional Strategy. In this regard, the following assertions can be made:

- The Project Application Area does not intersect with any areas earmarked for future conservation, employment, or urban renewal land uses in the Regional Strategy.
- The proposed Extension of Mining Area (within the Project Application Area) is proposed within the Newcastle Coalfield on land identified as a 'coal resources' area and 'rural and resource land' in the Regional Strategy.
- The project is not proposed on any of the land identified within the Regional Strategy that has been earmarked for 'green corridors' (corridors of vegetation that provide fauna habitat).
- The project is located within proximity to a number of economic hubs, including suburbs such as Toronto and Warners Bay, the 'emerging regional centre' of Glendale/Cardiff, the 'regional centre' of Charlestown, and the 'city' of Newcastle. The ongoing direct and indirect employment opportunities that will be provided by the project and the positive flow-on effects that these will provide to the local and regional economies will contribute to the continued prosperity of these centres of economic activity.

3.1.3 Integrated Mining Policy

The Integrated Mining Policy is a whole-of-government initiative that aims to:

- Improve the regulation and assessment of major mining projects.
- Strike a balance between the significant benefits mining can bring to the economy and the potential impacts on communities and the environment.
- Help manage the environmental and social impacts of mining.
- Ensure the community has access to relevant and timely information about mining projects.

The Integrated Mining Policy includes a series of guidelines to assist proponents of mining projects to communicate key issues that are of interest to government and the community when lodging development applications. The Integrated Mining Policy documents that have been considered during development of the EIS for the project include:

- Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals (NSW Government, 2015a).
- The Mine Application Guideline (NSW Government, 2015b).
- Water Regulation Overview (NSW Government, 2015c).
- Voluntary Land Acquisition and Mitigation Policy (NSW Government, 2018a).

3.1.4 Strategic Regional Land Use Policy

The Strategic Regional Land Use Policy (NSW Government, 2012) sets out a range of initiatives to better balance growth in the mining and coal seam gas industries with the need to protect important agricultural land and water resources. In accordance with the requirements of the Policy, all new SSD applications for mining and petroleum projects with the potential to affect agricultural resources or industries are required to prepare an Agricultural Impact Statement (AIS) as part of the EIS.

As part of the Scoping Report prepared for the project, Centennial Newstan expressed an intention to complete an assessment of the project's potential to affect agricultural resources through the preparation of an AIS as part of the EIS. However, in its response to Centennial Newstan's request for project-specific SEARs, the NSW Department of Industry – Agriculture indicated that in this instance an AIS is not necessary as it is unlikely that the project will impact on any existing or future agricultural activity or resources that would not already be addressed elsewhere in the EIS. Accordingly, an AIS has not been prepared for project.

A review of NSW Government's Strategic Agricultural Land (SAL) Map indicates the project is not located on land mapped as SAL. Further, the land is not the subject of a site verification certificate issued under the Mining SEPP. As such, the gateway process does not apply to the project.

Aquifer Interference Policy

The Aquifer Interference Policy (AIP) (DPI, 2012) forms part of the Strategic Regional Land Use Policy by:

- Clarifying the requirements for obtaining water licenses for aquifer interference activities under NSW water legislation.
- Establishing and objectively defining considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The AIP sets the requirements for assessing potential impacts to groundwater and surface water resources as a result of aquifer interference activities. The project's potential impacts on groundwater and surface water resources have been assessed in accordance with the requirements of the AIP as part of the EIS. Further details regarding the projects impacts on groundwater and surface water resources are presented in Section 6.3 and 6.4 respectively.

3.2 Land use

The project is located in the Newcastle Coalfield within an existing underground mining precinct that has been established for over 130 years. Underground coal mining operations commenced on the western side of Lake Macquarie in the area now known as Newstan Colliery in 1887.

The project is also located adjacent to the Eraring Power Station, which has a generation capacity of 2,880 MW, and is Australia's largest power station. Coal from the existing Newstan Colliery Surface Site, including coal mined from Newstan and Awaba Collieries, is supplied directly to the Eraring Power Station via either the Newstan-Eraring Private Haul Road or the railway network.

The majority of the proposed Extension of Mining Area is located under undulating, unpopulated bushland. The Extension of Mining Area also underlies the Eraring Power Station and associated infrastructure including the Eraring Ash Dam. The proposed Extension of Mining Area is bordered by previous Newstan Colliery mine workings to the north and northwest while the western and northern area of the proposed Extension of Mining Area is partially overlaid with mine workings from the Awaba Colliery in the Fassifern and Great Northern coal seams.

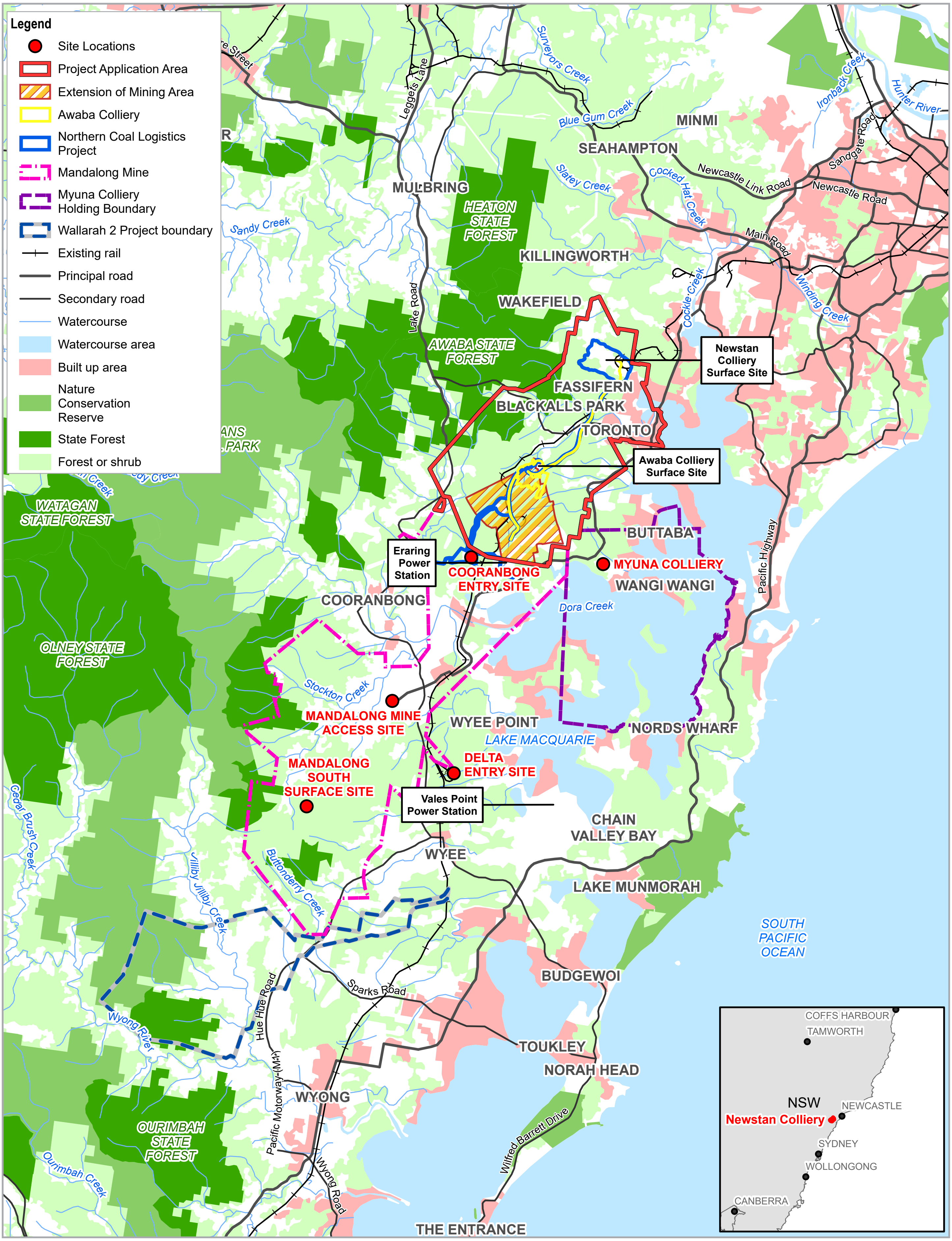
Lake Macquarie and the surrounding residential suburbs of Toronto and Rathmines border the Project Application Area to the east. To the south lie the suburbs of Dora Creek and Myuna Bay. To the west lies the M1 Pacific Motorway. The Main Northern Railway dissects the Project Application Area in a north-south direction.

The Newstan Colliery Surface Site is located in Fassifern approximately 4 kilometres north of the township of Toronto. The Awaba Colliery surface site is located approximately one kilometre south of the Awaba village and 5.5 kilometres south-west of Toronto, adjacent to the Newstan-Eraring private haul road.

There are also a number of other operating coal mines and associated industry in the vicinity of the Project Application Area, including:

- Mandalong Mine, an underground coal mine owned and operated by Centennial Mandalong Pty Ltd (a subsidiary of Centennial Coal). The consolidated development consent boundary for the Mandalong Mine (approved under SSD-5144 for the Mandalong Southern Extension Project) abuts the southern boundary of the Project Application Area.
- Myuna Colliery, an underground coal mine owned and operated by Centennial Myuna Pty Ltd (a subsidiary of Centennial Coal). The consolidated development consent boundary for the Myuna Colliery (approved under Project Approval 10_0080) abuts the eastern boundary of the Project Application Area.
- Wallarah 2 Coal Project, an approved (but not operational) underground coal mine project being developed by Wyong Coal Pty Limited. The development consent boundary for the Wallarah 2 Coal Project (approved under SSD-4974) is located approximately 15 km to the south of the Project Application Area.

The location of the project relative to other operating coal mines and associated industry is illustrated in Figure 3-1.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Operating mines and associated industry near the project

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Figure 3-1

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Data source: Centennial: Consent boundary, 2016; Geoscience Australia: 250k Topographic Data Series 3, 2006. . Created by:

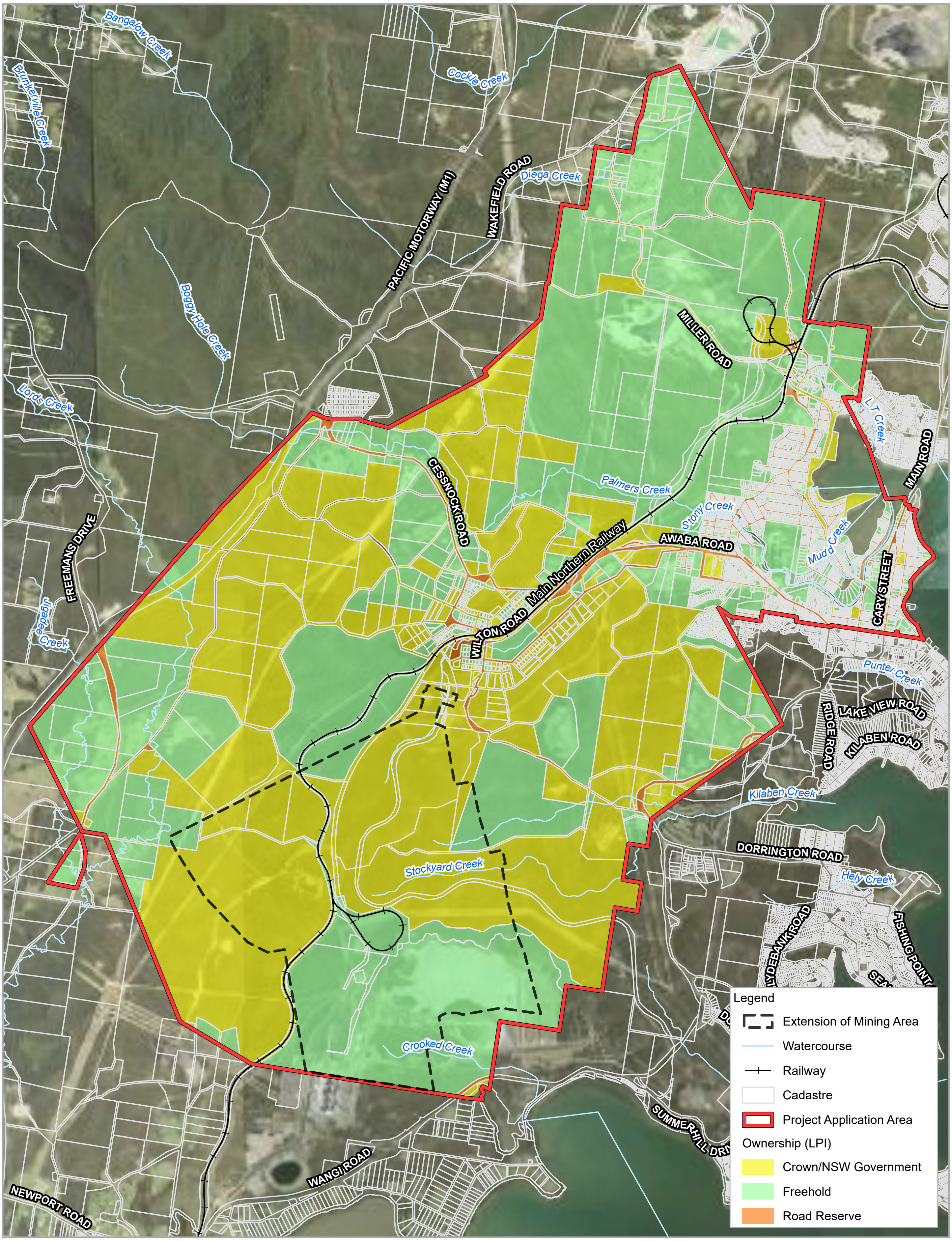
3.3 Land ownership

Land ownership within and immediately surrounding the Project Application Area includes:

- Crown land, Crown roads and Crown reserves.
- Private freehold land.
- State Forest managed by Department of Primary Industries (DPI) Forestry.
- State Conservation Area.
- Freehold land owned by Centennial Coal.
- Freehold land owned by Lake Macquarie City Council.
- Freehold land owned by Origin Energy.
- Freehold land owned by RailCorp.

The majority of land that will be affected by mining within the Project Application Area is Crown land or land owned by Origin Energy (the owner of Eraring Power Station).

A schedule of land for the Project Application Area is provided in Appendix B. The land tenure within the Project Application Area is shown on Figure 3-2.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

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Date 09/06/2020

Land tenure

Figure 3-2

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Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

3.4 Protected areas

Parts of the north-western portion of the Project Application Area are overlaid by the Awaba State Forest. None of the Extension of Mining Area is overlaid by the Awaba State Forest.

The Extension of Mining Area is overlaid by a biodiversity offset site owned by Lake Macquarie City Council. The site, known as the Awaba Biodiversity Conservation Area, is located on Lot 463 DP 1138964 and managed for biodiversity conservation in accordance with the terms of an agreement established under the EPBC Act.

Protected areas are illustrated on Figure 2-2.

3.5 Geology

The project is located in the south-western part of the Newcastle Coalfield, which occupies the north-eastern portion of the Sydney Basin. The stratigraphy of the region consists of material from the Triassic and Permian periods.

The Newcastle Coal Measures are characterised by complex patterns of splitting and coalescence of the various coal seams. This is generally related to the localised presence of alluvial paleochannels within the sedimentary sequence. The West Borehole seam is contained within the Lambton Formation, the earliest formation of the Newcastle Coal Measures.

The surface lithology in the vicinity of the Extension of Mining Area comprises shallow Quaternary alluvium (associated with the major watercourses) as well as bedrock and surface deposits from the Narrabeen Group and the Moon Island Beach Group of the Newcastle Coal Measures, which dip gently at approximately 1 to 2 degrees to the south-west. The Triassic and Permian rocks that comprise the surface lithology include conglomerate, sandstone, siltstone, claystone, tuff and coal.

The Young Wallsend, Great Northern, Fassifern, Borehole and West Borehole seams have been previously mined at Newstan Colliery. Most recently, mining has been undertaken in the West Borehole seam.

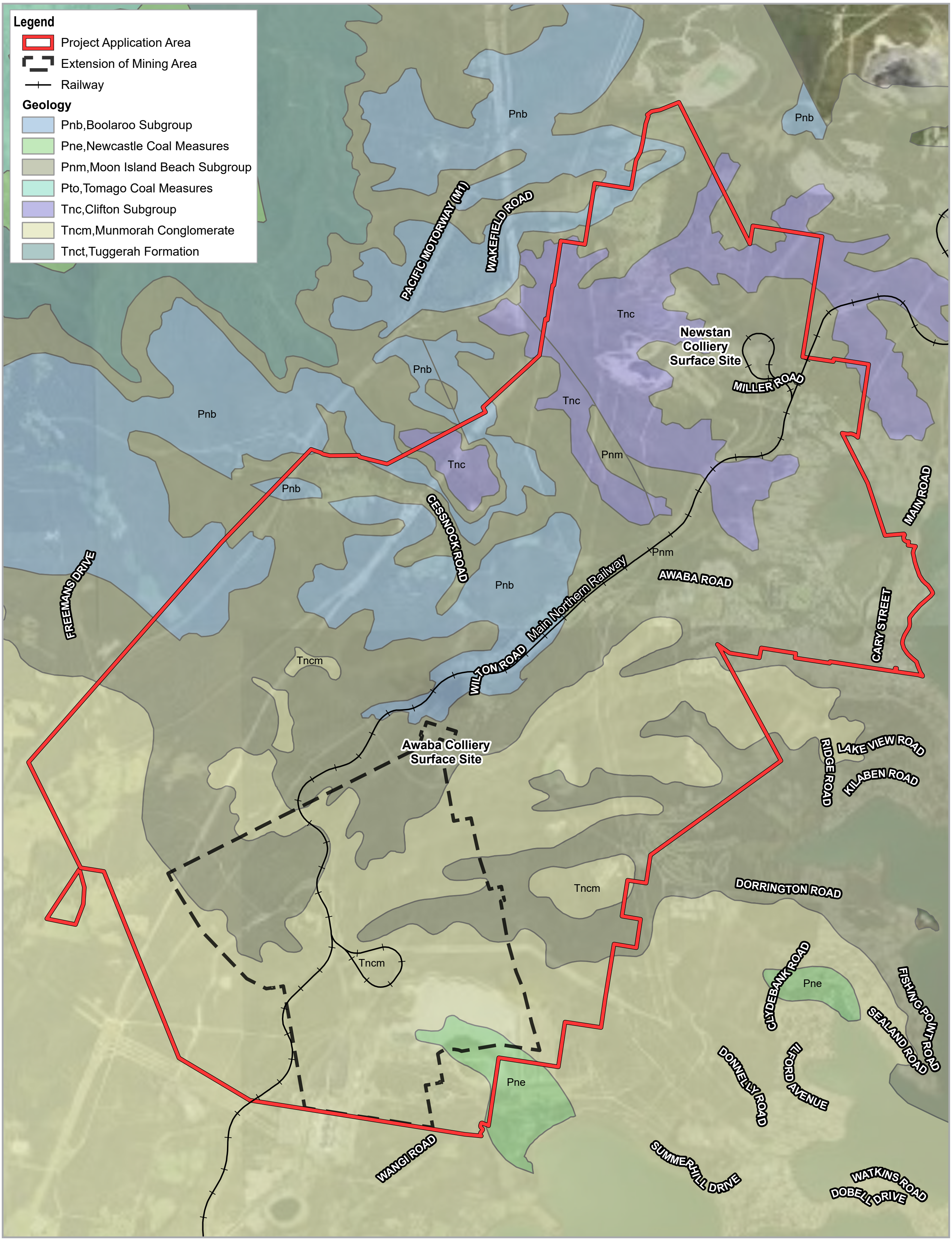
The key geological features within the Extension of Mining Area are presented in Figure 3-3.

Coal resource

The target coal resources are contained within the lower part of the Late Permian Newcastle Coal Measures. Within the Extension of Mining Area, the Lambton Formation, at the base of the Newcastle Coal Measures, contains the only seam considered to have economic mining potential. The seam of interest is the West Borehole seam, which is the agglomeration of the Borehole, Young Wallsend and Yard seams. Indicative stratigraphy of the coal resources is presented in Figure 3-4.

The coalesced West Borehole seam exists in the south-western part of the Project Application Area where it ranges in thickness from 3.5 m to 5.5 m, with average raw ash content of 29.6%.

The coal seams generally dip gently to the southeast at grades of 1 in 20; however localised seam rolls associated with paleochannels and seam splitting are present in the central part of the Extension of Mining Area. This can increase seam grades locally up to 1 in 10. The depth of cover to the target seam ranges from 140 m in the north-west to 320 m in the east.



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Map Projection: Transverse Mercator
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Key geological features

Figure 3-3

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Data source: Centennial: Consent boundary, 2016; DPI: Geology, 2010; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

Group	Formation	Coal Seams		
NEWCASTLE COAL MEASURES	Moon Island Beach	Vales Point		
		Wallarah		
		Great Northern		
	Awaba Tuff			
	Boolaroo	Fassifern		
		Upper Pilot		
		Lower Pilot		
		Hartley Hill		
	Warners Bay Tuff			
	Adamstown	Australasian		
		Montrose		
		Wave Hill		
		Fern Valley		
		Victoria Tunnel		
	Nobbys Tuff			
	Lambton	West Borehole	Young Wallsend	Nobbys
				Dudley
			Yard	
			Borehole	
Waratah Sandstone				

Figure 3-4 Indicative stratigraphy

4. Statutory context

This chapter describes the key relevant State and Commonwealth statutory requirements which apply to the project. This section has only identified the relevant statutory requirements. The detailed consideration of these requirements is contained in the relevant sections of this EIS.

4.1 Requirement for development consent

Centennial Newstan is seeking SSD consent for the project under Divisions 4.7 of Part 4 of the EP&A Act. The project has also been declared a controlled action and, as such, requires approval under the EPBC Act.

The project's approval pathway is described in further detail in the following subsections.

4.1.1 Approval for proposed operations

Centennial Newstan is seeking development consent under the SSD provisions (Division 4.7) of the EP&A Act.

Section 4.36(2) of the EP&A Act provides that any development or class of development, such as mining may be declared as SSD by a State Environmental Planning Policy.

Clause 8 of the State and Regional Development SEPP provides that the development is declared to be SSD for the purposes of the EP&A Act if:

(a) the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the EP&A Act and

(b) the development is specified in Schedule 1 or 2.

With respect to (a) above, the project may be carried out only with development consent under Part 4 of the EP&A Act pursuant to clause 7 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP)).

With respect to (b) above, Schedule 1, Item 5(1) of the State and Regional Development SEPP specifies that development for the purpose of mining that is coal mining is declared as being SSD. Consequently, the project constitutes SSD.

In accordance with section 4.5(a) of the EP&A Act and clause 8A of the State and Regional Development SEPP, the Independent Planning Commission (IPC) or the Minister administering the EP&A Act will be the consent authority for the project.

A development application for SSD must be accompanied by an EIS, prepared in accordance with the EP&A Regulation (refer to Table 4-1). This EIS has been prepared to accompany Centennial Newstan's SSD application for the project.

4.1.2 Approval for existing operations

The project proposes the ongoing use of some of the infrastructure and mining areas authorised by the existing development consents for Newstan Colliery (DA 73-11-98) and Awaba Colliery (PA 10_0038) or by continuing use rights under section 4.68 of the EP&A Act. Centennial Newstan understands that these development consents will be surrendered subject to consent being granted for the project.

The requirement to consider the use and operation of existing infrastructure and mining areas is addressed in section 4.63(3) of the EP&A Act, which provides that:

If a development consent is to be surrendered as a condition of a new development consent and the development to be authorised by that new development consent includes the continuation of any of the development authorised by the consent to be surrendered:

a. *the consent authority is not required to re-assess the likely impact of the continued development to the extent that it could have been carried out but for the surrender of the consent, and*

b. *the consent authority is not required to re-determine whether to authorise that continued development under the new development consent (or the manner in which it is to be carried out), the works already authorised under the planning approvals proposed to be consolidated and surrendered as part of the Project, do not require re-assessment in the EIS.*

Accordingly, the continued development authorised under existing planning approvals and proposed to be consolidated and surrendered as part of the project, does not require re-assessment in the EIS. Only development which is in addition to the development currently approved under DA 73-11-98 for Newstan Colliery, PA 10_0038 for Awaba Colliery and continuing use rights has been assessed in this EIS.

4.1.3 Permissibility of the project

The project is located within the Lake Macquarie LGA and is therefore subject to the provisions of the Lake Macquarie Local Environmental Plan 2014 (Lake Macquarie LEP).

Land zonings within the Project Application Area pursuant to the Lake Macquarie LEP are:

- B1 Neighbourhood Centre
- B2 Local Centre
- B4 Mixed Use
- E1 National Parks and Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- IN2 Light Industrial
- R2 Low Density Residential
- R3 Medium Density Residential
- RE1 Public Recreation
- RE2 Private Recreation
- RU2 Rural Landscape
- RU3 Forestry
- RU4 Rural Small Holdings
- RU6 Transition
- SP1 Special Activities
- SP2 Infrastructure
- SP3 Tourist
- W1 Natural Waterways

Land zoning within the Project Application Area is shown on Figure 4-1.

The permissibility of the project under the Lake Macquarie LEP varies and in some zones the project is prohibited. Section 5(3) of the Mining SEPP provides, where there is any inconsistency between provisions of the Mining SEPP and those contained in the Lake Macquarie LEP, the Mining SEPP will prevail to the extent of the inconsistency. Clause 7(1) of the Mining SEPP provides that:

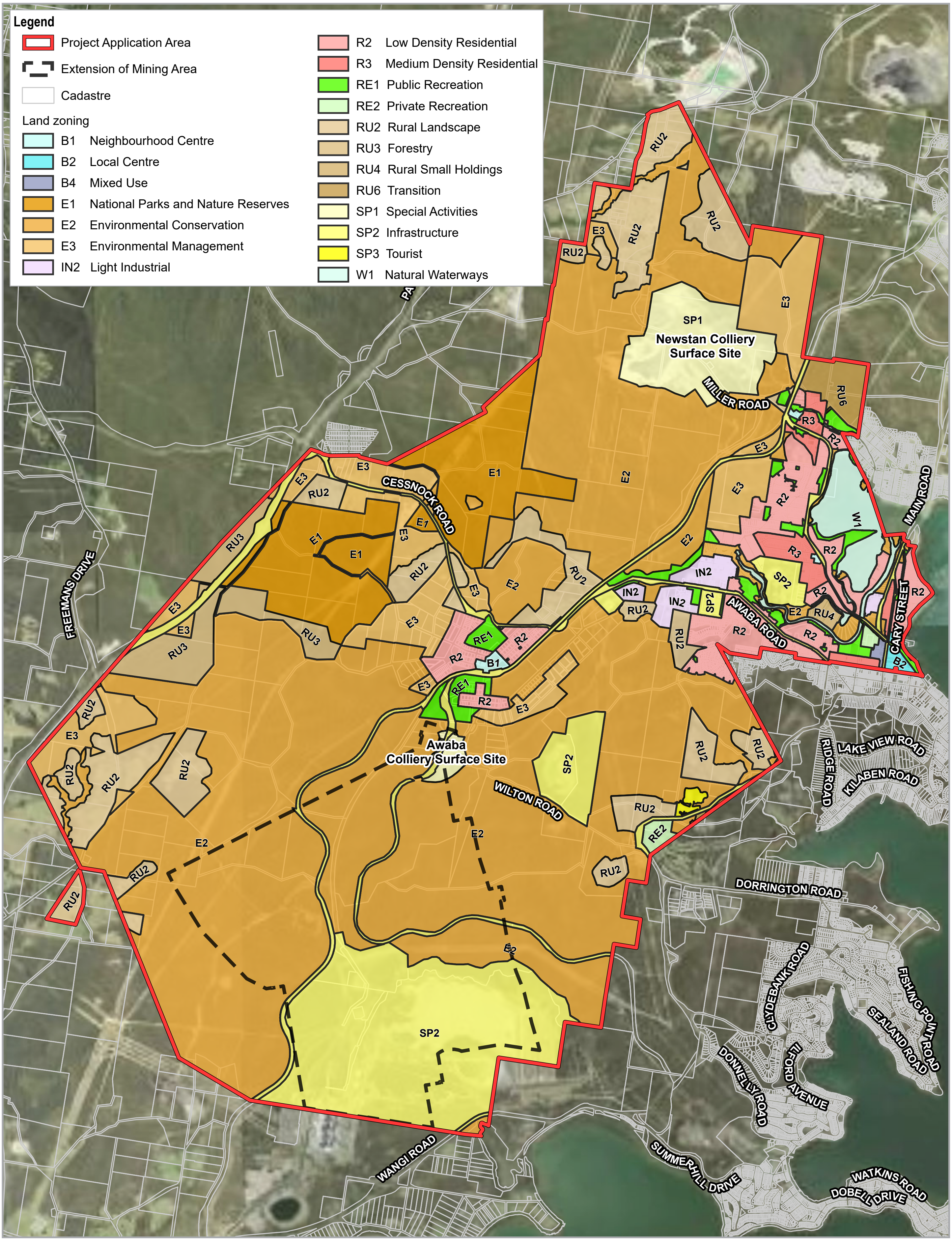
(1) Mining development for any of the following purposes may be carried out only with development consent –

> *(a) Underground mining carried out on any land*
>
> *(b) mining carried out—*
>
> > *(i) on land where development for the purposes of agriculture or industry may be carried out (with or without development consent), or*
> >
> > *(ii) on land that is, immediately before the commencement of this clause, the subject of a mining lease under the Mining Act 1992 or a mining licence under the Offshore Minerals Act 1999,*
>
> *(c) mining in any part of a waterway, an estuary in the coastal zone or coastal waters of the State that is not in an environmental conservation zone,*
>
> *(d) facilities for the processing or transportation of minerals or mineral bearing ores on land on which mining may be carried out (with or without development consent), but only if they were mined from that land or adjoining land,*
>
> *(e) mining on land that is reserved as a state conservation area under the National Parks and Wildlife Act 1974,*
>
> *(f) extracting a bulk sample as part of resource appraisal of more than 20,000 tonnes of coal or of any mineral ore.*

The project fulfils the definition of 'underground mining' in the Mining SEPP given in clause 3(2). The project is for underground mining purposes. Accordingly, the project is permissible with development consent.

Development for the purpose of the surface facilities which form part of the project is permissible with consent, as it is either:

- On land where agriculture or industry can be carried out.
- Subject to mining upon the commencement of clause 7 the Mining SEPP, being 16 February 2007.



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Newstan Mine Extension Project
Environmental Impact Statement

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Land zoning

Figure 4-1

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Data source: Centennial: Consent boundary, 2016; DPE: Land Zoning, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

4.1.4 Mandatory matters for consideration

The consent authority for SSD is required to take into consideration a range of matters, as outlined in Section 4.15 of the EP&A Act. These matters are reproduced as follows:

(1) Matters for consideration—general

In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:

(a) the provisions of:

(i) any environmental planning instrument, and

(ii) any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Planning Secretary has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and

(iii) any development control plan, and

(iiia) any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under section 7.4, and

(iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph),

(v) (Repealed)

that apply to the land to which the development application relates,

(b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,

(c) the suitability of the site for the development,

(d) any submissions made in accordance with this Act or the regulations,

(e) the public interest.

Relevant matters for consideration under Section 4.15 of the EP&A Act are discussed in the following subsections. Section 4.15 (1) (a) (iii), Clause 11 of the State and Regional Development SEPP states that development control plans do not apply to SSD. As such, development control plans are not considered further in this EIS.

Environmental planning instruments

Environmental planning instruments relevant to the project comprise a number of State Environmental Planning Policies and the Lake Macquarie LEP. The relevance of these instruments to the project is discussed in Section 4.2.

Planning agreements

Part 7, Division 7.1, Subdivision 2, Section 7.4 of the EP&A Act defines planning agreements as follows:

(1) A planning agreement is a voluntary agreement or other arrangement under this Division between a planning authority (or 2 or more planning authorities) and a person (the developer):

(a) Who has sought a change to an environmental planning instrument, or

> *(b) Who has made, or proposes to make, a development application for a complying development certificate, or*
>
> *(c) Who has entered into an agreement with, or is otherwise associated with, a person who paragraph (a) or (b) applies,*
>
> *under which the developer is required to dedicate land free of cost, pay a monetary contribution, or provide any other material public benefit, or any combination of them, to be used for or applied towards a public purpose.*

Section 7.4 allows the proponent of a development to enter into a voluntary planning agreement (VPA) or other arrangements with planning authorities in lieu of a contribution made under Section 7.11 or a levy imposed under Section 7.12 of the EP&A Act.

The regulations

Clauses 6 and 7 of Schedule 2 of the EP&A Regulations set out the form and content requirements for the preparation of an EIS in support of development application. These requirements are reproduced in Table 4-1, together with a reference to where each has been addressed within this EIS.

Table 4-1 EIS form and content requirements under the EP&A Regulations

Requirement	Where addressed within this EIS
6 Form of an environmental impact statement *An environmental impact statement must contain the following information:*	
(a) The name, address and professional qualifications of the person by whom the statement is prepared,	Appendix G
(b) The name and address of the responsible person,	Section 1.2.1
(c) The address of the land: *(i) In respect of which the development application is to be made, or* *(ii) On which the activity or infrastructure to which the statement relates is to be carried out,*	Section 2.2.1 and Appendix B
(d) A description of the development, activity or infrastructure to which the statement relates,	Chapter 2
(e) An assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule,	Chapter 6
(f) A declaration by the person whom the statement is prepared to the effect that:	Appendix F
(i) The statement has been prepared in accordance with this Schedule, and *(ii) The statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and* *(iii) That the information contained in the statement is neither false nor misleading.*	
7 Content of an environmental impact statement *(1) An environmental impact statement must also include each of the following:*	
(a) A summary of the environmental impact statement,	Executive summary
(b) A statement of the objectives of the development, activity or infrastructure,	Section 1.2.2

Requirement	Where addressed within this EIS
(c) An analysis of the feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure,	Section 2.4
(d) An analysis of the development, activity or infrastructure, including:	
(i) A full description of the development, activity or infrastructure, and	Chapter 2
(ii) A general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected, and	Chapter 3 and Chapter 6
(iii) The likely impact on the environment of the development, activity or infrastructure, and	Chapter 6
(iv) A full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment, and	Chapter 6 and Appendix D
(v) A list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out,	Section 4.5
(e) A compilation (in a single section of the environmental impact statement) of the measures referred to in item (d) (iv),	Appendix D
(f) The reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4). *Note: a cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure.*	Chapter 7

Likely impacts of the development

This EIS presents a comprehensive assessment of the likely impacts of the project, including the predicted impacts on both the natural and built environment, and social and economic impacts in the local area, region and State. It also describes in detail the commitments proposed by Centennial Newstan to manage, mitigate and offset the identified impacts. The assessment of project-related impacts has been completed by a team of suitably qualified and experienced persons using the best available data, in line with current industry standards and guidelines, and in accordance with relevant legislation and policies.

The likely natural and built environment and social and economic impacts of the project are described in Chapter 6. A summary of these impacts is presented in Section 7.5. A consolidated list of the measures proposed by Centennial Newstan to manage, mitigate and offset the identified impacts from the project is presented in Appendix D.

Suitability of the site for the development

The suitability of the site for the development is discussed in Chapter 7.

Submissions

This EIS will be placed on public exhibition by DPIE – Planning and Assessment. During this time, government agencies, community and industry groups, and members of the public will be invited to provide feedback on this EIS to DPIE – Planning and Assessment via a written submission. Any submissions received will be reviewed and forwarded to Centennial Newstan. Submissions will need to be addressed by Centennial Newstan in a Submissions Report for the project, which will be provided to DPIE – Planning and Assessment for consideration.

Following receipt of the Submissions Report, DPIE – Planning and Assessment will prepare its assessment report considering this EIS, the submissions received during the public exhibition period, and Centennial Newstan's response to those submissions documented in the Submissions report.

Public interest

The extent to which the project is in the public interest in discussed in Chapter 7.

4.2 Environmental planning instruments

Environmental planning instruments relevant to the project include State Environmental Planning Policies and the Lake Macquarie LEP. The relationship of these environmental planning instruments to the project is described in the following subsections.

State Environmental Planning Policy (State and Regional Development) 2011

The State and Regional Development SEPP identifies development that is SSD. Division 4.36 of the EP&A Act enables an EPI to declare a development to be SSD. The project is SSD pursuant to Schedule 1 of the State and Regional Development SEPP, as it is development for the purpose of (coal) mining.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007

The Mining SEPP regulates the permissibility of mining and related development and specifies matters that must be considered in assessing mining developments requiring consent under Part 4 of the EP&A Act.

Sub-clause 7(1)(a) of the Mining SEPP states that development for the purpose of underground mining (which includes mine related development) may be carried out on any land with development consent.

Clauses 12 to 17 (inclusive) require consideration to be given to the compatibility of projects with other surrounding land uses, including the existing and potential extraction of minerals, natural resource management and environmental management, resource recovery, transportation and rehabilitation.

The matters of consideration outlined in Clauses 12 to 17 of the Mining SEPP are addressed in Table 4-2.

Table 4-2 Matters for consideration under the Mining SEPP

Matter for consideration	Response
<u>12AB Non-discretionary development standards for mining</u> This clause outlines a number of non-discretionary development standards that, if complied with, prevents the consent authority from requiring more onerous standards for those matters (but that does not prevent the consent authority granting consent even though any such standard is not complied with) for the purpose of section 4.15(2) and (3) of the EP&A Act in relation to mining developments. These standards relate to cumulative noise levels, cumulative air quality levels, airblast overpressure, ground vibration, and aquifer interference.	These standards are addressed in Sections 6.3, 6.8 and 6.9 respectively for groundwater, air quality, and noise and vibration.
<u>12 Compatibility of proposed mine, petroleum production or extractive industry with other land uses</u> This clause requires a consent authority to consider the compatibility of the development with other land uses. It states: *Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must—* *(a) consider—* *(i) the existing uses and approved uses of land in the vicinity of the development, and* *(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and* *(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and* *(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and* *(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).*	Land uses within and surrounding the Project Application Area are described in Section 3.2, and include coal mining, industrial, electricity generation, forestry, environmental management, agricultural, rural residential and residential developments. Potential impacts to these land uses have been assessed in this EIS and demonstrate that the project will not have a significant impact on existing and approved land uses near the project.
<u>12A Consideration of voluntary land acquisition and mitigation policy</u> This clause requires the consent authority to consider relevant provisions of the Voluntary Acquisition and Mitigation Policy (NSW Government, 2018a). In particular: *(a) any applicable provisions of the policy for the mitigation or avoidance of noise or particulate matter impacts outside the land on which the development is to be carried out, and*	The provisions of the Voluntary Acquisition and Mitigation Policy have been considered in the air quality and greenhouse gas, and noise and vibration assessments, as summarised in Sections 6.8 and 6.9 respectively.

Matter for consideration	Response
(b) any applicable provisions of the policy relating to the developer making an offer to acquire land affected by those impacts.	
<u>13 Compatibility of proposed development with mining, petroleum production or extractive industry</u> <u>This clause requires the consent authority to:</u> *(a) consider—* *(i) the existing uses and approved uses of land in the vicinity of the development, and* *(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and* *(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and* *(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and* *(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii).*	The project is proposed within an existing mining precinct. It is also located entirely within the current Colliery Holding Boundary for the approved Newstan Colliery. Further, the project is centrally located within the Newcastle Coalfield and its location is identified in mapping within the Lower Hunter Regional Strategy 2006 – 2031 (DoP, 2006) as a 'Coal Resources' area and 'rural and resource land'. Further details regarding the existing and approved uses of the land in the vicinity of the project are presented in Section 3.2 The measures taken by Centennial Newstan to avoid or minimise any incompatibility with existing and approved land uses are presented in Section 2.4 (Project rationale and alternatives considered).
<u>14 Natural resource management and environmental management</u> *(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following—*	
(a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,	The project's groundwater and surface water impacts are presented in Sections 6.3 and 6.4 respectively.
(b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,	The project's impacts to threatened species and biodiversity are presented in Section 6.5.
(c) that greenhouse gas emissions are minimised to the greatest extent practicable.	The project's greenhouse gas emissions are presented in Section 6.8.
(2) Without limiting subclause (1), in determining a development application for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider an assessment of the greenhouse gas emissions (including downstream emissions) of the development, and must do so having regard to any applicable State or national policies, programs or guidelines concerning greenhouse gas emissions.	An assessment of the project's greenhouse gas emissions has been prepared in accordance with relevant State and national policies, programs and guidelines concerning greenhouse gas emissions. A summary of the assessment findings is presented in Section 6.8 and a copy of the assessment is provided in Appendix O.

Matter for consideration	Response
(3) Without limiting subclause (1), in determining a development application for development for the purposes of mining, the consent authority must consider any certification by the Chief Executive of the Office of Environment and Heritage or the Director-General of the Department of Primary Industries that measures to mitigate or offset the biodiversity impact of the proposed development will be adequate.	Measures to mitigate and offset biodiversity impacts from the project are presented in Section 1.1
<u>15 Resource recovery</u>	
(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery. (2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material. (3) The consent authority may refuse to grant consent to development if it is not satisfied that the development will be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials.	The current proposed bord and pillar mine plan aims to strike a balance between optimising resource recovery and protecting sensitive environmental features. It has been developed based on extensive modelling of subsidence impacts and through consultation with key government agencies and infrastructure owners (refer to Section 5).
<u>16 Transport</u> (1) Before granting consent for development for the purposes of mining or extractive industry that involves the transport of materials, the consent authority must consider whether or not the consent should be issued subject to conditions that do any one or more of the following—	Traffic and transport related impacts from the projet are presented in Section 6.10.
(a) require that some or all of the transport of materials in connection with the development is not to be by public road,	
(b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,	
(c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.	
(2) If the consent authority considers that the development involves the transport of materials on a public road, the consent authority must, within 7 days after receiving the development application, provide a copy of the application to—	
(a) each roads authority for the road, and	

Matter for consideration	Response
(b) the Roads and Traffic Authority (if it is not a roads authority for the road). Note. Section 7 of the Roads Act 1993 specifies who the roads authority is for different types of roads. Some roads have more than one roads authority.	
(3) The consent authority—	
(a) must not determine the application until it has taken into consideration any submissions that it receives in response from any roads authority or the Roads and Traffic Authority within 21 days after they were provided with a copy of the application, and	
(b) must provide them with a copy of the determination.	
(4) In circumstances where the consent authority is a roads authority for a public road to which subclause (2) applies, the references in subclauses (2) and (3) to a roads authority for that road do not include the consent authority.	
17 Rehabilitation	
(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development. (2) In particular, the consent authority must consider whether conditions of the consent should— (a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or (b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or	A conceptual rehabilitation strategy for the project (refer to Section 6.19) has been developed in consultation with stakeholders and with consideration of the detailed environmental investigations undertaken as part of the EIS. The purpose of the rehabilitation strategy is to establish preliminary objectives for the decommissioning and rehabilitation of disturbed land as part of the project. The strategy identifies potential final land use options, defines the preferred final land use option, and sets out rehabilitation objectives and preliminary rehabilitation success criteria that can be used to demonstrate that the desired final land use outcome has been achieved. The rehabilitation strategy also makes provision for ensuring public safety is maintained and any soil contamination is appropriately managed as part of the decommissioniong and rehabilitation process.
(c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under clause 3 of Schedule 6 to the Act and the *Contaminated Land Management Act 1997*), or (d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety.	

State Environmental Planning Policy No. 44 – Koala Habitat Protection

SEPP No. 44 – Koala Habitat Protection (SEPP 44) provides for the protection of koala habitat by ensuring that areas subject to development proposals are considered for their value as habitat or potential habitat for koalas. The Lake Macquarie LGA is listed under Schedule 1 of SEPP 44 as an area to which the SEPP applies.

SEPP (Koala Habitat Protection) 2019 repealed and replaced SEPP 44 on 1 March 2020. Although this assessment was largely completed prior to the transition from SEPP 44, it has been included herewith for brevity. The primary changes which are of particular relevance to the project with regards to the new SEPP are: the updated definition of Core Koala Habitat; the inclusion of two new Koala SEPP maps; and an expanded list of feed tree species listed in schedule 2 from ten to 123 species.

The project's potential to impact areas of koala habitat has been assessed as part of the terrestrial ecology assessment completed for the EIS. The project is not expected to adversely impact Core Koala Habitat as defined under either SEPP 44 or SEPP (Koala Habitat Protection) 2019, and hence no further provisions of these policies apply to the project. Further details are presented in Section 6.66.5.

State Environmental Planning Policy (Infrastructure) 2007

The SEPP (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across NSW. ISEPP includes provisions for development in rail corridors, electricity easements and within or adjacent to road corridors and road reservations, which are relevant to the project and have been addressed in the EIS.

Centennial Newstan has undertaken extensive consultation with a number of infrastructure owners and managers including Transport for NSW (TfNSW) (including the former Roads and Maritime Services), TransGrid and Origin Energy during the EIS process with respect to project activities that have the potential to impact on their infrastructure. The project has been developed and refined in response to the outcomes of these consultations to avoid and minimise impacts, where possible.

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development

SEPP No. 33 - Hazardous and Offensive Development (SEPP 33) regulates, amongst other matters, the determination of development applications to carry out what is defined in SEPP 33 as development for the purposes of a "potentially hazardous industry" or "potentially offensive industry". The project has been assessed to determine if it is classified as "potentially hazardous" or "potentially offensive" development, with consideration of DP&E's guidelines Applying SEPP 33 (DoP, 2011).

With the continued implementation of best management practices for hydrocarbons used within the Project Application Area and the other measures outlined in this EIS to reduce or minimise the impact of the project, as well as effective implementation of the approved environmental and workplace health and safety management systems, the project should not pose any significant risk in relation to its locality, to human health, life or property, or the biophysical environment.

Further, by employing the mitigation and management strategies identified in this EIS, the project is unlikely to result in the emission of a polluting discharge in a manner which would pose a significant risk or impact in its locality or on the existing or likely future development on other land.

On the above basis, the project is not considered to comprise a "potentially hazardous industry" or a "potentially offensive industry" within the meaning of these expressions in SEPP 33, and therefore a preliminary hazard analysis was not prepared as required by clause 12 of SEPP 33 and nor does clause 13 of SEPP 33 apply to the consent authority's determination of the development application for the project. Further details are presented in Section 6.17.

State Environmental Planning Policy (Coastal Management) 2018

SEPP (Coastal Management) 2018 (Coastal Management SEPP) updates and consolidates into one integrated policy SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection), including clause 5.5 of the Standard Instrument – Principal Local Environmental Plan. These policies are now repealed. 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.

There are coastal environment areas mapped under the Coastal Management SEPP that are within the Project Application Area. The EIS has assessed the project’s impact on the coastal environment area in accordance with the requirements of the Coastal Management SEPP. Matters for consideration under the Coastal Management SEPP, together with a description as to how they have been dealt with in this EIS, are presented in Table 4-3.

Table 4-3 Matters for consideration under the Coastal Management SEPP

Matter for consideration	Response
(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following—	
(a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,	A detailed assessment of the potential impacts to the biophysical, hydrological and ecological environment from the project has been completed, the findings of which are documented in Chapter 6 of this report.
(b) coastal environmental values and natural coastal processes,	No coastal environmental values or natural coastal processes are likely to be affected by the project.
(c) the water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,	No sensitive coastal lakes identified in Schedule 1 are likely to be impacted by the project.
(d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms	An assessment of the project’s impacts to native vegetation and fauna and their habitats has been completed, the findings of which are documented in Section 6.5 of this report. The project is not expected to impact marine vegetation, undeveloped headlands or rock platforms.

Matter for consideration	Response
(e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,	The project is not expected to impact existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public.
(f) Aboriginal cultural heritage, practices and places,	Aboriginal cultural heritage impacts from the project are addressed in Section 6.12 of this report.
(g) the use of the surf zone.	The project is not expected to impact the surf zone.

Lake Macquarie Local Environmental Plan 2014

The project is located on a variety of land zonings (as listed above in Section 4.1.3) pursuant to the Lake Macquarie LEP. Under the Lake Macquarie LEP the proposed project activities are prohibited in many of these zones. However, as described in Section 4.1.3, the project is permissible with development consent under the Mining SEPP, which prevails over any inconsistencies with a LEP.

4.3 Other relevant NSW legislation

The following NSW Acts may be applicable to the project:

- Aboriginal Land Rights Act 1983.
- Biodiversity Conservation Act 2016.
- Coal Mine Subsidence Compensation Act 2017.
- Contaminated Lands Management Act 1997.
- Crown Land Management Act 2016.
- Dams Safety Act 2015.
- Electricity Supply Act 1995.
- Eraring Power Station Act 1981.
- Fisheries Management Act 1994.
- Heritage Act 1977.
- Mining Act 1992.
- National Parks & Wildlife Act 1974.
- Native Title (NSW) Act 1994.
- Pipelines Act 1967.
- Protection of the Environment Operations Act 1997.
- Roads Act 1993.
- Water Act 1912.
- Water Management Act 2000.
- Work Health and Safety Act 2011.
- Work Health and Safety (Mines and Petroleum Sites) Act 2013.

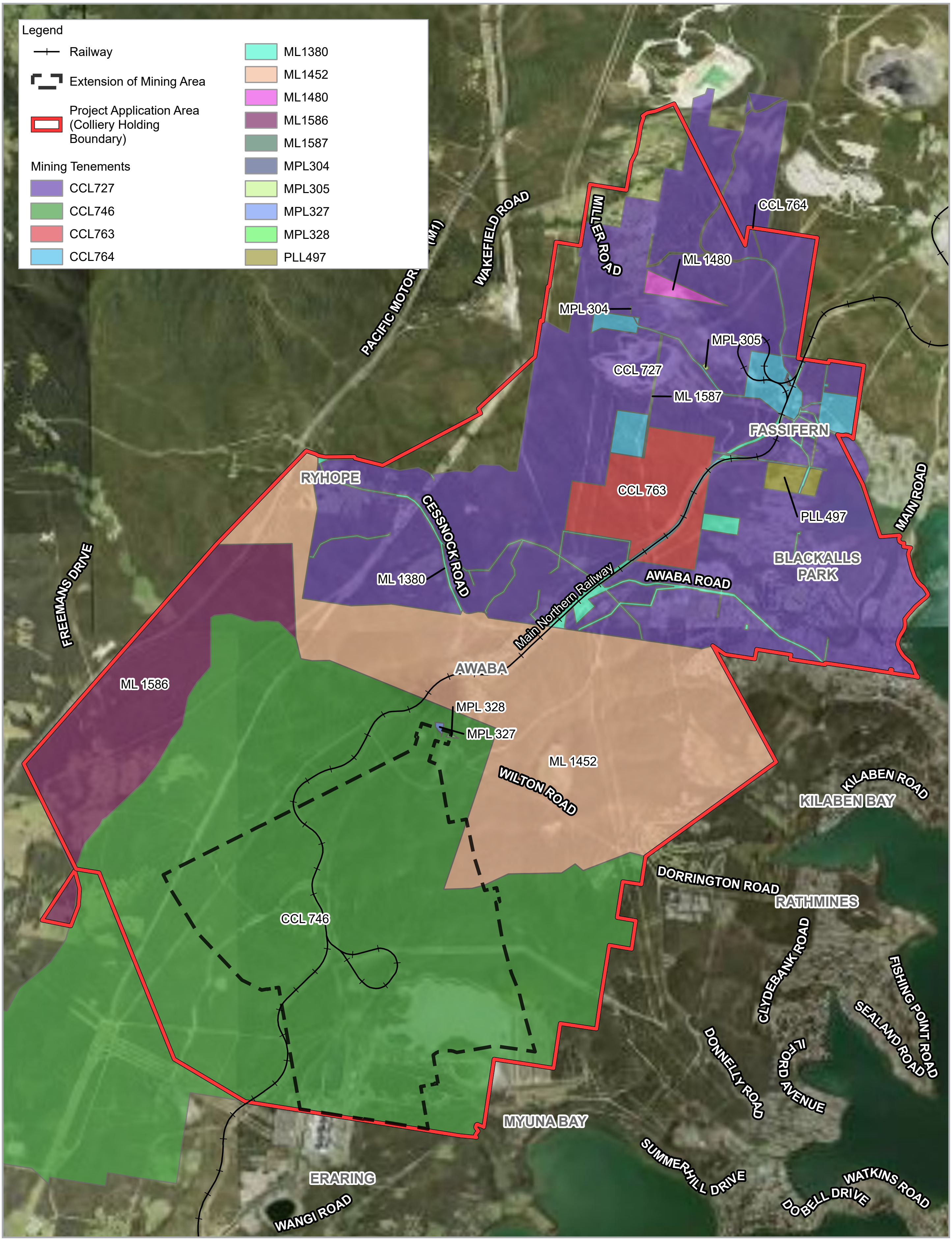
Relevant licences or approvals required under these Acts would be obtained for the project as required. Additional detail on the likely requirements under the most pertinent legislation is provided in the subsections below.

Mining Act 1992

The objects of the *Mining Act 1992* (Mining Act) are to encourage and facilitate the discovery and development of mineral resources in NSW, having regard to the need to encourage Ecologically Sustainable Development (ESD). Centennial Newstan is the holder of mining leases Group 9 minerals (coal and oil shale) over all relevant land where mining for coal is proposed to be carried out for the project.

Under section 4.42(1)(c) of the EP&A Act, if the project is approved as SSD, mining leases granted under the Mining Act that are required for carrying out the project cannot be refused and are to be substantially consistent with any development consent granted under Division 4.7 of the EP&A Act.

Centennial Newstan does not anticipate that any additional mining leases will be required for the carrying out of the project. The Colliery Holding Boundary and associated mining leases for the project are shown in Figure 4-2.



Paper Size ISO A4

0 0.4 0.8 1.2 1.6 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Mining tenements

Figure 4-2

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) sets out the legal requirements for environmental protection for development in NSW. Schedule 1 of the POEO Act identifies activities that require an environment protection licence (EPL). An EPL sets the management standards and monitoring requirements to control pollution for the relevant ‘scheduled activity’. Schedule 1 lists ‘mining for coal’ and ‘coal’ works’ as scheduled activities. The project is a scheduled activity as it constitutes "coal works" and "mining for coal" (clauses 10 and 28 of Schedule 1) PEO Act.

These activities are currently licenced at Newstan Colliery under the provisions of EPL 395 and at Awaba Colliery under the provisions of EPL 443. Accordingly, Centennial Newstan does not anticipate that any additional EPLs will be required for the carrying out of the project.

Water Management Act 2000 and Water Act 1912

Under section 4.41(1)(g) of the EP&A Act, if the project is approved as SSD, water use approvals under section 89, water management works approvals under section 90, or activity approvals (excluding aquifer interference approvals) under section 91 of the Water Management Act 2000 would not be required for the project.

Centennial Newstan has previously lodged applications for licences under the *Water Act 1912* (Water Act) which are underdetermined. These valid licence applications once granted will provide sufficient volume for the licensing of water taken as part of the project as Centennial Newstan anticipates that they will be granted for water access licences in the Sydney Basin-North Coast water source covered by the Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources 2016.

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) contains provisions for the protection and management of nature and places, objects and features of significance to Aboriginal people.

A person must not harm or desecrate an Aboriginal object or place without an Aboriginal heritage impact permit under Section 90 of the NPW Act. Section 4.41 of the EP&A Act removes the need for a Section 90 permit when development consent has been granted for an SSD.

An assessment of the project’s potential to impact Aboriginal heritage has been completed as part of the EIS. The findings of that assessment are summarised in Section 6.12.

Biodiversity Conservation Act 2016

The purpose of the *Biodiversity Conservation Act 2016* (BC Act) is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future. The BC Act lists threatened species, populations and ecological communities as well as critical habitat and key threatening processes that must be considered when assessing the effects of an activity.

An assessment of the project’s impacts on biodiversity, including any offsetting requirements, has been completed as part of the EIS in accordance with the requirements of the BC Act. The findings of that assessment are summarised in Section 6.5.

Roads Act 1993

The *Roads Act 1993* (Roads Act) regulates activities that may impact on public roads in NSW. Consent is required from the relevant roads authority under Section 138 of the Roads Act for any work in, on or over a public road.

Section 4.42 of the EP&A Act stipulates that a consent under Section 138 cannot be refused for SSD and must have terms that are substantially consistent with the development consent for the SSD.

The project was referred to Transport for NSW (TfNSW) (formerly Roads and Maritime Services) as part of the SEARs request process. TfNSW's assessment recommendations, which were appended to the project SEARs, have been considered in the traffic and transport assessment completed for the EIS, the findings of which are summarised in Section 6.10.

Coal Mine Subsidence Compensation Act 2017

The *Coal Mine Subsidence Compensation Act 2017* (CMSC Act) provides a scheme for the provision of compensation for damage caused by subsidence from coal mines, and the assessment and management of risks associated with subsidence from coal mines.

The project is located within the West Lake Mine Subsidence District declared under Section 20 of the CMSC Act, and the regulations made under the CMSC Act.

At all times while the project is an active mine, Centennial Newstan (or the relevant proprietor) will be liable to pay compensation in relation to damage caused by subsidence arising from the project on improvements or goods under Part 2 of the CMSC Act. Any claims for compensation by another party under the CMSC Act would be lodged with Subsidence Advisory NSW.

Heritage Act 1977

Historical archaeological relics, buildings, structures, archaeological deposits and features are protected in NSW under the *Heritage Act 1977* (Heritage Act). Section 4.41 of the EP&A Act removes the need for approvals under Part 4 or an excavation permit under Section 139 of the Heritage Act when development consent has been granted for a SSD.

An assessment of the project's potential to impact historic heritage has been completed as part of the EIS. The findings of the historic heritage assessment are summarised in Section 6.13.

Dams Safety Act 2015

The objects of the *Dams Safety Act 2015* (Dams Safety Act) are to manage matters relating to dams safety, and promote the application of risk management. The project will involve underground mining in the vicinity of the Eraring Ash Dam, which is a declared dam under the Dams Safety Act.

Section 48(4) of the Dams Safety Act states:

"(4) A consent authority must, before granting development consent for the carrying out of any mining operations under the Mining Act 1992 in a notification area:

(a) refer the application for the development consent to Dams Safety NSW, and

(b) take into consideration any matters that are raised by Dams Safety NSW in relation to the application within 28 days (or such other period as is agreed between the consent authority and Dams Safety NSW) after the application is referred to Dams Safety NSW."

Centennial Newstan held a dam safety risk assessment for the project on 19 November 2019. The risk assessment was attended by Centennial Newstan representatives, engineering consultants from Golder Pty Ltd who were experienced in dam design, earthquake and liquefaction risk management, and subsidence engineers from Mine Subsidence Engineering Consultants Pty Ltd (MSEC). The risk assessment reviewed risks to the existing Eraring Ash Dam wall and quantified the risk to that structure from mining, the potential effects of ash/water seeping into underground workings and the potential effects of ash liquefaction. The risks were considered in accordance with Dams Safety NSW risk rating methodologies (NSW Government, 2019b).

A copy of the risk assessment was provided to Dams Safety NSW on 25 November 2019. Dams Safety NSW acknowledged receipt of the risk assessment on in a response provided to Newstan Colliery on 11 December 2019. No issues were raised in the response.

Aboriginal Land Rights Act 1983

The *Aboriginal Land Rights Act 1983* provides for the establishment of local, regional and State Aboriginal Land Councils and a mechanism for Aboriginal Land Councils to claim Crown land.

The land on which the Forest Road Ballast and Borehole Services Site is located, Lot 194 DP755207, is owned by New South Wales Aboriginal Land Council (NSWALC). Centennial Newstan has a lease agreement in place with NSWALC for the continued utilisation of this land.

4.4 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Commonwealth Department of Agriculture, Water and the Environment (DAWE) (formerly Department of the Environment and Energy (DotEE)) and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES). An action that "has, will have or is likely to have a significant impact on a matter of National Environmental Significance" may not be undertaken without prior approval from the Commonwealth Minister, as provided under Part 9 of the EPBC Act. Approval under the EPBC Act is also required where actions are proposed on, or will affect, Commonwealth land and its environment.

The project was referred to the DAWE (formerly DotEE) on 4 September 2019 for consideration as a controlled action, based on potential impacts to listed threatened species and communities, and water resources. The project was deemed a controlled action by DAWE (formerly DotEE) on 23 December 2019 on the basis that it may impact the following MNES:

- Listed threatened species and communities.
- A water resource in relation to a large coal mining development.

The project's impacts on threatened species and communities and water resources have been assessed in detail via an accredited assessment process. The findings of those assessments are presented in Section 6.5 (Terrestrial ecology) and 6.7 (Aquatic ecology), and Section 6.3 (Groundwater) and 6.4 (Surface water) respectively. No significant impacts to MNES are expected as a result of the project.

Native Title Act 1993

The *Native Title Act 1993* (NT Act) recognises that Aboriginal people have rights and interests to land and waters which derive from their traditional laws and customs. Native title may be recognised in places where Indigenous people continue to follow their traditional laws and customs and have maintained a link with their traditional country. It can be negotiated through a Native Title Claim, an Indigenous Land Use Agreement (ILUA) or future Act agreements.

An ILUA is an agreement between a native title group and other parties who use or manage the land and waters. The ILUA process allows for negotiation between indigenous groups and other parties over the use and management of land and water resources, and the ability to establish a formal agreement. An ILUA is binding once it has been registered on the Native Title Tribunal's Register of Indigenous Land Use Agreements.

Much of the land within the Project Application Area is subject to an ILUA that was entered into on 28 May 1999 by the Wonnarua people (Wonnarua Nation Aboriginal Corporation) and Powercoal Pty Ltd (since acquired by Centennial Coal). As such, Centennial Coal is bound by the terms of the ILUA, which are set out in the Master Deed, in the use and management of the subject land. Clause 7 of the Master Deed outlines Centennial Coal's obligations, including provisions for compliance with an Aboriginal Heritage Protection Protocol (Clause 7.2 and Schedule 5). The Deed is subject to a confidentiality clause and, as such, detailed commentary regarding the ILUA is not provided in this report.

National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) is a national reporting framework for the reporting and publication of a corporation's greenhouse gas emissions and energy use. The NGER Act makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

The parent company of Centennial Newstan, Centennial Coal currently reports under the NGER Act and it is antipated anticipated that the relevant energy use and greenhouse gas emissions associated with the project will be included within this reporting regime that is currently in place.

4.5 Summary of approval requirements

The following approvals must be obtained before the project may commence:

- Development consent granted pursuant to section 4.38 the EP&A Act.
- Approval of the proposed action (EPBC 2019/8528) under section 133 of the EPBC Act.
- A Mining Operations Plan (MOP) prepared under the conditions of the project mining leases.

Other approvals required to support the project include, but are not limited to:

- A variation to EPL 395 and potentially also EPL 443 under the POEO Act, subject to consultation with NSW EPA.
- Relevant water access licences under the WM Act.
- Mining and occupational health and safety related approvals granted by the DRG and SafeWork NSW.
- An Extraction Plan approval prior to the commencement of secondary extraction.
- Construction certificates prior to the commencement of any construction of infrastructure required for the project.
- Any management plans required by the development consent or EPBC approval conditions.

5. Engagement

This chapter describes the stakeholder engagement program undertaken for the project, including:

- Identification of the key stakeholders.
- The methods of engagement.
- A summary of the key issues raised during consultations and how they have been dealt with in this EIS.

Further details are presented in the following subsections.

5.1 Historic stakeholder engagement overview

Newstan Colliery has operated for over a century and therefore has well-established local community networks and relationships with landholders and other stakeholders. The Newstan Colliery CCC (now Newstan-Awaba CCC) has operated for almost 20 years.

Centennial Newstan has consulted with a number of community members, Aboriginal groups, infrastructure owners and government agencies to present the project and, where relevant, seek feedback on key project design considerations and areas for investigation during the EIS.

Key project stakeholders include:

- Government (Federal, State and Local).
- Industry.
- Local community.
- Aboriginal groups.
- Centennial Newstan employees.

Extensive consultation has been undertaken regarding the management of direct and indirect subsidence-related impacts to key infrastructure assets such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and environmental features, including the Awaba Biodiversity Conservation Area. These consultations have formed an integral part of the mine design process and these consultations will continue during the construction, operation, and closure phases of the project.

5.2 Stakeholder engagement program

The engagement program commenced early on in the planning phase of the project and has remained ongoing during development of the EIS. The outcomes of the engagement activities have provided Centennial Newstan with a good understanding of stakeholder perceptions regarding potential project-related impacts and opportunities.

Certain elements of the engagement program were delivered by Centennial Newstan whereas others, to ensure independence and impartiality, were undertaken independently by Hansen Bailey as part of the development of the Social Impact Assessment (SIA) for the EIS. There were also some elements of the program, such as the community open days, that were delivered jointly between Centennial Newstan and Hansen Bailey.

A stakeholder consultation log was maintained by Centennial Newstan as a record of the consultation activities undertaken in relation to the project. Hansen Bailey also maintained a consultation log for all engagement activities undertaken to inform the SIA.

5.2.1 Stakeholder identification

The key stakeholders have been identified as those individuals, industries, groups or government agencies that are either directly impacted by the project or who have or will have an interest in the project as it progresses through the approval, construction, operational and closure phases. The key stakeholders identified include:

State government agencies

- DPIE – Planning and Assessment.
- DPIE – Division of Resources and Geoscience (DRG).
- DPIE – Biodiversity and Conservation Division (BCD).
- DPIE – Water Division (Water Division).
- DPIE – Resources Regulator (Resources Regulator).
- Crown Lands.
- Department of Premier and Cabinet – Heritage Branch (Heritage Branch).
- NSW Environment Protection Authority (EPA).
- Natural Resources Access Regulator (NRAR).
- DPI (including DPI Forestry, DPI Agriculture, DPI Fisheries).
- TfNSW (including the former Roads and Maritime Services).
- NSW Health.
- Subsidence Advisory NSW.
- NSW Rural Fire Service.
- Dams Safety NSW (formerly NSW Dam Safety Committee).

Federal government agencies

- DAWE (formerly DotEE).

Local government agencies

- Lake Macquarie City Council.

Industry

- Origin Energy.
- Ausgrid.
- TransGrid.
- Sydney Trains (part of TfNSW).

Aboriginal stakeholders

- Registered Aboriginal Parties (RAPs).
- Northern Holdings Aboriginal Cultural Heritage Committee.

Community

- Newstan-Awaba CCC.
- Residents of Awaba, Fassifern and Wakefield.

- Community stakeholders and residents (elected representatives, community groups, service providers, business) in the communities within and proximal to the Project Application Area, including:
  - Five Bays Sustainable Neighbourhood Group
  - Fassifern Public School
  - Awaba Rural Fire Service
  - Charleton Christian College
  - Rathmines Progress Association
- Community stakeholders and residents in the wider Lake Macquarie LGA (local government, elected representatives, business, community groups and residents) including:
  - Lake Macquarie City Council representatives
  - Non-government organisations (NGOs), including environmental groups
  - Non-governmental social housing providers

5.2.2 Stakeholder engagement approach

The stakeholder engagement program for the project was designed to involve local community members and stakeholders representing the wider community and regional interests. Given that Newstan Colliery is an established operation, and relationships with the community have been developed over time, the engagement approach adopted for the project aimed to build on the existing relationships and engagement activities.

The objectives of the stakeholder engagement program were to:

- Adopt a proactive approach to engagement with the community.
- Engage in an open and transparent relationship with the community.
- Collect and validate quantitative and qualitative data for the social baseline.
- Provide stakeholders with relevant and meaningful information on the project.
- Give stakeholders an opportunity to provide feedback on the project via a number of communication forums.
- Understand the interests and perspectives of people who may be directly affected by project impacts and opportunities to inform project planning and the EIS.
- Ensure that the assessment and evaluation of impacts were informed by the knowledge and experience of local stakeholders.
- Ensure key stakeholders were informed about the project and had opportunities to provide input to the assessment and mitigation strategies.
- Meet the consultation requirements of the SEARs for the project (refer to Appendix A).

Feedback obtained through engagement with key stakeholders has allowed Centennial Newstan to identify issues of concern or interest, and to consider these issues during project planning and assessment. Key issues are presented in Section 5.3.

5.3 Stakeholder engagement activities and issues raised

5.3.1 State government agencies

Centennial Newstan has consulted with a large number of State government agencies during preparation of the EIS. A summary of these engagement activities is presented in Table 5-1.

Table 5-1 Summary of State government agency consultation

Stakeholder	Date	Summary
DPIE – Planning and Assessment	10/05/2019	A Scoping Meeting was held to introduce the project, and discuss key project elements and assessment requirements for the EIS.
	16/05/2019	The Newstan Mine Extension Project Scoping Report was lodged with DPIE – Planning and Assessment to introduce the project and outline Centennial Newstan's proposed assessment approach for the EIS.
	12/06/2019	The initial SEARs for the project (SSD-10333) were issued by DPIE – Planning and Assessment. These SEARs were superseded by revised SEARs issued by DPIE – Planning and Assessment on 3 September 2019.
	9/08/2019	Centennial Newstan prepared a response to DPIE – Planning and Assessment requesting clarification of a number of matters set out in the SEARs along with Centennial Newstan's intended pathway to address the relevant issues in the EIS.
	3/09/2019	Revised SEARs for the project were issued by DPIE – Planning and Assessment in response to the matters raised for clarification in the letter issued to DPIE – Planning and Assessment by Centennial Newstan on 9 August 2019.
DRG	24/05/2019	Centennial Newstan presented a Conceptual Project Development Plan (CPDP) to DRG prior to the lodgement of the request for SEARs with DPIE – Planning and Assessment. The key matter discussed was DRG's desire for Centennial Newstan to comprehensively consider how the project would interact with the Eraring Ash Dam.
Dams Safety NSW	27/02/2019	Centennial Newstan discussed the proposed undermining of Eraring Ash Dam, including protection barriers to protect the integrity of the dam wall.
	28/10/2019	Centennial Newstan provided DamsSafety NSW with an overview of the project and the EIS. A copy of the risk assessment completed by Centennial Newstan with respect to potential interactions between the project and Eraring Ash Dam was also provided to Dams Safety NSW for review and comment.
	11/12/2019	Dams Safety NSW responded to Centennial Newstan via email stating that the risk assessment had been reviewed.
NSW EPA	30/05/2019	Centennial Newstan met with NSW EPA to introduce the project and the company's intention to submit an EIS during 2020.
	27/11/2019	Centennial Newstan provided NSW EPA with an overview of the project and the EIS. This included a summary of the findings of the noise and vibration, air quality, and surface water impact assessments. NSW EPA were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.
Resources Regulator	27/02/2018	Centennial Newstan met with the Resources Regulator to present the proposed project and discuss subsidence mitigation and management strategies, including those for critical infrastructure such as the Main Northern Railway.
TfNSW (formerly Roads and Maritime Services)	27/11/2019	Centennial Newstan provided Roads and Maritime Services with an overview of the project and the EIS. Roads and Maritime Services were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.

Stakeholder	Date	Summary
Water Division	18/02/2020	Centennial Newstan provided the Water Division with an overview of the project and the EIS, including an update on the scope and status of the surface water and groundwater impact assessments. The Water Division were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.
Crown Lands	30 January 2020	Regarding the requirement to establish a Compensation Agreement pursuant to Section 265 of the Mining Act 1992, representatives of Centennial Newstan met with Crown Lands at the Maitland office on Thursday 30 January 2020. An overview of the project was provided to delegates of Crown Lands in the context of predicted subsidence impacts which have been primarily mitigated through the mine design. During the meeting Crown Lands did not raise any significant concerns in relation to the project noting that a submission would be provided in writing to DPIE – Planning and Assessment as part of the EIS public exhibition.
	18/02/2020	Centennial Newstan provided Crown Lands with an overview of the project and the EIS. Crown Lands were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.
DPI Agriculture	18/02/2020	Centennial Newstan provided DPI Agriculture with an overview of the project and the EIS, noting that in line with DPI Agriculture's input into the SEARs, Centennial Newstan has not prepared an Agricultural Impact Statement to support the project. DPI Agriculture were also given the opportunity to schedule a meeting to discuss the project in person if they had any queries or required any further information regarding the project.
DPI Fisheries	19/03/2020	Centennial Newstan provided DPI Fisheries with an overview of the project, assessment pathway and specialist assessments completed prior to lodgement of the EIS.
Subsidence Advisory NSW	18/10/2019	Centennial Newstan provided Subsidence Advisory NSW with an overview of the project and the EIS, including a copy of the Subsidence Impact Assessment (MSEC, 2019b). Subsidence Advisory NSW were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.
NSW Rural Fire Service	27/11/2019	Centennial Newstan provided NSW Rural Fire Service with an overview of the project and the EIS, including the assessment of bushfire risk. NSW Rural Fire Service were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.
BCD	20/02/2020	Centennial Newstan met with BCD to provide them with an overview of the project and a summary of the outcomes of the biodiversity assessment completed for the EIS, including Centennial Newstan's proposed strategy for the management and offsetting of impacts.
NSW Health	27/11/2019	Centennial Newstan provided NSW Health with an overview of the project and the EIS. NSW Health were also invited to schedule a meeting with Centennial Newstan if they had any queries or required any further information regarding the project.

State government agency issues

The key issues raised during consultation with State government agencies, together with a reference to where each issue is addressed in this EIS, are presented in Table 5-2.

Table 5-2 State government agency issues

Stakeholder	Key issues	Where addressed
DRG	DRG requested that Centennial Newstan complete a comprehensive assessment of the project's impacts to the Eraring Ash Dam. Centennial Newstan has adopted the Resources Regulator's recommendations.	Section 6.1, Section 6.2
DamsSafety NSW	DamsSafety NSW requested that subsidence impacts to the Eraring Ash Dam wall from the project be minimised. Centennial Newstan has adopted the Resources Regulator's recommendations.	Section 2.4, Section 6.1, Section 6.2
NSW EPA	NSW EPA requested that during development and assessment of the project, detailed consideration be given to: • Sewage management at Awaba Colliery Surface Site. • Groundwater interactions between the proposed workings and Eraring Ash Dam.	Section 2.2.7, Section 6.2, Section 6.3
Resources Regulator	The Resources Regulator provided recommendations to Centennial Newstan regarding suitable protection barriers in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam. Centennial Newstan has adopted the Resources Regulator's recommendations.	Section 2.4
BCD	BCD requested that the EIS sets out in detail Centennial Newstan's proposed approach for the management and offsetting of biodiversity impacts, including indirect impacts associated with mine subsidence.	Section 6.6

5.3.2 Local government agencies

Centennial Newstan met with Lake Macquarie City Council representatives on 18 November 2019 to provide a presentation on the project, including an overview of the environmental assessments being completed for the EIS.

In leiu of another meeting, in April 2020, Centennial Newstan provided Lake Macquarie City Council with an update (via a series of EIS summary sheets) on the key findings of the various environmental assessments completed for the EIS.

Local government agency issues

Lake Macquaity City Council did not raise any further issues beyond those provided to DPI – Planning and Assessment as inputs to the SEARs, the details of which are presented in Appendix A.

5.3.3 Federal government agencies

Centennial Newstan consulted with the DAWE (formerly DotEE) in July and August 2019 as part of the lodgement of a Referral (EPBC 2019/8528) under the EPBC Act. This included attendance at a meeting in Canberra whereby Centennial Newstan introduced the project and proposed assessment approach.

On 23 December 2019, the referred action was determined to be a "controlled action" in relation to the following controlling provisions under the Act:

- Listed threatened species and communities.
- A water resource.

In the letter to Centennial Newstan that accompanied the notice of a controlled action, DAWE also confirmed that the project would need to be assessed by “accredited assessment” under the EP&A Act.

Federal government agency issues

DAWE did not raise any specific issues beyond confirming the EPBC Act assessment requirements for the project. A description of how the assessment requirements relevant to the EPBC Act have been addressed in this EIS is provided in Appendix A.

5.3.4 Industry

Key infrastructure owners Origin Energy (owners of Eraring Power Station and Eraring Ash Dam), Ausgrid (owners of power transmission infrastructure) and Sydney Trains (managers of the Main Northern Railway) have been consulted extensively during project planning and the development of the EIS. A summary of these industry consultation activities is presented in Table 5-3.

Table 5-3 Summary of industry consultation

Stakeholder	Date	Summary
Origin Energy	12/02/2019	Centennial Newstan and Origin Energy met to discuss the project and the ash dam augmentation project.
	8/03/2019	Centennial Newstan contacted Origin Energy to request access for biodiversity surveys on Origin Energy-owned land within the Extension of Mining Area.
	21/03/2019	Centennial Newstan and Origin Energy met to review Origin Energy’s plans to construct the western saddle embankment to increase the capacity of the existing dam (i.e. the ash dam augmentation project). Centennial Newstan also provided Origin Energy with an introduction to the project. The two parties agreed to form a working committee to move both projects forward.
	2/05/2019	Centennial Newstan and Origin Energy reviewed the updated plans for the ash dam augmentation project. Centennial Newstan provided a document to discuss the potential impact of the embankment on the project.
	30/05/2019, 13/06/2019, 25/07/2016	Centennial Newstan and Origin Energy met to provide updates on the status of the project and the ash dam augmentation project.
	25/09/2019	Centennial Newstan representatives attended a site visit to Eraring Power Station and Eraring Ash Dam.
	11/11/2019	Centennial Newstan provided Origin Energy with an overview of the project and the EIS.
	2/12/2019	Centennial Newstan supplied a full copy of the Subsidence Impact Assessment (MSEC, 2019b).
Sydney Trains	31/08/2018	Centennial Newstan met with Sydney Trains to introduce the project and present initial subsidence impact assessments.
	23/05/2019	Centennial Newstan met with Sydney Trains to review the project subsidence predictions and discuss potential impacts and the factor of safety in the mine design.
	18/10/2019	Centennial Newstan provided Sydney Trains with an overview of the project and the EIS.

Stakeholder	Date	Summary
Ausgrid	17/12/2019	Centennial Newstan gave a presentation to the Ausgrid technical evaluation team to discuss the project and any potential impacts on Ausgrid assets.
	31/10/2019	Centennial Newstan provided Ausgrid with an overview of the project and the EIS.
TransGrid	10/03/2020	Centennial Newstan provided Transgrid with an overview of the project and the EIS. The letter also notified TranGrid that there is no direct interaction between Transgrid assets and the project.

Industry issues

Key issues raised during consultation with industry are presented in .

Table 5-4 Industry issues

Stakeholder	Key issues	Where addressed
Origin Energy	Concerns were raised over the following potential subsidence related issues: • How subsidence from the project would impact the Eraring Ash Dam augmentation project (PA 07_0084 Mod 1), including Origin Energy's proposed Western Saddle Embankment and void filling works in the former Awaba Colliery workings. • Potential subsidence impacts to the Eraring Ash Dam wall from the project. • The relatively low tolerance that the steam turbines and generator unit within the Eraring Power Station have to ground movements and how these tolerances should be considered in the mine design. • Potential subsidence impacts to existing diesel tanks at Eraring Power Station. • Potential subsidence impacts to other water management infrastructure associated with Eraring Power Station, including dams, pipelines and channels.	Section 2.4, Section 6.1, Section 6.2, Section 6.3
Sydney Trains	Management of subsidence impacts to the Main Northern Railway.	Section 2.4, Section 6.1

5.3.5 Landholders, special interest groups, and the broader community

Consultation with landholders, specialist interest groups, and the broader community was undertaken to validate social baseline data, understand community values and aspirations, and inform an understanding of the different stakeholder perceptions of the project.

A diverse range of engagement methods were utilised to gain an understanding of the community perceptions regarding the project. A summary of the consultation activities undertaken is presented in Table 5-5.

Table 5-5 Community consultation summary

Engagement method	Description
Letterbox drops	An invitation seeking resident participation in interviews and community open days was letterbox dropped to proximal neighbours in the Fassifern, Wakefield and Awaba area.
Face-to-face meetings with community groups	Various meetings with community groups were held throughout 2018 and 2019 to discuss Newstan Colliery DA 73-11-98 and introduce the project, including: • Three meetings with Five Bays Sustainable Neighbourhood. A meeting held in April 2019 included a tour of the water treatment plant at Newstan Colliery Surface Site. • Separate meetings with Awaba Public School Parents and Citizens (P&C) and Fassifern Public School P&C. • A meeting with Coal Ash Alliance and Hunter Community Environment Centre. • A meeting with Northern Holdings Aboriginal Cultural Heritage Management Plan Committee.
Face-to-face interviews	Nine interviews were conducted with landowners proximal to the Newstan Colliery Surface Site and/or Awaba Colliery Surface Site and three interviews were conducted with residents of nearby communities. • One interview each was also conducted with: • The Vice Chair of the Five Bays Sustainable Neighbourhood Group. • The Principal of Fassifern Public School. • The Principal and Business Manager of Charlton Christian College. • Representatives of the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee. • A representative of the Awaba Rural Fire Service. • A representative of the Rathmines Progress Association. • Employees of Lake Macquarie City Council. • Newstan-Awaba CCC.

Telephone interviews	• Four telephone interviews were conducted, including:
	• One interview with a proximal landowner.
	• One interview each with:
	  – Lake Macquarie City Council councillors
	  – A Lake Macquarie City Council employee
	  – A representative of Compass Housing, a non-governmental social housing provider

Community open days	Two community open days were held at the Newstan Colliery Surface Site and Awaba Colliery Surface Site on 20 and 23 November 2019. The purpose of these sessions was to share information about the project and to provide a forum for feedback. Structured interviews were conducted with five attendees.
CCC meetings	Briefings regarding Newstan Colliery DA 73-11-98 Mod 8 and the project have been provided to the Newstan-Awaba CCC on an ongoing basis since March 2018. These have included project-specific presentations to CCC members.
Surveys	Surveys were distributed to attendees of the two community open days and the face-to-face meetings. : The purpose of the surveys was to capture information about the project and to provide a forum for feedback. The project team received 19 individual survey responses.

Landholders, special interest groups, and the broader community issues

The perceived community project benefits and impacts are presented in the following subsections.

Perceived project benefits

The potential social benefits and opportunities presented by the project and identified through consultation (i.e. benefits perceived by the stakeholders) included:

- Creation of direct and indirect employment opportunities within the Lake Macquarie LGA.
- Creation of additional supply arrangements for local businesses and enhancement of existing supply arrangements.
- Ongoing and possibly increased voluntary contributions from Centennial Newstan to the surrounding community through event attendance, sponsorship and donations, and the VPA with Lake Macquarie City Council.
- In-migration of new residents to Lake Macquarie LGA as people seek to capitalise on employment opportunities associated with the project.
- Greater diversity in future land use opportunities for post mining land if:
  - Centennial Newstan's rehabilitation and mine closure planning for the project is aligned with the strategic planning aspirations of Lake Macquarie City Council, and/or
  - The project results in complete subsidence of the historic Awaba Colliery underground workings and leads to surface stabilisation.

Perceived project impacts

The potential social impacts identified through consultation (i.e. impacts perceived by the stakeholders) included:

- Changes in property values. A number of Wakefield and Awaba residents expressed concern that the noise and dust impacts of the project may lead to a reduction in the value of property for proximate neighbours.
- Changes in housing market conditions. A small number of residents were unsure if the project would place additional demand on the housing supply in the immediate communities of Awaba, Fassifern and Wakefield. Awaba residents were not concerned that housing demand would change as the growth of Awaba is confined by the railway and other land uses.
- The impact of subsidence on valued environmental assets. Some stakeholders were concerned that:
  - The project may impact the hydrology of creeks traversing the Extension of Mining Area (e.g. Stony Creek) with permanent loss of biodiversity.
  - Subsidence may result in changes to the surface of the Extension of Mining Area and adversely impact biodiversity.
  - The project may lead to increased discharge volumes and increased discharge frequency into LT Creek and Stony Creek adversely impacting water quality and biodiversity, which in turn could impact the use and enjoyment of the creek systems and environs for recreational and aesthetic purposes.
- Changes in the residential amenity of Awaba. A number of residents of Awaba expressed concern that construction activities at Awaba Colliery Surface Site may adversely impact the residential amenity of Awaba. The majority of Awaba residents interviewed for the SIA anticipate tangible and adverse changes in amenity.

- Residential amenity changes for residents to the west of the Newstan Colliery Surface Site. A number of Wakefield residents expressed strong concern that the project would impact residential amenity due to increases in noise and dust emissions from the Northern Coal Logistics Project, associated with increased production. These residents anticipate a change in residential amenity (primarily noise levels).
- Increased vehicle traffic on Miller Road and connecting roads through Wakefield and Fassifern with resulting impacts on road safety.
  - Several Wakefield residents expressed road safety concerns in relation to any potential increase in traffic volumes on Miller Road from the west of Newstan Colliery Surface Site.
  - Representatives of Fassifern Public School and Charlton Christian College expressed some expectation that the project would exacerbate existing traffic delays on Fassifern Road, citing existing traffic jams at the viaduct on Fassifern Road during school drop off and pick up hours. Concern was also expressed regarding potential safety issues arising for school children due to a combination of increased vehicle movements in the locality and a potential increase in vehicle speed.
- Cumulative amenity impacts. A number of Wakefield residents expressed concern in relation to the potential cumulative amenity impacts of the project, increased production and Northern Coal Logistics Project and the development of the proposed Black Rock Motor Park (DA/1556/2017) at the old Rhondda Colliery mine site at Wakefield.
- Impacts to local Aboriginal cultural heritage values and artefacts within the Extension of Mining Area.
- Social, economic and environmental implications of any changes in the permeability and stability of the geology underlying the Eraring Ash Dam due to mining from the project.
- Residents of Lake Macquarie LGA were vocal regarding the potential social, economic and environmental consequences of a failure in the Eraring Ash Dam wall.

5.3.6 Aboriginal stakeholders

Aboriginal stakeholder consultation for the project was undertaken in accordance with the relevant aspects of Part 5, Division 2, Clause 60 of the NPW Regulation and the Aboriginal cultural heritage consultation requirements for proponents (DECCW, 2010). A detailed log of all Aboriginal party consultation completed for the project is included in the Aboriginal Cultural Heritage Impact Assessment (refer to Appendix S).

There are four stages of the Aboriginal stakeholder consultation process, as specified in the Aboriginal cultural heritage consultation requirements for proponents (DECCW, 2010). Broadly, these include:

- Stage 1: Identifying, notifying and registering Aboriginal people with relevant cultural knowledge.
- Stage 2: Presenting information about the project and the proposed assessment process.
- Stage 3:
  - Seeking feedback on proposed assessment methods.
  - Seeking cultural information from Aboriginal stakeholders.
- Stage 4: Seeking feedback on the draft assessment report.

The implementation of each of these stages, as relevant to the project, is summarised in the following subsections.

Stage 1 - notification and registration

As a result of the project notification and registration process, 15 Aboriginal parties registered an interest in ongoing consultation regarding the project. These parties are:

- Biraban Local Aboriginal Land Council.
- Wannangirni Pty Ltd (previously Guringai Tribal Link Aboriginal Corporation).
- Didge Ngunawal Clan.
- Awabakal Descendants Traditional Owners Aboriginal Corporation.
- Awabakal Traditional Owners Aboriginal Corporation.
- Corroboree Aboriginal Corporation.
- Kauwul Pty Ltd trading as Wonn1 Sites.
- Awabakal & Guringai Pty Ltd.
- Murra Bidgee Mullangari Aboriginal Corporation Cultural Heritage.
- Divine Diggers Aboriginal Cultural Consultants.
- Yinarr Cultural Services.
- Worimi Aboriginal Cultural Services.
- Widescope.
- Lower Hunter Aboriginal Incorporated.
- Wonnarua Nation Aboriginal Corporation.

Stages 2 and 3- presenting information and gathering information about cultural significance

Correspondence providing information about the proposed project and requesting information about cultural significance was provided to all registered Aboriginal parties. It included a proposed methodology for a cultural heritage survey and an invitation for input in relation to developing an understanding of the cultural values of the Project Application Area and the ways in which these values may be identified during the field assessment activities.

The registered Aboriginal parties were requested to provide comment on the draft cultural heritage survey methodology. Responses were received from:

- Biraban Local Aboriginal Land Council.
- Worimi Aboriginal Cultural Services.
- Murra Bidgee Mullangari Aboriginal Corporation Cultural Heritage.
- Kauwul Pty Ltd trading as Wonn1 Sites.
- Awabakal Traditional Owners Aboriginal Corporation.
- Worimi Aboriginal Cultural Services.

None of the responses were in objection to the proposed methodology, which detailed the proposed on-site survey assessment, however Awabakal Traditional Owners Aboriginal Corporation expressed some concern regarding a section of the methodology that noted Centennial Newstan did not have available detailed survey data for Aboriginal archaeological investigations conducted on site over six years prior. This concern was subsequently discussed during fieldwork.

Invitations to submit an Expression of Interest for commercial engagement to undertake a survey of the assessment areas to assist in identifying any areas of cultural value were provided to all registered Aboriginal parties with the draft methodology on 1 October 2019. Expressions of interest were received from ten Aboriginal parties, of which six were invited to be commercially engaged to attend the archaeological and cultural heritage survey.

Stage 4- review of draft Aboriginal cultural heritage assessment report

A draft copy of the Aboriginal cultural heritage assessment report (refer to Appendix S for a final copy of the report) was provided to all registered Aboriginal parties on 22 January 2020 for review and comment. Responses were received from the following registered Aboriginal parties:

- Murra Bidgee Mullangari.
- Worimi Aboriginal Cultural Services (Tamara Towers).
- Kauwul Pty Ltd Trading as Wonn1 Sites.

All responses were in agreement with the findings and recommendations of the Aboriginal cultural heritage assessment. No further feedback was provided.

6. Assessment of impacts

This chapter presents detailed summaries of the results of the relevant environmental, social and economic impact assessments completed for the project. The summaries presented in the following subsections should be read in conjunction with the detailed specialist impact assessment reports provided in Appendix H to Appendix X.

6.1 Subsidence

A Subsidence Impact Assessment was prepared by Mine Subsidence Engineering Consultants Pty Ltd (MSEC) to predict the likely subsidence related ground movements resulting from the project and to assess the impacts of predicted subsidence on the natural and built environment. The information presented in this section is summarised from the Subsidence Impact Assessment (MSEC, 2019b), which is presented in full in Appendix H.

6.1.1 Background

Overview of subsidence effects

Subsidence induced by underground mining can result in a range of different ground movements with corresponding impacts. These ground movements are grouped into three categories: conventional subsidence effects, far field movements and non-conventional subsidence effects, as described in the follow subsections.

Conventional subsidence effects

The normal ground movements resulting from the extraction of panels are referred to as conventional subsidence effects. These include:

- **Subsidence** which refers to the vertical or horizontal displacement of a point on the ground surface.
- **Tilt** is the change in the slope of the ground as a result of differential subsidence of two different points.
- **Curvature** is the rate of change of tilt based on the change in tilt between two adjacent sections of the tilt profile. Convex curvature is referred to as “hogging” and concave curvature is referred to as “sagging”.
- **Strain** is the relative difference in horizontal movements of two different points. **Tensile strains** occur where the distances between two points increase and **Compressive strains** occur when the distances between two points decrease.

Far field movements

Far-field movements are the horizontal movements that can occur outside of the area directly over the proposed mining area. The horizontal movements in these areas are often much greater than the vertical movements.

Non-conventional subsidence effects

Non-conventional subsidence effects can occur in relation to specific mining conditions or geological and topographic features, including multi-seam mining, shallow depth of cover, geological structures and steep topography. Non-conventional subsidence effects can include surface cracking, stepping and localised plug failures, as well as elevated tilts, curvatures and ground strains. Additionally, some irregular ground movements that can occur as a result of non-conventional subsidence effects cannot be explained with available geological or topographic information. These movements are referred to as anomalous movements.

Streams can also be affected by valley related movements. These are natural ground movements related to formation of the valley, which can be induced or accelerated by mine subsidence. Valley related movements include upsidence (relative uplift of an area), closure (reduced horizontal distance between the valley sides) and compressive and tensile strains.

Study area

The study area adopted for the Subsidence Impact Assessment was defined by the surface area that could be impacted by the extraction of the proposed bord and pillar panels including:

- The Extension of Mining Area.
- Areas that could be impacted by valley related effects and far-field movements, which includes areas within a minimum of 600 m outside of areas predicted to be impacted by vertical subsidence.

6.1.2 Methodology

Subsidence for the project was predicted primarily using empirical modelling. Empirical modelling methods predict subsidence using parameters derived from actual subsidence data measured in previously mined areas. Numerical modelling was also undertaken to supplement the empirical modelling predictions.

Empirical modelling

The predicted conventional subsidence effects for the project have been determined using the Incremental Profile Method (IPM). The method is an empirical model based on a large database of ground monitoring data from previous mining within the Southern, Newcastle, Hunter and Western Coalfields of NSW.

Based on the extensive empirical data, standard subsidence prediction curves have been developed for each of the coalfields in NSW. The prediction curves can then be further refined, for the local conditions, based on the available ground monitoring and geological data from the area.

A total subsidence profile was derived by first predicting the magnitude of subsidence based on the width and depth of cover of each proposed panel, as well as the width of the pillars that will remain in each panel void. The shape of the subsidence profile was then determined using the subsidence profiles from the Newcastle Coalfield database where the mining geometry and overburden geology are reasonably similar to those for the proposed panels. The profile shapes were further refined, based on local monitoring data.

The comparisons of the predicted total subsidence profiles obtained using the IPM with measured profiles show that this method provides reasonable, if not, slightly conservative predictions where the mining geometry and overburden geology are within the range of the empirical database. The model was further tailored to local conditions using available ground monitoring data.

The IPM subsidence model was calibrated for the local conditions using the available ground monitoring data from Newstan Colliery for both single-seam and multi-seam mining conditions.

Single-seam conditions calibration

The southern ends of the proposed bord and pillar panels are not located beneath the existing Awaba Colliery workings. These parts of the panels consist of single-seam mining conditions.

The ground monitoring data from full extraction panel mining in the NSW coalfields show that the measured subsidence is similar to that for longwall mining of similar mining geometries. However, the magnitude of subsidence is less due to the remnant coal that remains in the full extraction panel workings.

Full extraction of bord and pillar workings can typically recover between 75 percent and 85 percent of the coal due to both the first and second workings. The full extraction panels therefore result in vertical subsidence that is around 75 percent to 85 percent of that for a longwall with a similar mining geometry.

The IPM subsidence predictions were compared with measured vertical subsidence above previously extracted longwalls at Newstan Colliery. The standard IPM provides reasonable predictions of vertical subsidence when compared with the measured subsidence. It is expected, therefore, that the standard IPM should also provide reasonable predictions for the proposed panels based on single-seam conditions.

Multi-seam conditions calibration

The central and northern ends of the proposed bord and pillar panels are located beneath existing Awaba Colliery workings in the Great Northern seam. These parts of the panels consist of multi-seam mining conditions.

The existing Awaba Colliery workings in the Great Northern seam comprise areas of first workings, partial extraction, full extraction and the Teralba Conglomerate spanning areas[5].

The stabilities of the existing Awaba Colliery workings in the Great Northern seam are affected by the conditions of the pillars (unknown), flooding of the workings and the presence of geological structures (known and unknown). It is difficult, if not impossible, to assess the stabilities of the pillars in their existing condition, or when subjected to subsidence due to the mining of the proposed panels beneath them.

The multi-seam interaction of the existing Awaba Colliery workings due to the extraction of the proposed panels has been assessed based on the mining geometries, monitoring data and engineering principals. The theoretical maximum additional subsidence based on the thickness of the Great Northern seam and available voids within the Awaba Colliery workings has been compared with measured subsidence data to determine factors that represent the additional subsidence due to multi-seam mining conditions. These factors are presented in Table 6-1.

[5] Teralba Conglomerate spanning areas refers to areas within the Great Northern seam where wide voids exist due to the removal of pillars beneath the Teralba Conglomerate, which is capable of spanning up to 100 m where the unit is continuous and there are no geological structures.

Table 6-1 Multi-seam factors due to the reactivation of the existing Awaba Colliery workings

Existing Awaba Colliery workings in the Great Northern seam	Additional subsidence divided by the thickness of the Great Northern seam		
	Theoretical maximum based on geometry	Measured along ground monitoring lines	Adopted
First workings	0.22 to 0.29	0.05 to 0.20	0.20
Partial extraction	0.40	0.10 to 0.20	0.30
Full extraction	0.51	0.10 to 0.30	0.40
Teralba Conglomerate spanning areas	0.60	0.40 to 0.50	0.60

The multi-seam factors for the full extraction areas and the Teralba Conglomerate spanning areas are less than those presented in Table 6-1 where these workings have already failed. However, it has been conservatively assumed that these areas are currently standing and that full reactivation of these existing workings will occur due to the extraction of the proposed panels directly beneath them. This represents an additional layer of conservatism as certain areas of the Awaba Colliery workings are known to have failed previously.

Numerical modelling

A numerical model was developed for the proposed panels using Universal Distinct Element Code (UDEC). This method is a two-dimensional Discrete Element Method (DEM) for modelling jointed and blocky material with deformable elements. The numerical modelling was undertaken to supplement the predictions obtained using the empirical IPM.

The UDEC model was derived from the base model that was developed for the Southern Coalfield for mining in the Bulli seam. The numerical model was updated for the local stratigraphy and compared with the predictions obtained using the IPM.

The profiles of vertical subsidence obtained from the UDEC model reasonably match those predicted using the IPM, with the magnitudes of maximum vertical subsidence directly above each of the proposed panels being within 15 percent. It was not considered necessary, therefore, to further calibrate the IPM based on the outcomes of the numerical model.

The numerical model was used to assess the potential deformations within the overburden in single-seam mining conditions outside of the existing Awaba Colliery workings.

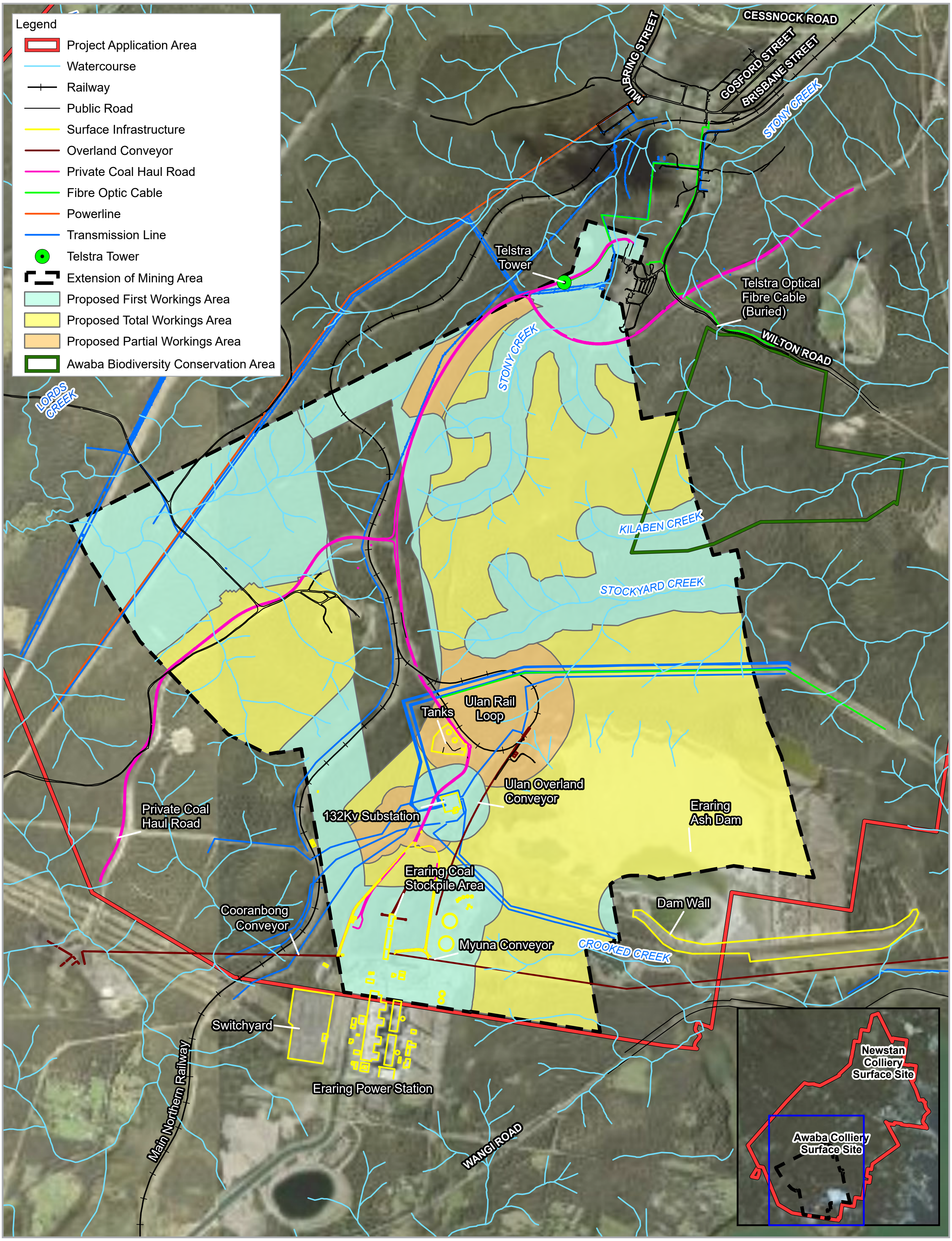
6.1.3 Existing environment

The assessment considered the potential impacts and environmental consequences for natural features and surface infrastructure that could be impacted by subsidence due to the project. Natural and built features identified within or in the vicinity of the study area include:

- Second order streams (Stony Creek, Stockyard Creek and an unnamed watercourse) and other drainage lines.
- Steep slopes and rock outcrops.
- The Main Northern Railway.
- A railway loop line.
- A mine haul road and other local roads.
- Bridges.
- Potable water pipelines.
- Communications infrastructure, including an optical fibre cable.

- Electrical infrastructure, including powerlines and substations.
- Aboriginal cultural heritage sites.
- The Eraring Power Station and Eraring Ash Dam.

The natural and built features within the study area are shown on Figure 6-1.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Indicative natural features and surface infrastructure

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Figure 6-1

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Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

6.1.4 Impact assessment

Conventional subsidence effects

The maximum predicted subsidence effects and the predicted subsidence contours are provided in Figure 6-2.

The greatest subsidence effects are predicted to develop where the proposed panels are mined beneath the Teralba Conglomerate spanning areas within the existing Awaba Colliery workings. Intermediate subsidence effects are predicted where the proposed panels are mined beneath the partial and full extraction areas within the existing Awaba Colliery workings. Lower level subsidence effects are predicted outside of the existing Awaba Colliery workings or where there are only first working areas for the proposed panels and/or the existing workings.

A summary of the maximum predicted values of total vertical subsidence, tilt and curvature is provided in Table 6-2. The total parameters represent the accumulated movements resulting from the proposed panels, including the reactivation of the overlying existing workings.

Table 6-2 Maximum predicted total vertical subsidence, tilt and curvature

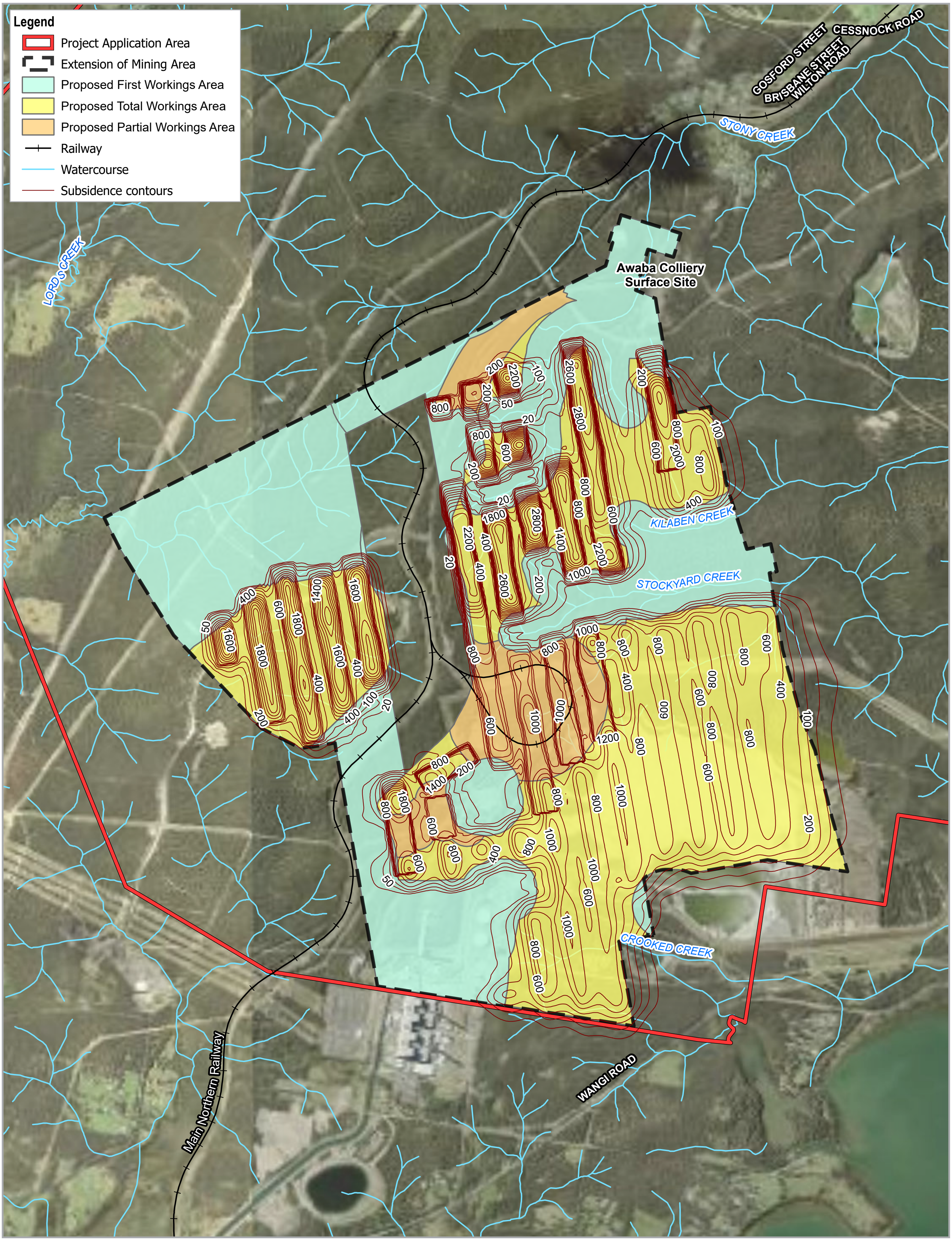
Location	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km-1)	Maximum predicted total sagging curvature (km-1)
Within the extents of the existing Awaba Colliery workings (multi-seam conditions)	3250	> 100	> 3.0	> 3.0
Outside extents of the existing Awaba Colliery workings (single-seam conditions)	1100	14	0.45	0.60
First workings within the West Borehole Seam	< 20	< 0.5	< 0.01	< 0.01

The prediction of strain is more difficult than the predictions of subsidence, tilt and curvature. The reason for this is that strain is affected by many factors, including ground curvature, horizontal movement and multi-seam effects, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock, and the depth of bedrock. An industry standard statistical approach has therefore been adopted to account for this variability, instead of just providing a single predicted conventional strain. The confidence levels of the predicted conventional strains due to the project are presented in Table 6-3.

Table 6-3 Maximum predicted conventional strain

Location	Maximum conventional tensile strain (mm/m)		Maximum conventional compressive strain (mm/m)	
	95% confidence level	99% confidence level	95% confidence level	99% confidence level
Within the extents of the existing Awaba Colliery workings (multi-seam conditions)	15	29	19	30
Outside extents of the existing Awaba Colliery workings (single-seam conditions)	2.7	6.9	2.6	5.9

As the vertical subsidence is predicted to be less than 20 mm where first workings only are developed within the proposed panels, the strains in these areas are not expected to be measurable. The predicted strains therefore are expected to be less than 0.5 mm/m tensile and compressive (refer to Table 6-2).



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No.	22-20261
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Predicted subsidence contours

Figure 6-2

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Non-conventional subsidence effects

Irregular ground movements have been observed above the existing Awaba Colliery workings, including sink holes, localised plug failure, pillar failure, soft floor failure and other localised effects. There is potential for such effects to occur due to the project within the multi-seam mining areas based on both the existing conditions and the proposed panel extraction.

It is also likely that far-field horizontal movements will occur outside of the mining area. Observations of far-field movements from the Southern and Western Coalfields were used to derive statistical predictions of far-field movements for the project. The predicted far-field horizontal movement at a distance of 1 km outside the mining area is 80 mm based on the 95% confidence level. The predicted far-field horizontal movements due to the proposed panels are expected to be small, with impacts on the natural features and surface infrastructure within the vicinity of the proposed panels not expected to be significant.

The shear deformations through the overburden have been determined from the UDEC model as described in Section 6.1.2. The predicted horizontal shear is approximately 20 mm near the surface increasing to approximately 100 mm to 150 mm above the top of the caving zone.

Rate of subsidence development

The mining of the proposed panels beneath the existing Awaba Colliery workings will result in a variety of different subsidence impacts, depending on the mining method at a particular location. The magnitude of subsidence that is predicted to occur varies within the study area depending on the mining scenario at each location. Similarly, the development of subsidence over time will vary within the study area. The potential rate of subsidence development over time based on the specific mining scenarios is presented in Table 6-4.

Table 6-4 Potential rate of subsidence development within the study area

Mining method	Overlying existing Awaba Colliery workings	Maximum predicted additional subsidence (mm)	Potential rate of subsidence development over time
First workings only	None (single seam)	< 20	Gradual and very small rates of change
First workings only	First workings only	< 20	Gradual and very small rates of change
First workings only	Teralba Conglomerate spanning area	< 20	Gradual and very small rates of change
First workings only	Partial or full extraction	< 20	Gradual and very small rates of change
Partial or full extraction	None	1100	Gradual development of subsidence
Partial or full extraction	First workings only	1800	Gradual development of subsidence
Partial or full extraction	Partial or full extraction	2220	Gradual development of subsidence generally with potential for rapid development of subsidence where goafing has not previously occurred
Partial or full extraction	Teralba Conglomerate spanning area	3250	Gradual development of subsidence generally with potential for rapid development of subsidence where spanning areas have not previously goafed

Streams

There are five named streams within the study area being Stony Creek, Stockyard Creek, Kilaben Creek, Crooked Creek and Lords Creek (refer to Figure 6-1). The remaining streams within the study area are unnamed.

A summary of the maximum predicted values of total vertical subsidence, tilt and curvature for the named streams within the study area is provided in Table 6-5.

Table 6-5 Maximum predicted total vertical subsidence, tilt and curvature for the named streams

Stream	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km-1)	Maximum predicted total sagging curvature (km-1)
Stony Creek	475	18	0.80	1.1
Kilaben Creek	100	< 1	0.02	0.01
Stockyard Creek	1100	40	1.9	1.5
Crooked Creek	1000	8.0	0.08	0.16
Lords Creek	< 20	< 0.5	< 0.01	< 0.01

Sections of Stony Creek, Stockyard Creek, Lords Creek and an unnamed watercourse (identified as WC08) are second order within the study area. A summary of the maximum predicted values of total vertical subsidence, tilt and curvature for the second order sections of the streams within the study area is provided in Table 6-6.

Table 6-6 Maximum predicted total vertical subsidence, tilt and curvature for the second order sections of the streams within the study area

Drainage line	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km-1)	Maximum predicted total sagging curvature (km-1)
Stony Creek	60	0.5	0.01	0.01
Stockyard Creek	< 20	< 0.5	< 0.01	< 0.01
Lords Creek	< 20	< 0.5	< 0.01	< 0.01
Watercourse WC08	975	25	1.0	0.60

The streams within the study area could also experience valley related upsidence and closure. The maximum predicted valley related effects for the first order sections of the streams are 250 mm upsidence and 400 mm closure. The predicted compressive strains due to valley related effects are 10 mm/m to 15 mm/m. The maximum predicted valley related effects for the second order sections of the named streams are less than 20 mm upsidence and less than 20 mm closure. The compressive strains due to the valley related effects are less than 1 mm/m.

Ponding

The proposed extraction could result in increased levels of ponding in locations where the mining-induced tilts oppose and are greater than the existing natural stream gradients.

There are predicted reductions of stream grade along the first order sections of Stockyard and Crooked Creeks. There are also predicted reductions of stream grade along the upper reaches of the unnamed watercourse WC08. Increased ponding could develop upstream of each of these locations. However, natural ponding is already evident along the flatter sections of these streams. It is possible that there could be other localised areas that could experience small increases in the levels of ponding, where the natural gradients are low.

The predicted changes in grade along Stony Creek, Kilaben Creek and the other unnamed streams within the study area are small and, therefore, no significant changes in ponding are anticipated for these streams. Also, the upper reaches of the first order tributaries have high natural gradients and, therefore, no significant changes in ponding are anticipated for these streams.

Fracturing

Fracturing in bedrock beneath streams can occur where the tensile strains are greater than 0.5 mm/m or where the compressive strains are greater than 2 mm/m. It is likely, therefore, that fracturing will occur along the streams within the study area, which can result in subterranean flows, potentially reducing the normal environmental flow of the stream.

Stony, Kilaben and Stockyard Creeks are located above the first workings areas within the proposed panels. The second order sections of Stony and Stockyard Creeks are also located above first workings only or solid coal within the Great Northern Seam. These sections of streams are predicted to experience vertical subsidence of 100 mm or less. Minor fracturing could occur in the bedrock beneath these streams; however, adverse impacts on the surface water flows are not anticipated due to the low levels of predicted movement and their distances from the secondary extraction areas within the proposed panels.

The first order sections of Stony and Stockyard Creeks are located above the Teralba Conglomerate spanning areas and partial extraction areas, respectively, in the existing Awaba Colliery workings. Larger fracturing could develop along these sections of creek, due to the proposed mining beneath and adjacent to them, and this could result in the diversion of the surface water flows into the strata beneath the beds and the draining of any ponded surface water.

The mining-induced compression due to valley closure effects can also result in dilation and the development of bed separation in the topmost bedrock. Previous experience of single-seam longwall mining in similar conditions elsewhere in the Newcastle and Hunter Coalfields indicates that the impacts on ephemeral streams with shallow incisions into the surface soils are relatively low. It is, therefore, unlikely that the extraction of the proposed panels will have adverse impacts on the streams outside the extents of the existing Awaba Colliery workings.

Additionally, previous mining beneath streams in multi-seam conditions at Newstan Colliery with greater voids than those proposed for the project, has not resulted in adverse impacts to surface water flows. It is, therefore, considered unlikely that the extraction of the proposed panels will have adverse impacts on the streams within the extents of the existing Awaba Colliery workings.

Lords Creek is located at a distance of 500 m west of the proposed mining area. At this distance, the creek is not predicted to experience measurable conventional or valley related effects. It is unlikely, therefore, that Lords Creek will experience adverse impacts due to the proposed mining.

Sink holes

Sink holes have previously developed along some streams that are located above the existing Awaba Colliery workings, due to their shallow depths of cover. The first order sections of Stony, Kilaben and Stockyard Creeks are located above the Teralba Conglomerate spanning areas and full extraction areas in the Great Northern seam. Hence, there is potential for sinkholes to develop along these sections of streams due to their existing conditions, regardless of the proposed mining. The extraction of the proposed panels is not expected to increase the potential for sinkholes.

Steep slopes and rock outcrops

The rock outcrops and steep slopes within the study area are primarily located along the upper reaches of the first order streams. The natural grades of the steep slopes typically range between 1 in 3 and 1 in 2, with isolated areas having natural grades up to 1 in 1.5.

The steep slopes and rock outcrops are located across the study area and are expected to experience the full range of predicted subsidence effects. A summary of the maximum predicted values of total vertical subsidence, tilt and curvatures for the steep slopes and rock outcrops is provided in Table 6-7.

Table 6-7 Maximum predicted total vertical subsidence, tilt and curvatures for the steep slopes and rock outcrops

Location	Maximum predicted total vertical subsidence (mm)	Maximum predicted total tilt (mm/m)	Maximum predicted total hogging curvature (km-1)	Maximum predicted total sagging curvature (km-1)
Steep slopes and rock outcrops	2700	> 100	> 3.0	> 3.0

Based on an analysis of ground monitoring data from Newstan Colliery and elsewhere in the NSW coalfields, the maximum predicted strains for the steep slopes and rock outcrops located above both the existing workings and the proposed panels are 15 mm/m tensile and 19 mm/m compressive strain.

The steep slopes and rock outcrops are likely to be affected by the predicted curvatures and strains, resulting in tension cracks appearing at the tops and on the sides of the steep slopes and rock outcrops, compression ridges forming at the bottoms of the steep slopes, and buckling of the bedrock at the bottoms of rock outcrops.

Based on surface cracking observed for multi-seam mining conditions in the Hunter Coalfield, it is expected that the surface cracking on the steep slopes located above the proposed panels that mine beneath the existing Awaba Colliery workings will typically be between 100 mm and 200 mm, with more isolated cracking with widths greater than 200 mm. Series of cracks and localised plug failures could occur with widths in the order of 1 m or greater.

The impacts on the steep slopes will be less in areas located outside the extents of the existing Awaba Colliery workings. Based on surface cracking observed at Newstan Colliery and elsewhere in the NSW coalfields for single-seam mining conditions, surface cracking is expected to be in the order of 25 mm to 100 mm with isolated crack of greater than 150 m.

The proposed mining is also likely to result in fracturing of the rock outcrops. Previous experience of mining beneath rock outcrops in the NSW coalfields, at similar depths of cover, indicates that the percentage of rock outcrops that are likely to be impacted by mining is very small and will be in locations directly above the proposed mining area.

With appropriate management strategies in place, including remediation of larger surface cracking, it is unlikely that there would be long term impacts on the steep slopes and rock outcrops resulting from the proposed mining.

Main Northern Railway

The Main Northern Railway is the main rail link between Sydney, Newcastle and Brisbane. The section of the railway within the study area is located approximately between track kilometrages 130.0 km and 135.5 km.

First workings only are proposed directly beneath the Main Northern Railway. The total length of railway located directly above these first workings is approximately 470 m. First workings are also proposed adjacent to other sections of the railway at minimum distances of 75 m and 30 m, respectively.

Neither partial nor full extraction are proposed directly beneath the Main Northern Railway. The partial and full extraction areas are located at a minimum distance of 250 m from the centreline of the Main Northern Railway.

The existing Awaba Colliery workings are generally set back from the Main Northern Railway providing a coal pillar beneath it. However, the first workings within the Great Northern seam do extend beneath the railway in eight locations.

The Main Northern Railway is predicted to experience vertical subsidence of less than 20 mm due to the mining of the proposed panels. It is possible, however, that the railway could experience additional low level subsidence movements due to mining-induced effects on the existing Awaba Colliery workings.

It is noted that full extraction is proposed directly beneath the existing Teralba Conglomerate spanning areas, which are located within approximately 160 m of the railway track, at its closest point. If a subsidence event were to occur, focussed within 160 m of the railway, subsidence monitoring indicates that the section of railway between approximately 132.5 km and 133.8 km could experience vertical subsidence up to approximately 50 mm.

The predicted vertical subsidence for the section of railway located adjacent to the full extraction areas between approximately 130.7 km and 132.3 km is less than 20 mm. Whilst the railway could experience low levels of vertical subsidence, it is not predicted to experience measurable tilts, curvatures or strains.

Based on the subsidence predictions described above and the fact that only first workings or no mining has occurred directly beneath or adjacent to the railway in the overlying Great Northern seam, it is unlikely that the Main Northern Railway will experience adverse impacts due to the extraction of the proposed panels.

Notwithstanding this, there remainsa low likelihood that the railway could experience low level subsidence movements where the track is adjacent to the existing Teralba Conglomerate spanning areas and the full extractiontotal extraction areas within the existing Awaba Colliery workings. Whilst the likelihood is extremely low, there is a possibility that higher than expected movements could occur at the track and adverse impacts could occur along the railway, if management measures were not implemented. The adverse impacts could include changes in rail stress, changes in track geometry and/or changes in the performance of overhead electrical wiring.

Whilst the predicted mining-induced movements are small, the rate of subsidence development could be rapid, thereby reducing the time available to respond and prevent a safety hazard developing on the track.

The management measures proposed in Section 6.1.5 consider the development of these low level movements. The proposed management strategies to will ensure that the railway remains safe and serviceable during and after the proposed mining.

Railway loop line (Ulan Rail Loop)

A railway loop line for the Eraring Power Station (Ulan Rail Loop), comprising continuously welded track on concrete sleepers, is located within the study area above first workings and full extraction areas within the existing Awaba Colliery workings. Partial extraction is proposed directly beneath the railway loop line.

The railway loop line is predicted to experience between 500 mm and 1000 mm vertical subsidence due to the partial extraction within the proposed panels. The railway loop line has been designed for mine subsidence of 1 m. However, the track is sensitive to differential horizontal movements (strains) rather than the absolute vertical movements.

The track is continuously welded and it is unlikely to be able to accommodate the predicted strains of 15 mm/m tensile and 19 mm/m compressive due to the proposed mining. The mining-induced compressive strains could cause the rail to buckle and the mining-induced tensile strains could cause the rail to break, if management measures were not implemented.

Roads

There are two private sealed roads located within the study area. The Newstan-Eraring Private Coal Road (mine haul road) is located over areas of proposed first workings, partial extraction and full extraction. There is also a private road located over areas of proposed partial extraction and first workings.

The maximum predicted vertical subsidence along the mine haul road is 1700 mm and along the private road it is 1900 mm. The maximum predicted tilt along the alignment of the mine haul road is 50 mm/m and along the alignment of the private road is 35 mm/m.

Vertical subsidence and tilt could affect the drainage of surface water from the roads. Localised changes in grade are predicted along both the mine haul road and private road. The predicted post-mining grades are similar to the natural grades elsewhere along the alignments of these roads. It is unlikely, therefore, that there will be large-scale changes in the surface drainage along the roads due to the proposed mining. There is potential for increased ponding near the low point along the private road where the mining-induced tilts reverse the existing grades. If adverse impacts on the surface water drainage were to develop along these roads, this could be remediated using normal road maintenance techniques.

The maximum predicted curvatures are greater than 3.0 km^{-1} for the mine haul road and 1.7 km^{-1} for the private road. These roads could also experience tensile strains of 15 mm/m and compressive strains of 19 mm/m. It is expected that cracking, heaving and possibly stepping of the road pavements will occur based on these levels of predicted curvature and strain.

It is anticipated that the crack widths along the mine haul road and private road will be typically between 25 mm and 50 mm, with isolated cracks greater than 300 mm. Stepping of the road pavement could also occur in the order of 25 mm to 50 mm, with isolated steps with heights greater than 100 mm. The potential impacts on the mine haul road and private road could result in them becoming unsafe or unserviceable if preventive or remediation measures were not to be implemented.

The road cuttings within the study area contain loose rocks and are highly weathered. The extraction of the proposed panels beneath the cuttings could result in marginally stable rocks being dislodged and spilling across the roads.

There are also a number of unsealed tracks located across the study area that could experience the full range of predicted subsidence effects. It is expected that cracking, rippling and stepping of the unsealed tracks will occur as each of the proposed panels are mined beneath them. The unsealed tracks within the study area can be maintained in safe and serviceable conditions throughout the mining period using normal road maintenance techniques.

Bridges

There is one bridge located directly above the proposed mining area. However, first workings only are proposed directly beneath this bridge. There are also other road bridges located near the proposed mining area that could experience far-field horizontal movements and could be sensitive to these effects.

The bridges are all located outside the extents of the secondary extraction areas within the proposed panels at distances ranging between 140 m and 1000 m. At these distances, the bridges are predicted to experience vertical subsidence of less than 20 mm and are not predicted to experience measurable tilts, curvatures or strains.

The bridges could experience far-field horizontal movements due to the proposed mining. The predicted absolute horizontal movements, are 400 mm at a distance of 140 m, 140 mm at a distance of 600 m and 80 mm at a distance of 1000 m from the secondary extraction areas. These absolute horizontal movements are not expected to be associated with measurable tilts, curvatures or strains.

Differential horizontal movements along the alignments of the bridges could potentially affect the widths of the expansion joints or the capacities of the support bearings. Differential horizontal movements could also induce eccentricities into the structures or affect the capacities of the support bearings. The predicted differential horizontal movements at the bridges have been determined by statistically analysing the available 3D monitoring data from the NSW coalfields. The maximum predicted differential incremental horizontal movements between the adjacent headstocks and abutments of the bridges are between ±8 mm to ±10 mm.

The predicted mining-induced differential horizontal movements for the bridges, are similar orders of magnitude to the movements that normally occur due to the variation in ambient temperature (approximately 5 mm). It is probable, therefore, that the bridges could tolerate the potential movements due to the proposed mining, without adverse impacts, provided that the expansion joints have sufficient redundant capacities. The predicted subsidence effects will be provided to infrastructure owners so that the bridges can be reviewed based on these movements.

Drainage culverts

There are drainage culverts within the study area where the local roads cross streams. It is likely that there are other culverts within the study area, on the unsealed roads and tracks and on the private properties. The drainage culverts are located across the study area and could experience the full range of predicted subsidence effects.

The maximum predicted tilt for the drainage culverts is greater than 100 mm/m. The maximum predicted curvatures are greater than 3.0 km^{-1}. The maximum predicted strains for the culverts are 15 mm/m tensile and 19 mm/m compressive. The maximum predicted values occur where the culverts are located above both the existing Awaba Colliery workings and the proposed panels.

The predicted changes in grade could be of sufficient magnitude to affect the flow of water through the drainage culverts in the locations of the greatest tilts and where these tilts reduce the existing grades. If the flow of water through a drainage culvert was adversely affected, due to the proposed mining, this could be remediated by relevelling the affected culvert.

The predicted curvatures and strains could also be of sufficient magnitudes to result in cracking in the culverts or the headwalls. It is unlikely, however, that these movements will adversely impact on the stabilities or structural integrities of the culverts. The potential impacts on the drainage culverts can be managed by visual inspection and, where required, the affected culverts can be repaired or replaced.

Electrical infrastructure

A 132/33 kV substation is located above the northern end of the proposed panels. First workings only are proposed directly beneath the substation. The substation is also located above existing Awaba Colliery first workings. A 33 kV substation is also located within the study area approximately 110 m to the north of the Extension of Mining Area.

There are three 132 kV transmission lines that run to the 132/33 kV substation within the study area. Two of these transmission lines run to the north and then the east directly above the proposed panels, referred to hereafter as the 132 kV transmission line (east). The other transmission line runs to the south-west above the proposed panels, referred to hereafter as the 132 kV transmission line (west).

There are also two 33 kV powerlines located above the proposed mining area, one of which runs out of the 132/33 kV substation, and another that crosses the northern end of the proposed panels. The 33 kV powerlines comprise aerial conductors supported by dual timber poles and are owned by Ausgrid.

Only low level subsidence effects are predicted at the 132/33 kV substation (20 mm vertical subsidence) as it is located above first working areas within the proposed panels and within the existing overlying workings. It is unlikely, therefore, that the substation will experience adverse impacts due to the proposed mining.

The maximum predicted tilt for the 132 kV transmission lines is 60 mm/m. The maximum predicted tilt for the 33 kV powerlines is 100 mm/m. The greatest tilts occur where the transmission lines and powerlines are located above both the secondary extraction areas within the proposed panels and above the existing Awaba Colliery workings.

Based on these predicted tilts, it is likely that the 132 kV transmission lines and 33 kV powerlines will experience adverse impacts if management measures were not implemented. The potential impacts include increased cable tensions and lateral loads on the poles and/or reduced cable clearances. It is expected that the mining-induced movements on the 132 kV transmission lines and 33 kV powerlines could be accommodated with the implementation of the necessary preventive measures, such as the installation of cable rollers, guy wires or additional poles, or the adjustment of cable catenaries.

Telecommunications infrastructure

There is one optical fibre cable owned by AAPT located within the study area. The aerial cable is supported by the timber poles along the 132 kV transmission lines directly above the proposed panels.

There are also direct buried copper telecommunications cables owned by Telstra that generally follow the alignments of local roads within the study area.

There are also GSM installations (mobile phone towers) located within the study area. One installation is located directly above the proposed panels. This site is on the boundary of the first workings and full extraction areas.

The optical fibre cable will not be directly affected by the ground strains, as it is supported by poles above ground level. However, the cable can be affected by the changes in the distances between the poles at the level of the cable, resulting from the differential vertical subsidence, horizontal movements and tilt at the pole locations.

The maximum predicted horizontal movement at the tops of the poles is 1.4 m. The greatest movements occur where the optical fibre cable is located above both the secondary extraction areas within the proposed panels and above the existing Awaba Colliery workings.

It is likely, therefore, that the aerial optical fibre cable will experience adverse impacts if management measures are not implemented. It is expected that the mining-induced movements on the optical fibre cable could be accommodated with the implementation of the necessary preventive measures, such as the installation of cable rollers or the adjustment of cable catenaries.

The maximum predicted strains for the copper telecommunications cables are 2.7 mm/m tensile and 2.6 mm/m compressive. The direct buried copper cables cross a number of streams and, therefore, could experience valley related effects in these locations. The compressive strains resulting from the valley related effects could be in the order of 5 mm/m to 10 mm/mm at the stream crossings. Copper telecommunications cables can typically tolerate strains of 20 mm/m without adverse impacts. It is unlikely, therefore, that the copper cables will experience adverse impacts due to the proposed mining.

The maximum predicted tilt for the GSM installation is 1 mm/m. It is possible, that predicted tilt could affect the performance of the antenna panels or microwave dishes, as these can be sensitive to small angular deviations. The maximum predicted tilt represents an angular deviation of less than 0.1° and, therefore, it is expected that this could be managed by making any necessary adjustments to the lines of sight during the active subsidence period.

Eraring Power Station

The Eraring Power Station is a coal fired electricity power station which was constructed in 1977. The infrastructure associated with the power station extends above the southern ends of the proposed panels and includes a number of buildings, water and fuel storage tanks, an ash dam and coal stockpile and associated infrastructure. First workings areas only are proposed beneath and within a 35 degree angle of draw of the majority of the building structures and associated infrastructure. Full extraction is proposed directly beneath the ash dam. The main power generation facility itself is located to the south of the proposed mining area.

Main building structures

The main building structures associated with the Eraring Power Station, including the power generation facility, boiler enclosures, fabric filter hopper enclosures, the main warehouse, administration building and workshops, are located to the south of the proposed mining area or above first workings areas only within the proposed panels.

The main building structures associated with the Eraring Power Station are predicted to experience less than 20 mm vertical subsidence. Whilst the structures located close to or directly above the first workings areas within the proposed panels could experience very low levels of vertical subsidence, they are not predicted to experience measurable tilts, curvatures or strains.

The main building structures could experience far-field horizontal movements due to the proposed mining. The predicted absolute horizontal movements range from 150 mm to 210 mm. These absolute horizontal movements are not expected to be associated with measurable tilts, curvatures or strains.

The potential for impacts on main building structures does not result from absolute far-field horizontal movements, but rather from differential horizontal movements over the lengths of the structures. The power generation facility is predicted to experience horizontal bending with a minimum curvature of 0.67 km^{-1} and an average strain of less than 0.1 mm/m. The structural steel frame of this building is likely to tolerate these low level movements without adverse impacts. However the predicted subsidence effects will be provided to Eraring Energy so that this building structure and associated plant can be reviewed based on these movements.

The other main building structures associated with the Eraring Power Station (boiler enclosures, fabric hoppers, the main warehouse and administration building) are predicted to experience subsidence effects similar to or less than the power generation facility. It is also expected that these structures could tolerate the low level movements without adverse impacts.

Ancillary building structures

There are ancillary building structures located above the proposed mining area, including those associated with the rail receival facility, diesel storage, substation, weighbridges, light fuel storage and reclaimed water storage.

The maximum predicted tilt for the rail receival facility is 50 mm/m. This tilt could be sufficient to result in adverse impacts on the serviceability of this structure and associated coal handling infrastructure. The predicted curvatures and strains could also be sufficient to result in cracking of the concrete walls beneath the railway loop line. The predicted subsidence effects will be provided to Origin Energy so that the structure can be assessed based on these movements. If adverse impacts are anticipated, preventive or remedial measures will be developed so that the rail receival facility can be maintained in safe and serviceable condition during the mining period. The coal recovery directly beneath the facility could also be modified so as to reduce the predicted subsidence effects.

The structures associated with the diesel storage are single-storey brick structures on a concrete ground slab. The maximum predicted tilt for the diesel storage structures is 5 mm/m, which could result in minor serviceability impacts, including issues with gutter and wet area drainage. Additionally, moderate cracking (5 mm to 15 mm) could develop in the masonry walls based on the predicted curvatures and strains. It is unlikely that the building structure itself will become unserviceable or unsafe based on the predicted subsidence effects, and any adverse impacts on the structures could be repaired after active subsidence.

The maximum predicted tilt for the weighbridges is 40 mm/m. Tilting, if sufficiently large, can displace the centre of gravity of the vehicle which can then reduce the accuracy of the measurement. It is possible that the predicted mining-induced tilts will be sufficient to result in adverse impacts on the serviceability of the weighbridges. Additionally, the maximum predicted curvature (0.45 km^{-1}) and strains (2.7 mm/m tensile and 2.6 mm/m compressive) for the weighbridges could result in an opening or closure of approximately 50 mm and differential vertical movement of approximately 20 mm. If this exceeds the allowable tolerances, it may be necessary to modify the levels of the concrete ramp approach and steel angle.

The structures associated with the substation, light fuel storage and reclaim water storage are predicted to experience vertical subsidence of 100 mm or less. Whilst these structures could experience low level vertical subsidence, they are only expected to experience minor tilts, curvatures and strains. The building structures themselves are unlikely to experience adverse impacts due to the proposed mining. However, infrastructure and services associated with these structures could be sensitive to low level movements.

Water and fuel storage tanks

The disused diesel storage tanks are predicted to experience a maximum tilt of 35 mm/m and a maximum curvature of 1.5 km^{-1}. If the diesel storage tanks were to become operational again, the predicted subsidence effects could be sufficient to result in adverse impacts on them. The underground pipelines associated with these tanks could also experience adverse impacts especially where they are anchored to the ground. The predicted subsidence effects for the disused diesel tanks will be provided to Eraring Energy so that they can be assessed based on these movements. If the tanks were to become operational prior to or during the mining period, then management and monitoring strategies will be developed to manage the potential impacts.

The other main tanks (reclaimed water storage, light fuel storage, return and effluent storage, demin storage and ammonia storage) are predicted to experience vertical subsidence of 20 mm or less. Whilst the tanks located closest to the proposed mining areas could experience very low levels of vertical subsidence, they are not predicted to experience measurable tilts, curvatures or strains. It is unlikely that these tanks and associated pipelines and services will experience adverse impacts due to the proposed mining.

Eraring Ash Dam

The Eraring Ash Dam is located above the southern ends of the proposed panels including the full extraction areas. The full extraction within the proposed panels directly beneath the ash dam will result in fracturing of the overburden, with the height of discontinuous fracturing predicted to extend between 170 m to 250 m above the West Borehole seam.

The depth of cover above the West Borehole seam, within the extents of the ash dam and the proposed panels, varies between 250 m and 320 m. It is possible, therefore, that discontinuous fracturing could extend from the seam up to the surface. However, this does not infer direct connectivity, as the potential effects on groundwater and the ingress of leachate from the ash dam are dependent on the height of continuous fracturing, rather than the height of discontinuous fracturing.

The height of continuous fracturing and overburden permeability has been estimated using empirical methods (Ditton & Merrick, 2014; Tammetta, 2013) with these predictions supplemented by the UDEC numerical model. The height of continuous fracturing is predicted to be between 115 m to 233 m above the West Borehole seam, which would result in only minor changes in vertical permeability. Potential impacts on the ingress of leachate from the ash dam and groundwater are discussed in further detail in Sections 6.2 and 6.3.

Ash dam wall

Centennial Newstan consulted with Dams Safety NSW during development of the mine design to ensure that subsidence impacts to the Eraring Ash Dam wall would be minimised. First workings for the proposed panels partially extend into the 35 degree angle of draw for the Eraring Ash Dam wall. These first workings will not result in measurable subsidence at the surface and, therefore, are not anticipated to result in adverse impacts on the dam wall.

The ash dam wall is predicted to experience less than 20 mm vertical subsidence due to the proposed mining. Whilst the dam wall could experience very low levels of vertical subsidence, it is not expected to experience measurable tilts, curvatures or strains.

The ash dam wall could experience far-field horizontal movements of up to 250 mm due to the proposed mining. These absolute horizontal movements are not expected to be associated with measurable tilts, curvatures or strains.

Ash dam augmentation project (PA 07_0084 Mod 1)

An augmentation project is proposed for the Eraring Ash Dam, including the construction of the “Western Saddle Embankment” and void stabilisation works within the existing Awaba Colliery workings.

The extraction of the proposed panels beneath the Western Saddle Embankment could result in cracking within the embankment. Also, cracking could be exacerbated along the perimeter of the existing Awaba Colliery workings, due to differential settlement, depending on the effectiveness of the stabilisation works. The size and extent of this cracking will depend on the final design and construction of the embankment.

If adverse impacts are anticipated, the coal recovery beneath the embankment could be modified so as to reduce the predicted subsidence effects. The appropriate management strategies will depend on the final design and construction of the Western Saddle Embankment and the void stabilisation works (i.e. filling of vids with cement-stabilised ash).

Other dams

A number of other dams associated with the Eraring Power Station are located within the study area, including a recycled water dam, oils retention dam, reclaimed water dam and cooling water dam.

The north-western end of the recycled water dam is partially located above the full extraction area. Cracking could occur in the base of the dam based on the predicted curvatures and strains. Additionally, the wall of the recycled water dam is located 170 m outside of the proposed mining area at its closest point. The dam wall is predicted to experience less than 20 mm vertical subsidence due to the proposed mining and is not expected to experience measurable tilts, curvatures or strains.

The oil retention dam is located above the first workings areas; however, it is located adjacent to a full extraction area. The southern end of this dam could experience strains in the order of 1 mm/m to 2 mm/m due which could result in minor cracking in the dam subbases and linings.

The reclaimed water dam is located above the first workings area and is predicted to experience vertical subsidence of up to 100 mm due to the nearby full extraction. Whilst this dam could experience low level vertical subsidence, it is not predicted to experience significant tilts, curvatures or strains. Surface cracking is therefore not anticipated to occur at the reclaimed water dam.

The cooling water dam is not predicted to experience measurable vertical subsidence, tilt, curvature or strain. The dam could experience small far-field horizontal movements; however, these absolute movements are not predicted to be associated with measurable strains. It is therefore unlikely that the cooling water dam will experience adverse impacts due to the proposed mining.

The predicted subsidence effects for the dams will be provided to Eraring Energy so that the potential impacts can be assessed based on the predicted movements. If adverse impacts are anticipated, then preventive measures and monitoring will be developed to protect the integrity of the dams. Alternatively, the coal recovery near the dams could be modified to reduce the predicted subsidence effects.

Coal stockpile and associated infrastructure

The coal stockpile is generally located above the first workings areas only; however, the northern end is located above full extraction areas.

The main infrastructure is located near the southern end of the coal stock pile. This main infrastructure is predicted to experience less than 20 mm vertical subsidence. Whilst the infrastructure could experience low levels of vertical subsidence, it is not predicted to experience measurable tilts, curvatures or strains.

The coal stacker/reclaimer extends to the northern end of the site. This infrastructure could experience maximum vertical subsidence of 900 mm, maximum tilt of 30 mm/m and maximum curvature of 2 km^{-1}. The maximum predicted strains are 2.7 mm/m tensile and 2.6 mm/m compressive.

The predicted subsidence effects for the coal stacker/reclaimer will be provided to Eraring Energy so that it can be assessed based on these movements. Management measures will be developed so that the coal stacker/reclaimer can be maintained in serviceable condition during and after active subsidence as has been achieved at other operations.

Conveyors

There are three conveyors (north, east and west) associated with Eraring Power Station that transport coal from the rail receival facility, Myuna Colliery and the coal stockpile respectively.

The conveyor (west) is located above first workings areas only and is predicted to experience less than 20 mm vertical subsidence due to the proposed mining. Additionally, it is not predicted to experience measurable tilts, curvatures or strains. It is therefore unlikely that the conveyor (west) would experience adverse impacts due to the proposed mining.

The conveyor (north) and conveyor (east) are predicted to experience maximum vertical subsidence of 875 mm and 925 mm respectively. The maximum predicted tilt for the conveyors is 25 mm/m and the maximum predicted curvature is 0.85 km^{-1}. The northern end of the conveyor (north) is located above the existing Awaba Colliery workings and above partial extraction areas within the proposed panels. The maximum predicted strains for this section of conveyor are 15 mm/m tensile and 19 mm/m compressive. Elsewhere along the conveyor (north) and the entire length of the conveyor (east) are located outside the extents of the existing workings. The maximum predicted strains for these sections of the conveyors are 2.7 mm/m tensile and 2.6 mm/m.

It is likely that these predicted subsidence effects would be sufficient to result in adverse impacts, if preventive measures were not implemented. Management strategies will need to be developed for the conveyors. If strategies could not be effectively implemented and adverse impacts are anticipated, then the coal recovery beneath the conveyors could be modified so as to reduce the predicted subsidence effects on them.

Water storage dams

There are water storage dams located adjacent to the private road, above the proposed panels. These dams are located above both the full extraction areas within the proposed panels and above the existing Awaba Colliery workings.

The water storage dams are predicted to experience maximum vertical subsidence of 1950 mm, maximum tilt of 70 mm/m and a maximum predicted curvature of greater than 3.0 km^{-1}. The maximum predicted strains for the water storage dams are 15 mm/m tensile and 19 mm/m compressive.

The predicted subsidence effects are sufficient to result in fracturing of the bedrock and cracking in the bases of the dams and the dam walls. This could result in the loss of stored water within these dams. It is anticipated that the dams can be maintained in a serviceable condition throughout the mining period through visual monitoring and appropriate remediation of any identified impacts.

Aboriginal heritage sites

There are nine Aboriginal heritage sites that have been identified within the study area for the subsidence assessment. Six of the sites are isolated finds (45-7-0070, 45-7-0300, 45-7-0301, 45-7-0302, 45-7-0306 and 45-7-0312) and three are scarred trees (45-7-0318, 45-7-0319 and 45-7-0324).

Isolated find sites 45-7-0070, 45-7-0306 and 45-7-0312 and scarred tree site 45-7-0324 are located outside of the proposed mining area and are predicted to experience less than 20 mm vertical subsidence. Whilst these sites could experience very low levels of vertical subsidence, they are not predicted to experience measurable tilts, curvatures or strains. Adverse impacts are not anticipated at these sites due to the proposed mining.

Isolated find sites 45-7-0300, 45-7-0301, 45-7-0302 are located directly above the proposed mining area. These open sites can potentially be affected by cracking of the surface soils as a result of the proposed mining. It is unlikely, however, that the artefact scatters or isolated finds themselves would be impacted by surface cracking. It is possible, however, that if remediation of the surface was required after mining, that these works could potentially impact the open sites.

Isolated find sites 45-7-0301 and 45-7-0302 are located where the proposed panels mine beneath the existing Awaba Colliery workings. Partial extraction of pillars has been undertaken in these locations and, therefore, it is possible that plug failures of the Teralba Conglomerate could occur as a result of the proposed mining.

Scarred tree sites 45-7-0318 and 45-7-0319 are located directly above the proposed mining area and above the existing Awaba Colliery workings. It has been found, from past mining experience, that the incidence of impacts on trees is extremely rare. Impacts on trees generally occur where the depths of cover are extremely shallow, in the order of 50 m or less, or on very steeply sloping terrain, in the order of 1 in 1 or greater. It is unlikely, therefore, that any scarred trees would be adversely impacted by the proposed mining.

Scarred tree site 45-7-0318 is located where partial extraction of pillars has been undertaken in the Great Northern Seam, therefore, it is possible that a plug failure of the Teralba Conglomerate could occur as a result of the proposed mining.

Further assessment of potential impacts to Aboriginal heritage items is provided in Section 6.12.

Historic heritage sites

The historic heritage items identified within and near to the Study Area include the: Main Northern Railway, Eraring Power Station, Newstan Colliery, Awaba State Coal Mine, Awaba to Wangi Power Station Branch Railway Line and the Bridge over the Main Northern Railway Line.

Subsidence predictions and impact assessments for the Main Northern Railway and the Eraring Power Station are provided above.

Newstan Colliery is located well outside the Study Area based on the 600 m boundary. First workings only are proposed beneath the Awaba State Coal Mine and, therefore, it is predicted to experience less than 20 mm vertical subsidence. It is not anticipated therefore that adverse impacts would occur to Newstan Colliery and Awaba State Coal Mine due to the proposed mining.

The Awaba to Wangi Power Station Branch Railway Line could therefore experience the full range of predicted subsidence effects. The branch line is in poor condition (Umwelt, 2020) and the proposed mining could further affect its existing condition. Preventive measures could be considered, such as cutting the rails to allow it to accommodate the differential horizontal movements due to mining; however, this could result in greater impacts than those due to mine subsidence.

The Bridge over the Main Northern Railway Line is predicted to experience less than 20 mm vertical subsidence due to the proposed mining. The bridge could experience far-field horizontal movements; however, these effects are expected to be low level global movements towards the proposed mining area.

Further assessment of potential impacts to historic heritage items is provided in Section 6.13.

Other impacts

The survey control marks located up to approximately 3 km outside the proposed mining area could experience subsidence effects. The survey control marks that are required for future use will need to be re-established after the completion of the proposed mining and after the ground has stabilised.

There are no residential structures located within the study area. The nearest houses are located approximately 1 km from the proposed mining area. It is unlikely that the houses and their associated infrastructure would experience adverse impacts due to the proposed mining, even if the predictions were exceeded by a factor of two times.

The Hawkmount Quarry is proposed to be developed within the existing water storage dams located between the Main Northern Railway and the private road, partially located above a full extraction area within the proposed panels. The quarry could experience mine subsidence effects if it were to be constructed prior to the proposed mining, which could dislodge marginally stable rocks or loose boulders posing a safety risk for people beneath the quarry faces. It is expected that these potential impacts could be managed by periodic visual inspections and the implementation of preventive measures that will be included in a Built Features Management Plan for the quarry site.

6.1.5 Mitigation and management

Subsidence monitoring, management and remediation will be undertaken throughout the life of the project in accordance with approved Extraction Plans and in consultation with DPIE – Planning and Assessment, land and infrastructure owners, and other relevant stakeholders. Key mitigation measures for specific built and natural surface features to be incorporated into the Extraction Plans are identified below.

Streams

Watercourse impact monitoring and management provisions will be developed for the streams within the study area, including periodic visual monitoring along Stony, Kilaben, Stockyard and Crooked Creeks during active subsidence and establishment of longitudinal ground monitoring lines across the second order sections of the creeks.

If adverse or unacceptable impacts due to ponding or fracturing are anticipated along the streams, then partial extraction within the proposed panels could be carried out at these locations. Appropriate management measures will be developed as part of targeted moitoring and management plans as described in Section 6.5.5.

Steep slopes

Monitoring and management measures will be developed for steep slopes and rock outcrops within the study area. Periodic visual inspection will be carried out when mining directly beneath these features. Remediation, such as infilling or regrading, will be carried out on larger surface cracking which could result in increased erosion or restrict access along tracks. In some cases, erosion protection measures may be needed, such as the planting of additional vegetation in order to stabilise the slopes in the longer term.

Main Northern Railway

Centennial Newstan will appoint a Rail Technical Committee which will include representatives from the rail operator, the mine and specialist consultants. The Rail Technical Committee will consult with the Resources Regulator and the Office of the National Rail Safety Regulator to:

- Identify potential impacts to the railway.

- Apply a risk management approach, where identified risks are assessed and risk control measures are implemented.
- Develop management measures that include mitigation and preventive works, monitoring plans, trigger action response plans (TARP) and communication plans.

The Rail Technical Committee will implement robust management strategies to ensure that the railway remains safe and serviceable during and after the proposed mining. The strategies could include the following investigations and considerations:

- Field investigations to explore the current status of goafing within the Teralba Conglomerate spanning areas and full extraction areas in the Great Northern Seam that lie adjacent to the Main Northern Railway.
- Consideration of targeted grouting of large voids if discovered adjacent to the Main Northern Railway.
- Intensive monitoring of ground movements and other instrumentation to detect rapid subsidence events, such as geophones and seismic sensors above early proposed panels that are located well away from the Main Northern Railway and during and after the extraction of the proposed panels adjacent to the railway.
- Installation of a track expansion system to decouple the rail from potential mining-induced ground strains.
- Engineering assessment of the current condition of the railway track, overhead wiring and associated structures (the haul road overbridge, culverts, embankments and cuttings) and, if required, maintain the track and associated structures so that their condition is within operating tolerances prior to the influence of mining.
- Regular monitoring of ground movements and visual inspections directly above the proposed panels during and after extraction adjacent to the railway.
- Regular monitoring of ground movements and visual inspections along the railway corridor during and after the extraction of the proposed panels adjacent to the railway.
- Regular monitoring of changes in rail stress and track geometry along the railway and changes in the condition of associated railway structures during and after the extraction of the proposed panels adjacent to the railway.
- Installation of real-time monitoring with alarms if measured changes exceed trigger levels.
- Implementation of procedures to immediately respond in the unlikely event of adverse movements or changes are observed to the track to ensure that the railway remains safe. The procedures would include the worst case but extremely low likelihood response to immediately stop trains and inspect the track for hazards before allowing train operations to recommence.

Railway loop line (Ulan Rail Loop)

A Technical Committee comprising specialists in mine subsidence, railway engineering and railway maintenance will be established to develop the appropriate management strategies for the railway loop line. Centennial Newstan will liaise with Sydney Trains and the owners of the Eraring Power Station in developing these strategies.

Appropriate monitoring measures will be established, including monitoring visual, ground survey and rail stress. A TARP will be developed outlining the required trigger levels and actions so as to maintain the railway loop line in safe and serviceable condition at all times.

Roads

Management strategies will be developed for the mine haul road, private road and the other local roads, in consultation with their owners, so that adverse impacts can be identified and remediated, as required. Remediation will be carried out during active subsidence so that the roads can be maintained in safe and serviceable conditions throughout the mining period.

Loose rocks and highly weathered sections of the cuttings along the local roads will be removed or stabilised before the panels are mined directly beneath them. The cuttings will be visually monitored during the active subsidence period, so that any loose rocks or spalling along the cutting faces can be removed.

Bridges

The predicted subsidence effects will be provided to infrastructure owners so that the bridges can be reviewed based on these predicted movements. Management strategies will be developed, in consultation with the bridge owners. The management strategies for the bridges located closest to the proposed mining area could include 3D monitoring points on the bridge structures, tell-tales across the expansion joints and periodic visual inspections during the mining of the proposed panels closest to them.

Drainage culverts

The drainage culverts located directly above the secondary extraction area will be periodically visually inspected during the active subsidence. Management and remediation measures will be developed in consultation with the infrastructure owners.

Electrical infrastructure

The predicted subsidence effects for the substation will be provided to EnergyAustralia and the predicted subsidence effects for the 132 kV transmission lines and 33 kV powerlines will be provided to Ausgrid. Preventive and monitoring measures for the transmission lines and powerlines will be developed in consultation with Ausgrid.

The 132 kV transmission lines and the 33 kV powerlines located above the secondary extraction areas within the proposed panels will be visually monitored during active subsidence, so that they are maintained in safe and serviceable conditions at all times.

Telecommunications infrastructure

The predicted subsidence effects for the optical fibre cable will be provided to AAPT so that the necessary management plans can be developed. A TARP will be developed for the cable so that, if necessary, preventive measures can be undertaken if the strains in the cable approach the allowable tolerances. The predicted movements for the GSM installation will be provided to the owner so that the infrastructure can be reviewed based on these movements.

Eraring Power Station

Detailed management strategies for the Eraring Power Station will be developed, through ongoing consultation with Origin Energy, as part of the development of a Built Features Management Plan, including:

- The predictions for the power generation facility and major structures and plant enclosures will be provided to the structural engineer and machine manufacturers, so that the designs can be reviewed based on the predicted far-field movements.

- Development of management strategies for the conveyor (north) and conveyor (east), including:
  - Assessment of the serviceability and structural integrity of the conveyors based on a detailed inspection and the predicted mine subsidence movements.
  - Development of preventive measures, including the provision of the necessary adjustments to the conveyors, to maintain them in a safe and serviceable condition during mining.
- Development of management strategies for the larger tanks, weighbridges, pipelines and other services, so that they can be maintained in a safe and serviceable condition during mining.
- Development of management strategies for the ash dam, which could include a detailed assessment of the integrity of the ash dam wall and base as a result of the proposed mining. If these assessments show that the ash dam cannot be maintained in a safe and serviceable condition, during the extraction of the proposed panels, it may be necessary to reduce the percentage of coal extracted (i.e. pillar recovery, extraction height, panel width) beneath the dam, to limit the mine subsidence movements in this location.
- Development of a TARP, in consultation with Origin Energy, based on the outcomes of the detailed studies and the established preventive or remediation measures.
- Development of the appropriate monitoring at the Eraring Power Station, where required, including major structures and infrastructure located directly above mining, or where these features may be sensitive to far-field movements.

The preventive or remediation measures, TARP and monitoring plan will be formalised in an agreed Built Features Management Plan for the facility.

Water storage dams

Subject to consultation and agreement with the landowner, the water levels in the dams will be lowered during active subsidence. These dams will be visually monitored, as the proposed panels mine directly beneath them, such that any impacts can be identified and remediated accordingly.

6.2 Hydrogeotechnical

The information presented in this section is summarised from the report titled 'Newstan Mine Extension Project: EIS Assessment of Interaction with Eraring Ash Dam (SCT Operations Pty Ltd, 2019), which is presented in full in Appendix H.

6.2.1 Background

Centennial Newstan commissioned SCT Operations Pty Ltd to review the proposed mine design in the context of potential interactions with the Eraring Ash Dam, including the activities associated with Origin Energy's ash dam augmentation project, as approved under PA 07_0084 MOD 1. The review builds on the findings of the Subsidence Impact Assessment (MSEC, 2019b), and focusses on the potential for:

- Subsidence related ground movements associated with the proposed mining in the West Borehole seam to impact void filling works proposed by Origin Energy to manage groundwater inflows from Eraring Ash Dam.
- Groundwater interactions between the surface, the proposed workings in the West Borehole seam and the flooded Awaba Colliery workings in the Great Northern seam in the vicinity of the Eraring Ash Dam.

- Earthquake events to influence the stability of the mine workings.
- Subsidence events to contribute to liquefaction of the ash fill within the Eraring Ash Dam.

6.2.2 Methodology

The following information was drawn upon during the review:

- The Subsidence Impact Assessment completed for the project (MSEC, 2019b).
- Previous subsidence and groundwater monitoring data for Awaba and Newstan Collieries.
- Scientific literature regarding ground movements, groundwater, and hydraulic connectivity impacts from underground mining in Australia.
- Publically available information regarding Origin Energy's proposed ash dam augmentation project, as approved under PA 07_0084 MOD 1.
- Dams Safety NSW guidelines.

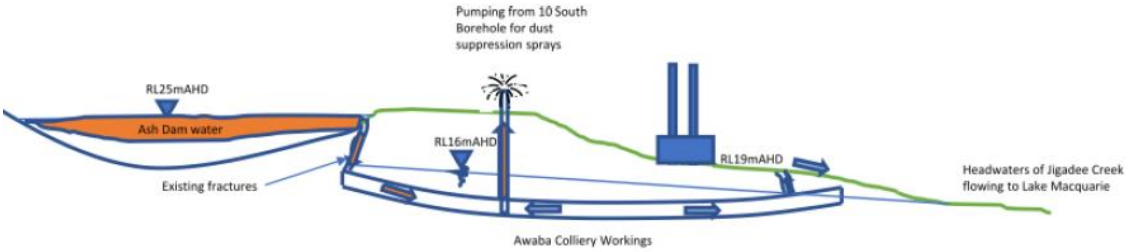
A three-dimensional conceptual model of the Eraring Ash Dam, the former Awaba Colliery workings in the Great Northern seam, and the proposed workings in the West Borehole seam was also developed to assist with the review. The SCT Operations Pty Ltd review (2019) utilised an empirical approach based on theoretical and empirical relationships regarding the impact of subsidence on ground movements and interrelated groundwater impacts. This approach contrasts with the methodology approach adopted for the Groundwater Impact Assessment (GHD, 2020a), summarised in Section 6.3, which involved the utilisation of localised groundwater and subsidence monitoring data to develop a numerical hydrogeological model for the project.

6.2.3 Existing environment

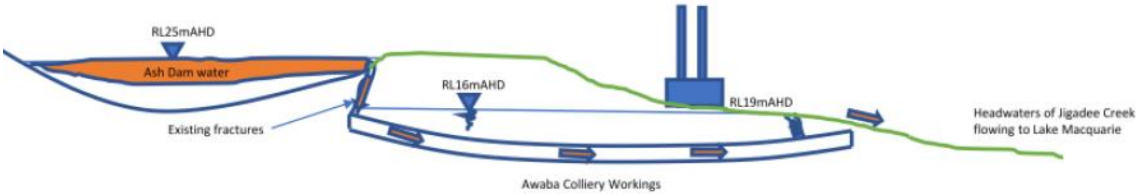
The environmental baseline was described in terms of:

- The overburden depth, mine geometry and extent of subsidence associated with the former Awaba Colliery workings in the Great Northern seam in the vicinity of the Eraring Ash Dam.
- The hydrogeological interactions between the former Awaba Colliery Workings in the Great Northern seam and the Eraring Ash Dam prior to the commencement of Origin Energy's proposed ash dam augmentation project, as approved under PA 07_0084 MOD 1.
- The hydrogeological interactions between the former Awaba Colliery Workings in the Great Northern seam and the Eraring Ash Dam following the completion of Origin Energy's proposed ash dam augmentation project, as approved under PA 07_0084 MOD 1.

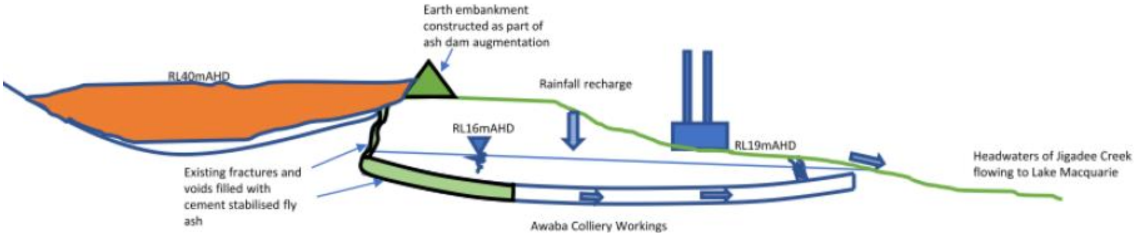
The hydrogeological interactions between the former Awaba Colliery workings in the Great Northern seam and the Eraring Ash Dam before and after completion of Origin Energy's ash dam augmentation project, in the absence of any project-related secondary extraction within the West Borehole seam, are illustrated conceptually (as per SCT, 2019) in Figure 6-3 and described in further detail below.



Current: flow path from Eraring Ash Dam to 10 South Bore where water is pumped out for dust suppression leaving mainly cleaner water outflows via the artesian overflow to the south of Awaba Colliery.



Pre-ash dam augmentation, but post-cessation of 10 South Bore pumping: Flow path from Eraring Ash Dam into Awaba Colliery and out via the artesian overflow to the south of Awaba Colliery allowing fly ash contaminated water to enter the Lake Macquarie catchment.



Post-ash dam augmentation: Flow path from Eraring Ash Dam into Awaba Colliery limited by void filling so flow of fly ash contaminated water out via the artesian overflow to the south of Awaba Colliery is also limited

Figure 6-3 Conceptualisation of flow paths between Eraring Ash Dam, Awaba Colliery, and nearby watercourses

Awaba Colliery in the Great Northern seam

The former Awaba Colliery workings cover approximately 61% of the area of the proposed West Borehole seam panels within the Extension of Mining Area. The Awaba Colliery mine geometry includes large areas of small standing pillars formed by splitting and quartering larger pillars, areas of extracted coal that caved or subsided at the time of mining (including as a result of pillar creep events), and areas where the overlying Teralba conglomerate is thought to be bridging across extracted panels between larger pillars so that surface subsidence and caving is limited to low levels.

The mining height at Awaba Colliery varies between 2.5 m and 3.2 m. The mining height below the edge of the Eraring Ash Dam is likely to be approximately 3 m. Roadways are likely to have been mined at between 5.5 m and 6.5 m wide. The elevation of the Great Northern seam in the area of overlap with the ash dam ranges from approximately RL 0 mAHD to RL 8 mAHD.

Overburden depth ranges from 10 m to 100 m, primarily as a result of the topography, and is typically in the range of 20 m to 30 m around the perimeter and 30 m to 50 m elsewhere except below localised topographic high points. The separation between the Great Northern seam and West Borehole seam varies from approximately 100 m in the northwest to 215 m along the south-eastern edge of the Awaba Colliery workings at the western edge of the Eraring Ash Dam.

Pre-existing interactions between Awaba Colliery and Eraring Ash Dam

Standing pillars and fully extracted panels in the former Awaba Colliery workings are located directly below the western edge of Eraring Ash Dam at depths of 20-30 m. These workings are completing flooded.

Along the edge of areas of pillar extraction, failure of the overburden strata through to the surface is inevitable at shallow depths. During full extraction, downward movement of up to 3m occurs in the immediate roof of the extracted void when the coal is extracted. With bulking of the falling overburden material, the ground displacements reduce gradually with height above the mining horizon. At shallow depths of less than 30m, there are likely to be large open voids that provide a direct pathway for water flow between the surface and underground. This type of failure is typically expressed on the surface as a sinkhole or as a step change on the surface, depending on the near surface soil composition. Both are evident along the edge of the existing Eraring Ash Dam and are expected to provide a direct flow path between the ash dam and the Awaba Colliery workings.

The water level in the flooded Awaba Colliery workings ranges from RL 16-19 mAHD. It is controlled by pumping from boreholes and artesian overflow into a watercourse (Jigadee Creek, a tributary of Dora Creek within the Lake Macquarie catchment) in the south-west. The water level in the Awaba Colliery responds to rainfall events. The overflow point is located where the 16 m surface contour overlaps with the Awaba Colliery workings.

Pumping from a borehole located above the ‘10 South Panel’ in the Awaba Colliery workings (known as the ‘10 South Bore’) is likely to be intercepting most of the water originating from the ash dam at present. Eventual cessation of pumping is expected to open a pathway for surface run-off and groundwater to flow from the ash dam into local watercourses.

A positive hydraulic gradient exists between the ash dam and the underground workings of Awaba Colliery. The artesian overflow at RL16 mAHD ensures that this gradient will continue to exist. With rainfall recharge reporting to the surface of the ash dam at RL 25-38 mAHD and the surface more generally at RL 40-120 mAHD, there is an ongoing flow path from the ash dam to the artesian overflow point as well as from the surface directly above Awaba Colliery.

An average flow rate into the Awaba Colliery workings of 3.6 ML/day was estimated by considering the surface area of the mine, the proportion of the mine where caving as occurred, the annual rainfall rate and an estimate of the proportion of rainfall that typically infiltrates the overburden strata above extracted coal mines.

The cumulative outflow rates from pumping from the Great Northern seam and measured overflow into Jigadee Creek are equivalent to 2.7ML/day of average outflow, which is consistent with the expected inflow from the surface assuming caving has occurred over 75% of the mine area.

Interactions between Awaba Colliery and Eraring Ash Dam following completion of the ash dam augmentation project

Origin Energy's ash dam augmentation project increases the footprint of ash dam interaction with Awaba Colliery by approximately five times. Origin Energy is planning to fill the mine voids in Awaba Colliery with cement stabilised fly ash to:

- Eliminate the potential for pillar collapse below the earth embankment including in the area where this embankment is to be extended and increased in height.
- Reduce the flow of leachate from the ash dam into Awaba Colliery to a low level.

Origin Energy are yet to finalise their proposed void filling methodology or confirm the area within which it will be undertaken. Filling in the vicinity of the Western Saddle Embankment is expected to be effective as a control to prevent the collapse of split and quartered pillars and as a control to prevent sinkhole formation.

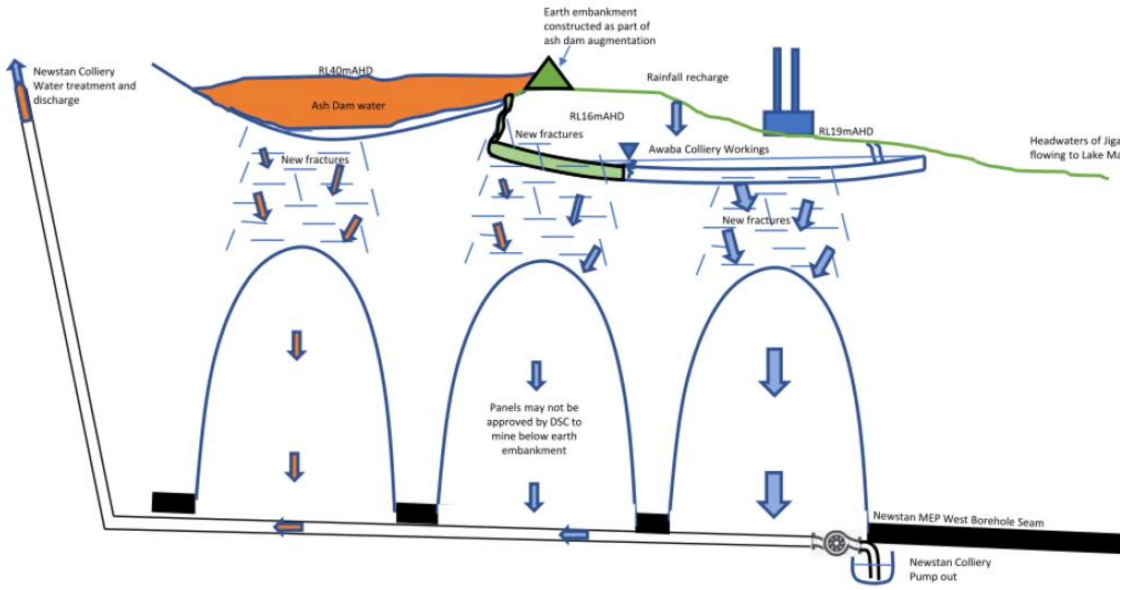
The proposed void filling by Origin Energy has potential to reduce the hydraulic conductivity of the strata between the surface and the Awaba Colliery workings and within the workings themselves so that although the hydraulic gradient will remain, the flow rate could be reduced to a tolerably low level. The reduction in hydraulic conductivity able to be achieved is likely to be sensitive to the effectiveness of the void filling strategy.

The minimum inflow from the ash dam to the Awaba Colliery workings achievable following the void filling is likely to be in the range of 0.001-0.1 ML/day. If the void filling is completely ineffective, is has been estimated that the flow would be effectively unrestricted, limited only by the availability of ash contaminated water. These inflow estimates confirm that the effectiveness of the void filling will be critical as a control on the rate of flow of ash contaminated water from the ash dam into the Awaba Colliery workings.

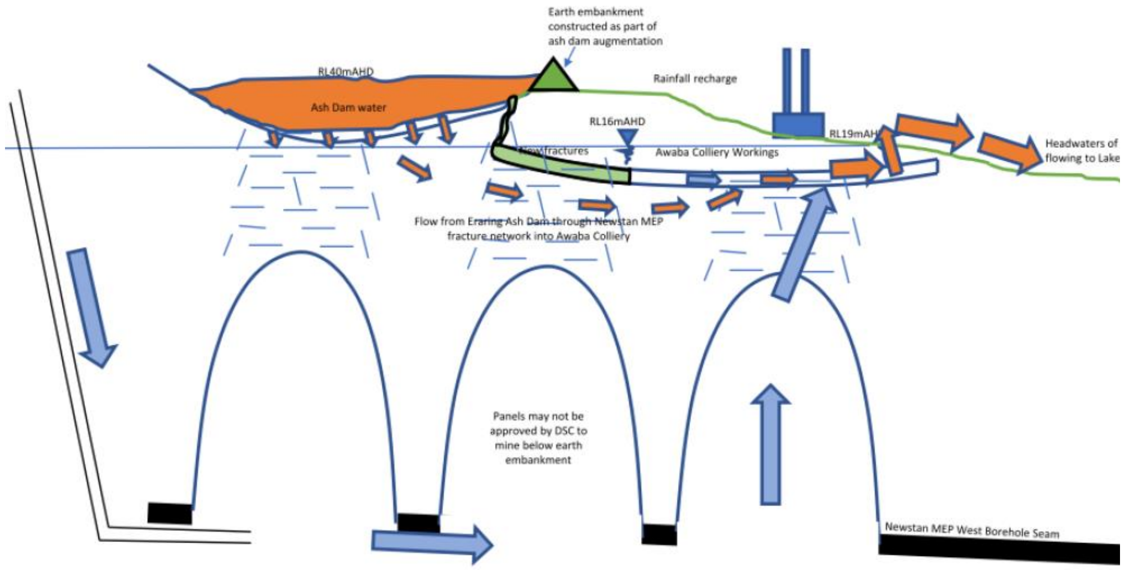
6.2.4 Impact assessment

Interactions relating to the proposed mining in the West Borehole seam

Project-related impacts to groundwater flow paths between Eraring Ash Dam, Awaba Colliery, Newstan Colliery and the receiving environment are illustrated conceptually (as per SCT, 2019) in Figure 6-4 and described in further detail in below.



During active mining in West Borehole seam: Flow gradients are maintly towards the West Borehole seam so outflow via the artesian overflow to the south of Awaba Colliery may reduce to low levels except in times of heavy rain



Following cessation of West Borehole seam mining and mine is flooded to RL 16 mAHD: Flow gradients are now towards the outflows from the artesian overflow to the south of Awaba Colliery, with all Newstan Colliery inflows also contributing to flow

Figure 6-4 Conceptualisation of flow paths between Eraring Ash Dam, Awaba Colliery, Newstan Colliery and nearby watercourses

According to SCT Operations Pty Ltd (2019), secondary extraction within the West Borehole seam in areas underlying Origin Energy's proposed void filling works may increase the pathways for flow from the unlined ash dam into the former Awaba Colliery workings by:

- Causing ground movements that may crack void filling materials (i.e. cement stabilised ash grouting) emplaced by Origin Energy.
- Creating an alternative flow path for ash contaminated water through the fractured ground above the proposed West Borehole seam workings that interact with the ash dam and the former Awaba Colliery workings.

Cracks in void fill material are likely if the proposed West Borehole seam workings are subject to full extraction below the areas where the voids are filled. The significance or otherwise of these mining induced subsidence cracks would depend on the effectiveness of the void filling conducted by Origin Energy. If Origin Energy can fill 100% of the voids, flows could theoretically be reduced to 0.001-0.1 ML/day. Additional cracks from the proposed West Borehole seam mining subsidence would likely provide a further pathway for flow from the surface into the former Awaba Colliery workings, but the flow rate would depend on the extent and effectiveness of filling the mining voids within the former Awaba Colliery workings.

If the voids are less than completely filled, significant flow pathways are likely to remain following filling. In this case, additional cracks from mining induced subsidence may not significantly change the direct flow path between the ash dam and the workings.

The impacts of the proposed mining within the West Borehole seam on the ash dam can be divided into short-term and long-term impacts.

In the short-term, during the period of active mining in the West Borehole seam, hydraulic gradients including those from the Awaba Colliery are likely to be in a direction that flows toward the West Borehole seam and away from the artesian overflow point in the south-west of Awaba Colliery. The pathway for rainfall runoff to flow from the ash dam into underground workings is likely to be predominantly via the West Borehole seam and the dewatering system for that section of the mine.

During the period of active mining, water pumped out of the West Borehole seam, including any runoff from the ash dam, will be able to be suitably treated at the existing Water Treatment Plant at Newstan Colliery Surface Site prior to discharge to ensure current water quality criteria can be me. Flow of potentially contaminated runoff water from the ash dam into the West Borehole seam panels is expected to be in the range of 0.03-3 ML/day. These flow rates are not significant in terms of flow volume from a mining perspective and indeed may be barely perceptible in the normal sequence of mining but they are potentially significant in the context of environmental flows.

Once the proposed workings in the West Borehole seam are mined, most of the water currently stored in the Awaba Colliery workings and runoff that finds its way into these workings following rainfall events would be expected to also flow into the West Borehole seam panels and would then need to be pumped out from there. Flow from the artesian overflow point is likely to be reduced during the period of active mining in the West Borehole seam but may be restored during periods of high rainfall.

In the long-term, following the completion of the proposed mining, and there is no pump out flow from the West Borehole seam, these workings would fill with water to the level of the lowest overflow point. The hydraulic gradient to the West Borehole seam workings reduces as the water level in the workings rises. Inflow rates from the ash dam into the West Borehole seam are expected to be in the range 0.006-0.6 ML/day when the workings are fully flooded.

SCT Operations Pty Ltd (2019) suggest that once the West Borehole seam workings are fully flooded, a pathway for flow would develop from the ash dam through fractured rock above those panels located under the ash dam and also under Awaba Colliery, through Awaba Colliery workings and out into surrounding watercourses. This flow path would not necessarily involve the workings in the West Borehole seam, only the fracture network above these workings. The estimated flow would be expected to continue at a rate in the range 0.006-0.6 ML/day under the action of the ongoing hydraulic head that exists between the surface and the lowest overflow point at Awaba Colliery or Newstan Colliery, whichever is lowest.

The overflow point at Newstan Colliery (i.e. discharge from the Fassifern underground storage at LDP017) is lower than the artesian overflow to the south of Awaba Colliery. The existing inflows to Awaba Colliery that flow out as artesian overflow would tend to be reduced by any long-term flows that occur into Newstan Colliery through the fracture network below Awaba Colliery.

The potential impacts described above (as per SCT, 2019) are based on a scenario where secondary extraction occurs in areas underlying Origin Energy's proposed void filling works. Under this scenario, the integrity of the fill as an effective seepage barrier may be compromised due to subsidence. Impacts to the fill may be avoided if only first workings were undertaken within these areas. As indicated above in Table 6-4, the maximum predicted vertical subsidence for first workings within the Extension of Mining Area, including those underlying the former Awaba Colliery workings, is less than 20 mm (MSEC, 2019b). This level of subsidence is considered unlikely to impact the integrity of Origin Energy's proposed void filling in the former Awaba Colliery workings or increase flow paths between the ash dam and former Awaba Colliery workings. As such, the short-term and long-term impacts on the ash dam identified by SCT Operations Pty Ltd (2019), and in particular potential impacts to the integrity of the void fill within the former Awaba Colliery workings, could be avoided if only first workings were undertaken in areas at risk of increasing flow pathways between the Eraring Ash Dam, and Awaba Colliery workings as a result of mining in the West Borehole seam.

Liquefaction and seismic activity risks

Filling of the mine voids below the earth embankment is likely to be a Dams Safety NSW pre-requisite for the augmentation project. This void filling is expected to obviate any potential for pillar instability. The small pillars formed in the '5 South Panel' of the former Awaba Workings in the overlap zone between Awaba Colliery and the ash dam are only lightly loaded and would not be expected to be destabilised by earthquake activity. These pillars were formed after the 1989 Newcastle earthquake.

The method of filling the Eraring Ash Dam has potential to generate a 'soil' mass that would be capable of liquefaction. Subsidence movements associated with the proposed mining in the West Borehole seam would be expected to occur slowly enough to dissipate excess pore pressures and prevent liquefaction.

The magnitudes of micro-seismic event generated ground movements caused by mining in the West Borehole seam are expected to be less than the magnitude of annual average background seismic events that occur naturally. Mining subsidence is therefore not expected to create a liquefaction hazard at the Eraring Ash Dam greater than the risk from naturally occurring seismic events.

6.2.5 Mitigation and management

As a result of the potential impacts identified above, Centennial Newstan has proposed changes to the mine design to manage the potential interactions from mining in the areas of the existing Eraring Ash Dam, and the proposed void filling areas within the Awaba Colliery workings and Western Saddle Embankment.

Origin Energy is yet to confirm the extent of void filling areas within the Awaba Colliery workings and finalise the detailed design of the Western Saddle Embankment. As such, flexibility in how changes to the mine design are implemented will be required. Notwithstanding, Centennial Newstan proposes the following measures to mitigate potential impacts:

- No secondary extraction (i.e. total or partial extraction) will be carried out within a 35 degree angle of draw of the Western Saddle Embankment. The area of any first workings within a 35 degree angle of draw of the Western Saddle Embankment will be determined following the completion of detailed designs by Origin Energy and subject to approval from Dams Safety NSW.
- To mitigate the impacts of secondary extraction and the associated fracture network impacting on the effectiveness of the void fill, no secondary extraction (i.e. total or partial extraction) will be carried out within a 26.5 degree angle of draw of any proposed void filling areas. The area of any first workings within a 26.5 degree angle of draw of any proposed void filling areas will be determined following the completion of detailed design by Origin Energy and subject to approval from Dams Safety NSW.
- A program of field measurements will be undertaken in consultation with Origin Energy during and after the void filling program to confirm the effectiveness of void filling as a barrier to flow from the ash dam into Awaba Colliery and provide a base line against which to assess further impacts from mining within the West Borehole seam.
- The height of depressurisation above an extracted panel will be monitored to confirm consistency with the estimates made by SCT Operations Pty Ltd (2019).
- Inflow rates will be monitored on a panel by panel basis during extraction of the initial panels within the West Borehole seam to better estimate the likely inflow rates below the ash dam.
- A Water Treatment Management Plan will be developed during detailed mine closure planning that accommodates potential interactions between Awaba Colliery, Newstan Colliery and the Eraring Ash Dam.
- A program of monitoring seismic energy released during subsidence will be undertaken to confirm that mine induced seismicity is less than natural background levels.

It is currently considered that the inflows of water from the Eraring Ash Dam can be adequately managed within the existing Newstan Colliery water management system. As such, Centennial Newstan propose secondary extraction beneath the existing Eraring Ash Dam, excluding the areas listed above (i.e. within a 35 degree angle of draw of the Western Saddle Embankment and within a 26.5 degree angle of draw of any proposed void filling areas). Notwithstanding, any mining beneath the existing Eraring Ash Dam will be subject to approval from the Dams Safety NSW and any secondary extraction will require an Extraction Plan approval.

6.3 Groundwater

A Groundwater Impact Assessment was prepared by GHD to assess the potential impacts of the project on the groundwater environment. The information presented in this section is summarised from the Groundwater Impact Assessment (GHD, 2020a), which is presented in full in Appendix J.

The scope of the Groundwater Impact Assessment was designed to address the SEARs (refer to Appendix A) with regard to the assessment of groundwater impacts and relevant MNES under the EPBC Act. This included assessment against the significant impact criteria set out in the *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments: Impacts on Water Resources* (DoE, 2013).

6.3.1 Background

The project has the potential to cause hydraulic connective fracturing, which can impact on groundwater resources through:

- Changes to groundwater inflows into the existing and proposed workings at Newstan Colliery in the West Borehole seam.
- Changes in groundwater level and resulting impacts on groundwater receptors.
- Changes in baseflow to waterways.
- Changes in groundwater quality and resulting impacts on groundwater receptors.
- Changes in groundwater inflow into the Awaba underground void and seepage from the Awaba underground void to underlying strata.
- Changes in seepage from Eraring Ash Dam to underlying strata.

To assess these potential impacts the Groundwater Impact Assessment included:

- A review of available background hydrogeological and mining data.
- Review of relevant statutory requirements and development of impact assessment criteria.
- Identification and description of groundwater sources within the Project Application Area.
- A search of the NSW Groundwater Bore Database to identify licensed groundwater users in the anticipated radius of groundwater drawdown.
- Identification of potential groundwater dependent ecosystems (GDEs) within the Extension of Mining Area.
- Development of a MODFLOW hydrogeological model to predict potential impacts on groundwater sources (quantity) as a result of the proposed underground workings.
- Identification of potential groundwater impacts resulting from the construction and operation of the Project, based on the NSW AIP minimal impact considerations.
- Assessment of potential impacts of the project on GDEs, licensed groundwater users and basic landholder rights.
- Identification of licensing requirements for the project.
- Development of measures to avoid, minimised and mitigate potential impacts of the project.

6.3.2 Methodology

Potential groundwater impacts from the project have been predicted by development and calibration of a numerical hydrogeological model. Impacts have been assessed in accordance with the criteria from the NSW AIP.

The numerical groundwater model has been used to make predictions for:

- Groundwater inflows into the existing and proposed workings at Newstan Colliery in the West Borehole seam.
- Change in the groundwater flow budget, including flux from the Awaba underground void to underlying strata and flux from the Eraring Ash Dam to underlying strata.
- Drawdown in groundwater sources.
- Changes in baseflow to waterways.

Development and calibration of the numerical hydrogeological model is outlined in the Groundwater Modelling Report (GHD, 2020b) which is included in Appendix J.

To predict potential impacts from proposed mining, the predictive model was run from the end of the calibration model in July 2019 to January 2635; 600 years after the end of mining. This was undertaken to allow assessment of impacts of proposed mining and assessment of post-mining recovery of groundwater levels.

To enable the assessment of impacts a number of models representing various baseline conditions were developed. To assess incremental impacts associated with proposed mining, a ‘no proposed mining’ scenario was developed. The ‘no proposed mining’ scenario does not simulate any proposed mining at Newstan Colliery within the Extension of Mining Area. The ‘no proposed mining’ scenario includes all existing mining at Newstan Colliery, Teralba, West Wallsend, Awaba and Cooranbong. In this scenario, existing Newstan Colliery workings are kept in ‘care and maintenance’ until the end of 2034 (end of mining). Incremental impacts were calculated as the difference in model results between the ‘proposed mining’ and ‘no proposed mining’ scenarios.

To assess cumulative impacts a ‘no regional mining’ model was developed, where all mining within the model boundary was not represented. Cumulative impacts were calculated as the difference between the predictive model and the ‘no regional mining’ model.

Uncertainty analysis for hydrogeological model predictions has been undertaken in accordance with the requirements *Information guidelines for proponents preparing coal seam gas and large coal mining development proposals* (IESC, 2018a) and the *Explanatory Note on Uncertainty Analysis in Groundwater Modelling* (IESC, 2018b). A copy of the uncertainty analysis is provided as part of the Groundwater Impact Assessment in Appendix J.

The NSW AIP requires that potential impacts on the groundwater sources, including their users and GDEs, be assessed against minimal impact considerations. If the predicted impacts are less than the minimal impact considerations, then these impacts will be considered as acceptable. The Level 1 minimal impact considerations have been adopted for the Groundwater Impact Assessment and are as follows:

- **Water table:** less than or equal to 10% cumulative variation in the water table, allowing for typical climatic ‘post-water sharing plan’ variations, 40 m from any high priority GDE or high priority culturally significant site listed in the schedule of the relevant WSP. A maximum of a 2 m decline cumulatively at any water supply work unless make good provisions should apply.

- **Water pressure:** a cumulative pressure head decline of not more than 40% of the 'post water sharing plan' pressure head above the base of the water source to a maximum of a 2 m decline at any water supply work.
- **Water quality:** any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. For alluvial water sources, there should be no increase of more than 1% per activity in the long-term average salinity in a highly connected surface water source at the nearest point to the activity.

6.3.3 Existing environment

Groundwater sources

The groundwater sources in the vicinity of the Project Application Area are generally low yielding and predominantly within the Quaternary alluvium, weathered and/or fractured sandstone and coal seams. They would be classified as 'less productive', in accordance with the NSW AIP, as yields are generally less than 5L/s and/or the total dissolved solids concentration is typically greater than 1500 mg/L.

Alluvial water sources

The alluvium throughout the Project Application Area forms an unconfined shallow aquifer with groundwater ranging in depth from less than 1 m to about 5 m below ground level (bgl), and aquifer thickness generally less than 16 m. The groundwater flow direction within the alluvium generally reflects the topography. Due to the clay content of the alluvium, yields and beneficial use of this groundwater are generally low. The alluvial groundwater is generally fresh to brackish and slightly acidic. Alluvial groundwater likely provides baseflow to the ephemeral creeks overlaying the Extension of Mining Area.

The alluvial water sources within the Project Application Area are covered under the WSP for the Hunter Unregulated and Alluvial Water Sources. This WSP commenced in August 2009 and regulates the interception and extraction of surface water and alluvium within the defined water sharing plan area.

Porous and fractured rock water sources

The porous and fractured rock water sources within the Project Application Area are covered under the WSP for the North Coast Fractured and Porous Rock Groundwater Sources. This WSP commenced in July 2016 and regulates the interception and extraction of groundwater in the fractured and porous rock aquifer within the defined water sharing plan area.

The piezometric head within the Permian coal seams tend to reflect the natural topography and proximity to Lake Macquarie, with reduced pressures at major surface drainage areas and in areas of coal extraction. Where coal seam groundwater has not been depressurised, the groundwater head tends to be in the order of 0-20 m AHD due to the coastal environment. Recharge of coal seams occurs in areas of seam subcrop and groundwater flow is generally to the east towards Lake Macquarie.

Permeability testing undertaken as part of the Newstan Colliery exploration program indicates that the hydraulic conductivities of the Young Wallsend seam and overlying seams are generally in the order of 10^{-8} to 10^{-7} m/s.

The existing workings within the West Borehole seam currently receive groundwater inflow in the order of 1 ML/day. Approximately 0.25 ML/day of this inflow occurs in Longwalls 22-25, underlying the Awaba underground void.

Groundwater inflow into the existing West Borehole seam workings is brackish and slightly alkaline, and sodium bicarbonate-chloride dominant. In comparison, water within the Awaba underground void is more magnesium sulfate dominant. This suggests that the groundwater inflow into the Longwall 22-25 area is from the adjacent porous and fractured rock groundwater source rather than via a continuous conduit, such as a continuous fracture or fault, from the Awaba underground void.

The overburden and interseam strata within the Newcastle Coalfield tend to have very low hydraulic conductivities (in the order of 10^{-11} to 10^{-9} m/s), unless joints or fracturing creates a secondary permeability.

Groundwater use

The search of groundwater bore database (operated by WaterNSW) identified 69 registered bores within approximately 2 km of the Project Application Area. A wider search identified 286 registered bores within the zone of groundwater drawdown within the West Borehole seam attributable to mining within the Extension of Mining Area. Of the registered bores within 2 km of the Project Application Area, the majority (50 bores) were registered as monitoring bores or test bores. One bore was registered for exploration, one bore was registered for dewatering or mining purposes and the remainder (17 bores) were registered for a combination of stock, domestic, irrigation and farming purposes. From the wider search, 122 of the 286 bores were registered as monitoring or exploration bores.

The majority of stock, domestic, irrigation and farming bores are less than 50 m in depth and extract groundwater from the Triassic Narrabeen Sandstone and the Permian Coal Measures and interburden.

Registered bore locations and details are provided Appendix J.

Groundwater dependent ecosystems

Plant Community Types (PCTs) that have a moderate or greater potential to be a Groundwater Dependent Ecosystem (GDE) were identified by RPS (2020a) based on a search of the GDE Atlas (BoM, 2019). The following PCTs were identified within the study area as having a moderate or greater potential to be a GDE:

- PCT 1588 Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast.
- PCT 1598 Forest Red Gum grassy open forest on floodplains of the lower Hunter.
- PCT 1619 Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
- PCT 1627 Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast.
- PCT 1636 Scribbly Gum - Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast.
- PCT 1638 Smooth-barked Apple – Red Bloodwood – Scribbly Gum grass – shrub woodland on lowlands of the Central Coast.
- PCT 1716 Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast.
- PCT 1718 Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast.
- PCT 1737 Typha rushland.

Lake Macquarie, Muddy Lake and Whiteheads Lagoon are mapped as potential aquatic GDEs.

There are no GDEs within the Project Application Area that are listed in Schedule 4 of the WSPs.

Groundwater levels and quality

A groundwater monitoring network has been progressively established at Newstan Colliery since 2005 and consists of monitoring bores installed in alluvial and coal seam strata. Full details of groundwater monitoring bores are provided in Appendix J.

Review of alluvial groundwater levels indicates that there is response to below and above average rainfall at a majority of the alluvial monitoring bores. Alluvial groundwater levels typically vary by 1 to 2 m.

Any statistically significant decreasing trends in groundwater level (independent of rainfall) were not found to be associated with mining since they did not correlate with the schedule of development and extraction of the adjacent mine workings.

Alluvial groundwater quality is generally slightly acidic. Within Lords Creek, alluvial groundwater quality varies from fresh to brackish. Monitoring data indicates that alluvial groundwater in Kilaben Creek, Stockyard Creek and Stony Creek is slightly brackish.

Comparison of the major ion chemistry of alluvial groundwater and surface water at some locations in the vicinity of the Extension of Mining Area indicates surface water / groundwater connectivity. Surface waters and alluvial groundwater are generally sodium chloride dominant. In particular there is strong similarity between surface water and alluvial groundwater at sites along Kilaben Creek at the south-eastern boundary of the Project Application Area.

Review of groundwater levels in the Permian Coal Measures at Newstan Colliery indicates that groundwater levels fluctuate with below and above average rainfall. Groundwater levels at monitoring bores in proximity to the coal seam outcrop may have a stronger influence from rainfall recharge.

Groundwater levels elsewhere in the Permian Coal Measures are relatively constant with levels generally varying by less than 2 m. Levels within the Fassifern underground storage are influenced by inputs and outputs of water from the Fassifern underground storage.

Groundwater drawdown has been observed at two locations overlying and within 500 m of the existing West Borehole seam workings, respectively. Drawdown occurred within six months of commencement of adjacent longwall mining to the south. With the exception of these two locations, there is no evidence of groundwater drawdown attributable to mining at Newstan Colliery at monitoring bores installed in the Permian Coal Measures. However, bores installed in the Great Northern seam are depressurised due to historical mining at Cooranbong.

Groundwater quality within the Permian Coal Measures is generally slightly brackish and varies from very slightly acidic to very slightly basic.

Underground water management

Newstan Colliery

The underground water management features at Newstan Colliery are the Fassifern underground storage and the underground workings in the West Borehole seam. The Fassifern underground storage is the void formed by previous mining activity in the Fassifern and Great Northern seams at Newstan Colliery and is used to manage water between Newstan Colliery and the Newstan Colliery Surface Site.

The Fassifern underground storage receives inflows as a result of infiltration from the surface catchment, groundwater inflows into active mining areas and injection transfers from the Newstan Colliery Surface Site. Water levels within the storage are managed by extraction transfers to the Clean Water Plant, which commenced operation at the Newstan Colliery Surface Site in late 2013.

Transfers from the West Borehole seam to the Fassifern underground storage are typically 1 to 2 ML/day, varying with day to day operations. Given the limited water storage capacity in the West Borehole seam, the average transfer rate is representative of the groundwater inflows into the West Borehole seam workings. The low inflow suggests low permeability overburden and minimal influence of geological structures on inflows.

Recent monitoring indicates approximately 0.25 ML/day of groundwater inflow to the West Borehole seam workings occurs in Longwalls 22-25, underlying the Awaba underground void. Based on the average interburden thickness between Longwalls 22-25 and the Awaba void of 110 m (MSEC, 2019b) a bulk hydraulic conductivity of approximately 0.0002 m/day would produce an inflow of 0.25 ML/day. Such a low hydraulic conductivity value suggests that the height of groundwater depressurisation above Longwalls 22-25 is likely to be much less than estimates from typical empirical methods such as Tammetta (2013). It also suggests that geological structures would be having minimal influence on groundwater inflow.

Groundwater inflow into the existing West Borehole seam is brackish and slightly alkaline, and sodium bicarbonate-chloride dominant. In comparison, water within the Awaba underground void is more magnesium sulfate dominant. This suggests that the groundwater inflow into the Longwall 22-25 area is from the adjacent porous and fractured rock groundwater source rather than via a continuous conduit, such as a continuous fracture or fault, from the Awaba underground void.

Water levels in the Fassifern underground storage have typically been maintained at around between 0 and -5 m AHD since 2017.

Awaba Colliery

The key underground water management feature of Awaba Colliery is the Awaba underground void, which was formed by previous mining activity in the Great Northern seam at Awaba Colliery. Following the cessation of mining in 2012, water levels in the Awaba underground void recharged due to a combination of inflows of surrounding groundwater and infiltration from the surface.

As water levels in the Awaba underground void equilibrated with the surrounding groundwater, infiltration of water from the surface became the dominant inflow and water from the void began to seep out via a series of natural faults at the south end of the void into an unnamed tributary of Muddy Lake. This area is known as the Awaba seepage. The observed flow is typically 1 ML/day to 2 ML/day and has been declining with water levels under the below average rainfall conditions in 2018 and 2019.

Seepage from the Awaba underground void has also been observed at the Eraring Power Station. Water levels in the underground void are currently managed by pumping water via the 10 South bore and boreholes at Eraring Power Station for the purpose of maintaining the water level below about 17 m AHD within the workings.

Newstan Colliery interaction with Awaba underground void and Eraring Ash Dam

The existing Newstan Colliery workings have undermined sections of the Awaba underground void, including existing longwall mining panels and first workings.

Existing West Borehole seam longwall panels that undermine the Awaba underground void include Longwalls 22-25. Approximately 0.25 ML/day of groundwater inflow to the West Borehole seam workings occurs in Longwalls 22-25. This volume of groundwater inflow likely includes groundwater inflow from the surrounding West Borehole seam. Therefore this volume of groundwater inflow does not indicate a direct connection between the Awaba underground void and the West Borehole seam workings. This is in contrast to the conceptualisation by SCT Operations Pty Ltd (2019), as described in Section 6.2.

SCT Operations Pty Ltd (2019) was commissioned by Centennial Newstan to review the proposed mine design in the Extension of Mining Area in the context of potential interactions with fly ash emplaced in the Eraring Ash Dam. SCT Operations Pty Ltd (2019) concluded that full extraction within the Extension of Mining Area will provide an enhanced flow pathway into Newstan Colliery from the Eraring Ash Dam and from the Awaba underground void. SCT Operations Pty Ltd (2019) estimated flows from the Eraring Ash Dam to the West Borehole seam workings to be in the order of 0.03 to 3 ML/day. These calculations were based on an empirical equation of the height of depressurisation (Tammetta (2013)), based on data from other sites. GHD (2020a) considers that this conceptualisation is highly conservative and not supported by groundwater monitoring data for Newstan Colliery and Mandalong Mine, as outlined in more detail below.

The SCT Operations Pty Ltd (2019) conceptualisation and flow estimates are based on a average and maximum heights of depressurisation, or continuous fracturing, of 180 m and 220 m respectively (calculated from Tammetta (2013)) and hydraulic conductivity of fractured strata above the height of continuous fracturing of 10^{-5} to 10^{-7} m/s. These hydraulic conductivity values were based on the hydraulic conductivity of overburden strata, maximum subsidence and overburden depth relationship from Gale (2010). At a height of 180 m above the mined seam and subsidence of 1 m (which is the subsidence predicted by MSEC (2019b) resulting from extraction of the panels under Eraring Ash Dam), the Gale (2010) plot indicates a hydraulic conductivity value of less than 10^{-7} m/s. This is more consistent with observed inflows into existing Longwalls 22-25.

Observed groundwater inflows into Longwalls 22-25 at Newstan Colliery (0.25 ML/day) are lower than would be expected if the actual height of depressurisation was in accordance with the Tammetta (2013) empirical equation (i.e. approximately 250 m). With an average interburden thickness between Longwalls 22-25 and the Awaba underground void of 110 m (range 90 m to 140 m), it would be expected that there would be complete drainage of the interburden and direct flow from the Awaba underground void into the Longwall 22-25 goaf. Since this is not the case, it is considered overly conservative and unreliable to apply the Tammetta (2013) height of depressurisation above the proposed panels as proposed by SCT Operations Pty Ltd (2019).

The thickness of interburden between the Longwall 22-25 and the Awaba void is approximately 90 m to 140 m. The elevation of the West Borehole seam dips to the south east from Longwalls 22-25 towards the proposed workings and Eraring Ash Dam and the depth of cover between the West Borehole seam and the surface increases. In the vicinity of the Eraring Ash Dam the depth of cover above the West Borehole Seam ranges from approximately 240 m to 295 m.

The proposed panels in the Extension of Mining Area have a lower void width (167 m) compared to Longwalls 22-25 (230 m), there is a greater interburden thickness between the proposed panels and Awaba underground void (average of 170 m) and the panels will only recover up to 85 % of available coal compared to 100 % for longwalls (MSEC, 2019b), thus reducing the equivalent mining height. These aspects of the mine design further reduce the likelihood of the SCT Operations Pty Ltd (2019) conceptualisation.

The major ion chemistry of groundwater inflow into the existing Newstan Colliery workings has been compared to that for the Awaba underground void. Groundwater inflow into the existing West Borehole seam workings at Newstan Colliery (sampled at location ‘cut through 19’) is brackish and slightly alkaline, and sodium bicarbonate-chloride dominant. In comparison, water within the Awaba underground void is more magnesium sulfate dominant (sampled at location 13 West 2). This suggests that the groundwater inflow into the Longwall 22-25 area is from the adjacent porous and fractured rock groundwater source rather than directly from the Awaba underground void, which would be the case under the SCT Operations Pty Ltd (2019) conceptualisation.

Finally, observed groundwater inflows into the Mandalong Mine longwall mining area (less than 1 ML/day) are low considering the current mine footprint (25 longwall panels have been extracted since 2005). This reflects the low hydraulic conductivity of the fractured overburden, particularly the Munmorah Conglomerate, and provides further evidence that groundwater inflow into mine workings tends to be low throughout the Newcastle Coalfield and less than what would be predicted using the common empirical methods (such as Tammetta (2013)) for calculating the height of continuous fracturing.

The height of depressurisation was simulated in the numerical groundwater model (GHD, 2020b) using the stacked drain approach. The height of stacked drains above the West Borehole seam was based on model calibration to groundwater inflows reported into the existing Newstan Colliery workings. This height was found to be approximately 140 m, which is at the lower end of the range calculated using Tammetta (2013) for the lowest mining height in the Extension of Mining Area.

As part of the uncertainty analysis, the SCT Operations Pty Ltd (2019) conceptualisation for height of continuous fracturing has been simulated using a stacked drain height of 220 m above all full and partial extraction areas. Results of the uncertainty analysis are provided in full in Appendix J and indicate the following for the SCT Operations Pty Ltd (2019) conceptualisation for height of continuous fracturing:

- Groundwater inflow rates into the West Borehole seam workings are modelled to peak at 6.1 ML/day in 2033.
- There is negligible change in net leakage out of the Eraring Ash Dam for the proposed and increased fracture height scenarios. Therefore, modelling results indicate proposed mining at Newstan Colliery will have no impact on leakage out of the Eraring Ash Dam.
- Fracturing up to the Awaba underground void would result in an increase in groundwater flows out of the Awaba underground void. This groundwater flow from the Awaba underground void would report to the West Borehole seam workings. The increased leakage from the Awaba underground void, although unlikely to occur, would likely results in a drop in the water level in the Awaba underground void and a potential reduction in the flow rate at the Awaba seepage.
- Fracturing up to the Awaba underground void will have no impact on the Fassifern underground storage.

These results, however, have not been assessed in the Groundwater Impact Assessment since they are considered very unlikely to occur.

6.3.4 Existing water management system

Basis of water management

Water management at the Newstan and Awaba Collieries is generally comprised of:

- Clean water management, which involves the separation of clean water runoff to maintain, as far as practicable, pre-development flows within downstream drainage systems. Clean water management also aims to minimise the volume of water being managed on-site within the dirty water management system.
- Dirty water management, which involves the management of sediment-laden surface water runoff from within operational areas. Dirty water management typically includes the operation of coarse reject sumps, dirty water dams (sediment dams), open channels and pit and pipe networks.
- Underground water management, which involves:
  - Dewatering of active underground workings to provide a safe working environment for underground mine workers.
  - Treatment of pumped groundwater as necessary to minimise pollutants entering the downstream environment via discharged water. Water treatment facilities are located at the Newstan Colliery Surface Site.
  - Storage of pumped groundwater for operational reuse.
- Discharges to the environment, which are subject to the quantity and quality limits specified within EPLs issued under the POEO Act.

The key features of the existing water management systems at the Newstan and Awaba Collieries are described in further detail the following subsections.

Newstan Colliery water management

The key water management features of Newstan Colliery are the Fassifern underground storage and the underground workings in the West Borehole seam (see Figure 6-5). The Fassifern underground storage is the void formed by previous mining activity in the Fassifern and Great Northern seams at Newstan Colliery. It is used to manage water between the Newstan Colliery underground workings and the Newstan Colliery Surface Site.

The workings in the West Borehole seam are maintained in a dewatered state by pumping.

The West Borehole seam workings intercept groundwater and mining operations can be supplied with water from the Newstan Colliery Surface Site. Water is collected in sumps and pumped to the Fassifern underground storage.

The Fassifern underground storage receives inflows from the surface catchment infiltration, inflows from aquifers, and transfers from Newstan Colliery Surface Site. Water levels in the Storage are managed by transferring water to Newstan Colliery Surface Site. During wet periods when water within the Fassifern underground storage rises above 16.6 m below ground level (6.4 m AHD), the storage discharges water by gravity through two 600 mm diameter pipes into Stony Creek via a licenced discharge point called ‘Newstan LDP017’ (operated as part of the Northern Coal Logistics Project (SSD-5145)).

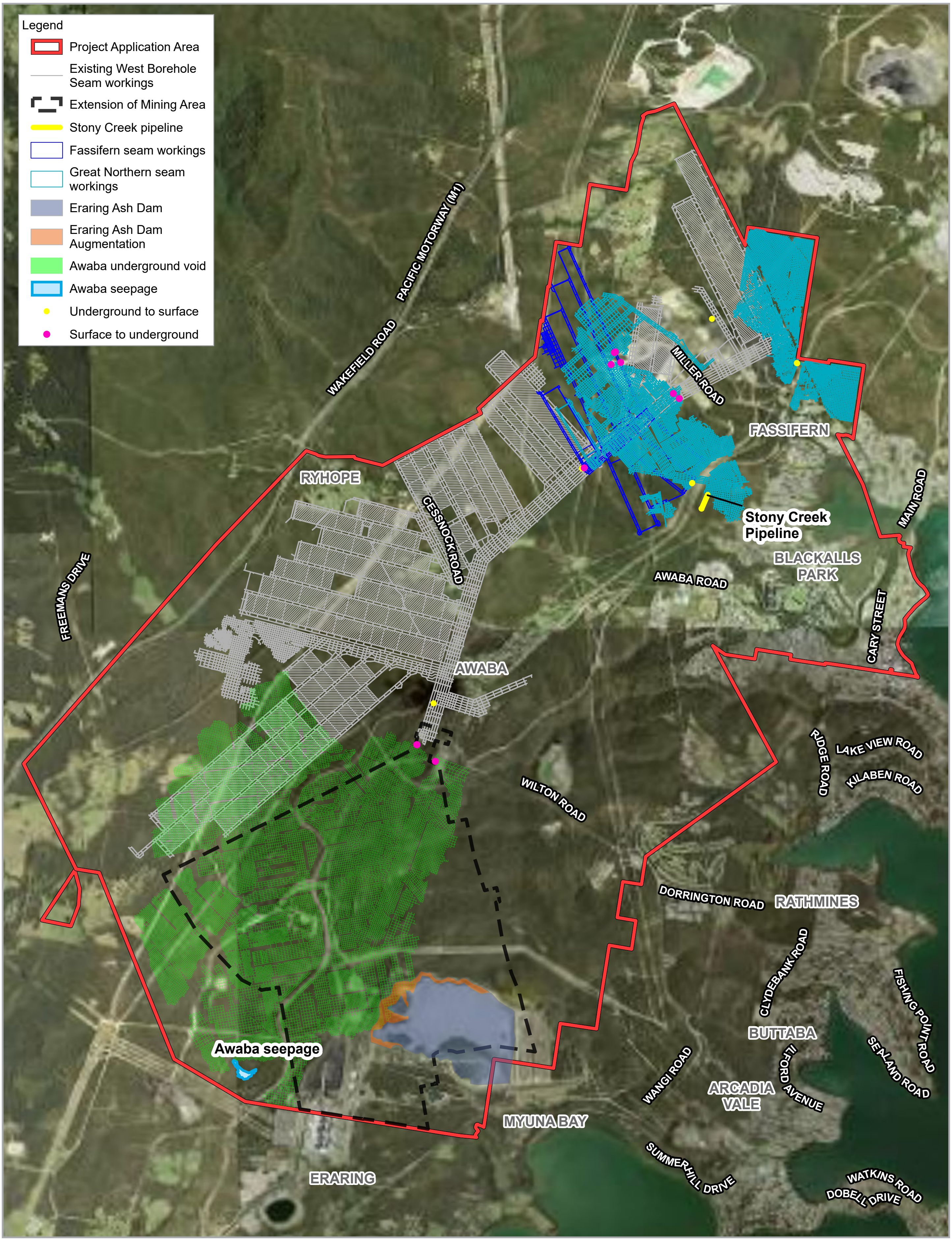
A water monitoring station at Newstan LDP017 was commissioned in 2013 to monitor emergency discharges required for the safety of personnel in the underground workings at Newstan Colliery. The water monitoring station allows for the continuous monitoring of discharge water quality.

Clean and dirty surface water at Newstan Colliery Surface Site is managed by Northern Coal Services as part of the Northern Coal Logistics Project (SSD-5145). Clean water is diverted around Newstan Colliery Surface Site by a series of clean water diversions, while dirty water is captured and managed in a number of water storages to minimise the potential of dirty water discharges to the surrounding environment. Northern Coal Services also manages potable water and waste water for the workforce at Newstan Colliery Surface Site as part of the Northern Coal Logistics Project.

Dirty water is transferred from various surface water storages at Newstan Colliery Surface Site to the Fassifern underground storage for temporary storage and management. Newstan Colliery Surface Site can also provide water to Newstan Colliery for underground mining operations.

Water levels in the Fassifern underground storage are managed by transferring water to the Clean Water Plant, which commenced operation at the Newstan Colliery Surface Site in late 2013 as part of the Northern Coal Logistics Project (SSD-5145). The Clean Water Plant employs coagulation, flocculation, sedimentation, filtration and ultra-violet treatment to reduce the concentrations of total suspended solids and metals in the untreated water. Water treated by the Clean Water Plant is either used to supply mining processes and the Coal Preparation Plant (CPP), or is discharged through licensed discharge point Newstan LDP001. In emergency situations (following prolonged heavy rainfall) water levels in the Fassifern underground storage may rise and discharge through LDP017.

The water management system at Newstan Colliery Surface Site is shown in Figure 6-6.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Existing underground water management

Project No. 22-20261
Revision No. 0
Date 09/06/2020

Figure 6-5

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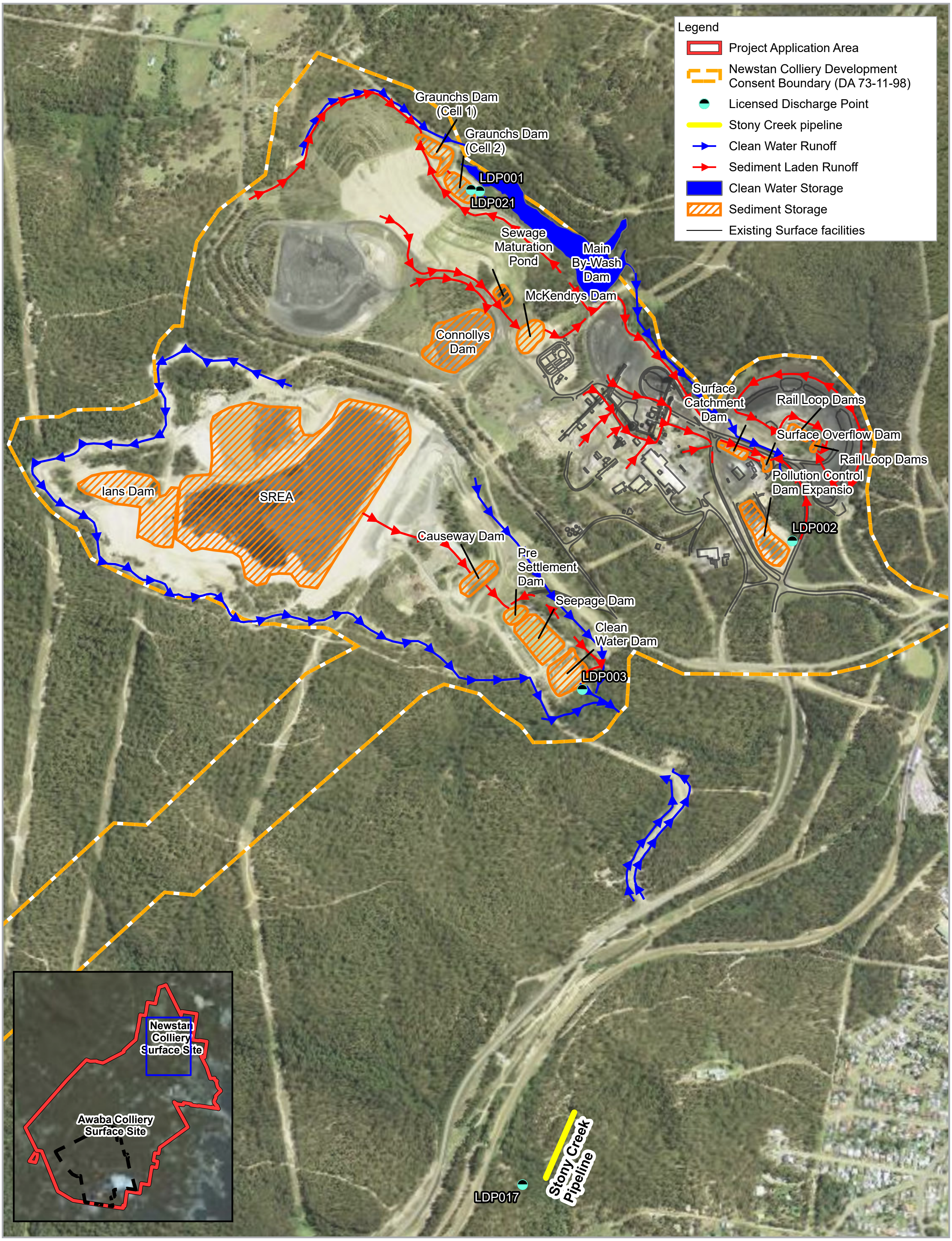
Print date: 09 Jun 2020 - 04:18

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Water management features
Newstan Colliery Surface Site

Project No. **22-20237**
Revision No. **0**
Date **09/06/2020**

Figure 6-6

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Print date: 09 Jun 2020 - 04:18

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

Awaba Colliery water management

The key water management features of Awaba Colliery are the Awaba underground void and the Pollution Control Dam at the Awaba Colliery Surface Site.

The Awaba underground void is the void formed by previous mining activity in the Great Northern seam at Awaba Colliery. Water levels in the Awaba underground void recharged following the cessation of mining.

Water management at Awaba Colliery Surface Site

The Awaba Colliery Surface Site is located within the Stony Creek catchment, which contributes to Lake Macquarie. Awaba Colliery's EPL (No. 443) includes both volumetric and concentration limits for the discharge of water off site from a licenced discharge point called 'LDP009'. The objectives of the water management system are primarily related to the separation of clean and dirty water. Diversion of clean water runoff around the pit top to avoid contamination reduces the volume of water reporting to the dirty water management system.

The management of clean water includes the diversion of external catchment runoff as well as management of clean surfaces within the pit top. Roof runoff from the administration, bathhouse and workshop buildings is collected through downpipes and directed to the underground piped stormwater network. This network discharges directly into Stony Creek.

External catchment clean water is managed through a series of diversion drains that intersect the runoff (to the north of the pit top area) before it enters disturbed areas. These diverted flows are either directed around the pit top area or conveyed within a piped network beneath the pit top prior to discharge into Stony Creek. These measures reduce the volume of water contributing to the dirty water system.

Runoff from the carpark and all hardstand areas at Awaba Colliery Surface Site is classified as dirty water. This water is directed to the Pollution Control Dam, which is the final structure for the management of dirty water prior to discharge from LDP009 to Stony Creek. Following cessation of mining at Awaba Colliery, an automated system was established to pump water from the Pollution Control Dam to the Awaba underground void to reduce the management requirement for discharges through LDP009.

Due to the limited numbers of personnel utilising the Awaba Colliery Surface Site, there is currently negligible use of the potable and wastewater systems at the site.

The water management system at the Awaba Colliery Surface Site is shown in Figure 6-7.

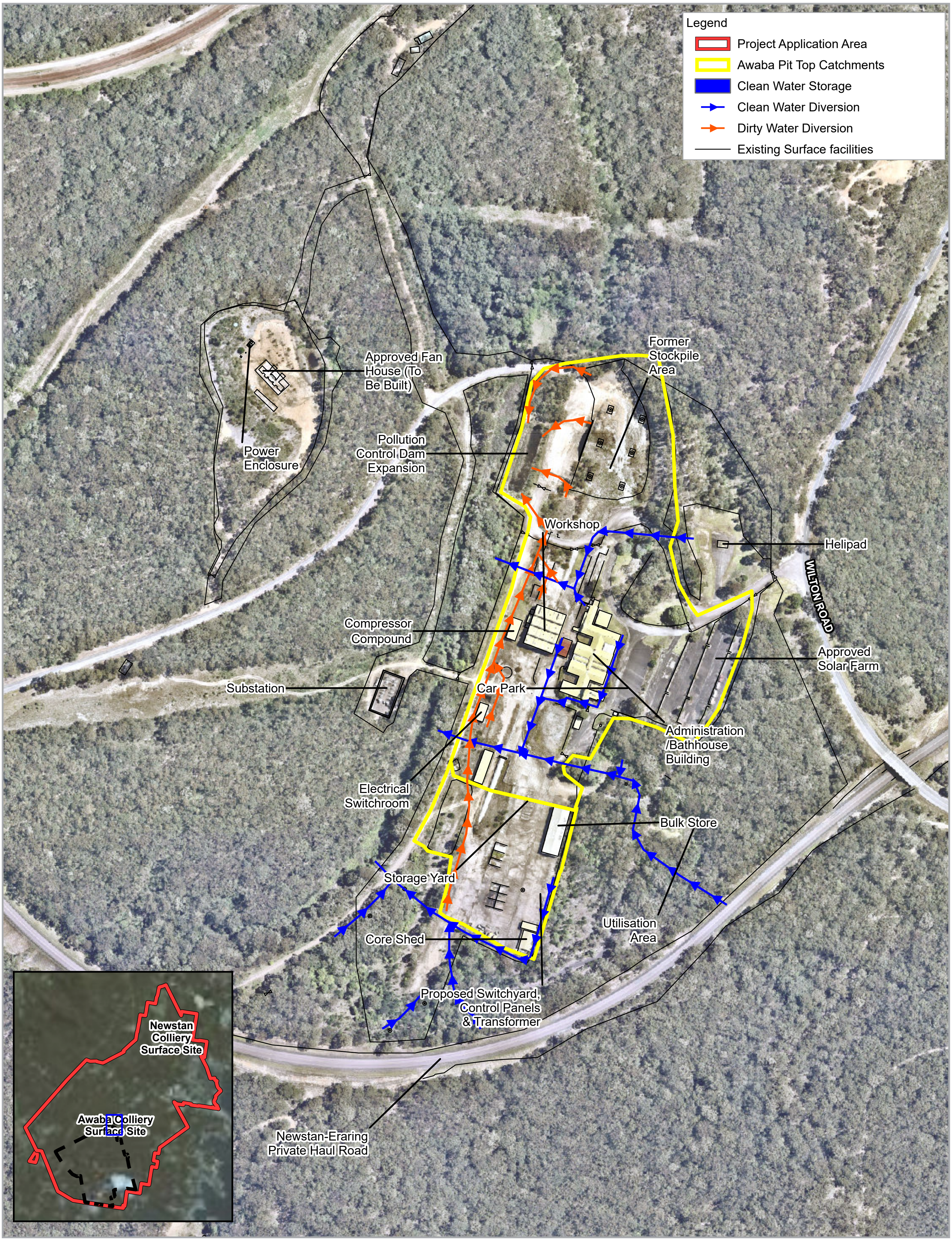
Underground water management at Awaba Colliery

Dewatering of the Awaba underground workings ceased in 2012 with the cessation of mining. However, pumping of water from the underground storage has continued for the purpose of maintaining the water level within the workings.

The closed mine workings at Awaba Colliery form an underground void in the Great Northern seam. When the mine was closed and dewatering ceased, water levels in the underground void began to return to pre-mining levels due to a combination of inflows of surrounding groundwater and infiltration from the surface. As water levels equilibrated with the surrounding groundwater, infiltration from the surface became the dominant inflow and water from the void began to seep out through a series of natural faults at the south end of the void. This area is known as 'the Awaba seepage'. Some seepage has also been observed at the Eraring Power Station.

Water levels in the underground void are currently managed by pumping water to Eraring Power Station, via the '10 South Bore', to the Eraring Ash Dam and from the Eraring groundwater manifold to the Eraring Discharge Canal.

The Awaba underground water management system is shown together with the Newstan underground water management system in Figure 6-5.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

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Water management features
Awaba Colliery Surface Site

Figure 6-7

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Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

6.3.5 Impact assessment

Groundwater inflow

Groundwater inflows to the Newstan West Borehole seam workings are modelled to increase from 2.8 ML/day under current conditions to a peak of 4.0 ML/day in 2029. Groundwater inflows are modelled to slightly decrease to 3.8 ML/day in the final year of mining. However, the hydrogeological model is noted to over predict current mine inflows (compared to observed rates of 1 ML/day). Therefore, it is likely that the model is over predicting future mine inflows and is highly conervative.

Groundwater drawdown

Modelled cumulative drawdown in the alluvium and regolith is centred on historical/existing Newstan Colliery workings in the Great Northern seam, Cooranbong Mine and Awaba Colliery workings. Note that all these workings are located in the Great Northern seam. Drawdown in the alluvium and regolith is likely attributable to the lower depth of cover above the Great Northern seam. Model results predict there will be no drawdown in the alluvium and shallow regolith due to the proposed mine workings.

Modelled drawdown in the Great Northern seam is also centred on Newstan Colliery workings in the Great Northern seam, Cooranbong Mine and Awaba Colliery workings. Cumulative drawdown in the Great Northern seam is greatest above existing workings. Drawdown in the Great Northern seam attributable to the proposed workings is negligible.

Cumulative modelled drawdown in the Fassifern seam is similar to cumulative modelled drawdown in the Great Northern seam. Cumulative drawdown in the Fassifern seam is greatest above the existing workings at Newstan Colliery, Awaba Colliery and Cooranbong Mine. Drawdown in the Fassifern seam at the end of mining, attributable to the proposed workings, is greatest above areas of panel extraction.

Drawdown in the West Borehole seam is centred on the Newstan Colliery workings. The cumulative radius of drawdown extends to the north, north-east, north-west and south of the workings.The radius of drawdown in the West Borehole seam attributable to proposed workings extends up to approximately 9.5 km to the north-east and approximately 11 km to the south of the proposed workings.

Baseflow

Changes to baseflow to creeks and Lake Macquarie have been estimated based on the output of groundwater from the alluvium and outcrop of fractured and porous rock. Model results indicate that there is no impact on baseflow or Lake Macquarie due to the proposed mine workings.

Eraring Ash Dam

Modelled net leakage from the Eraring Ash Dam indicates that there is no difference in net leakage out of the Eraring Ash Dam for the predictive and no proposed mining scenarios. Therefore, modelling results indicate proposed mining at Newstan Colliery will have no impact on leakage out of the Eraring Ash Dam. Note that these predictions are based on the height of depressurisation conceptualisation discussed in Section 6.3.3.

Modelled leakage out of the Eraring Ash Dam reflects changes in rainfall recharge. Modelled leakage out of the Eraring Ash Dam is constant throughout the prediction and post-closure period of modelling.

Awaba workings

There is a modelled net groundwater flow into the Awaba underground void for existing conditions and throughout the period of proposed mining. Proposed mining at Newstan Colliery is modelled to result in a slight reduction in groundwater inflow into the Awaba underground void.

The reduction in groundwater inflow into the Awaba underground void is attributable to groundwater drawdown in the surrounding porous and fractured rock groundwater source.

The reduction in groundwater inflow to the Awaba underground void continues after the end of mining. The maximum discrepancy in groundwater inflows into the Awaba underground void between the ‘proposed mining’ and ‘no proposed mining’ scenarios is 22 m^3/day and occurs between the year 2063 and the year 2175.

No increase in leakage from the Awaba underground void to underlying strata is predicted to result from mining in the Extension of Mining Area, Note that these predictions are not based on the SCT Operations Pty Ltd (2019) fracture height conceptualisation.

Fassifern underground storage

There is a modelled net groundwater flow into the Fassifern underground storage for existing conditions and throughout the period of proposed mining. The results show that there is no difference in net groundwater flow into the Fassifern underground storage due to proposed mining.

Alluvium groundwater sources

Incremental impacts

Groundwater impacts due to the proposed mine workings do not extend up to the alluvium. Therefore, there will be no impact to the alluvial water table or baseflow to creeklines attributable to the proposed workings. This specifically includes Stockyard and Kilaben Creek catchments. Note that this assessment is based on the predicted change in alluvial groundwater level only. Subsidence related impacts to creeks are addressed in Sections 6.1 and 6.4.

Impacts from proposed mining at Newstan Colliery will not extend to the alluvium and outcropping fractured and porous rock. Therefore the proposed mine workings will not impact on GDEs. This includes the GDEs within Lake Macquarie City Council’s Awaba Biodiversity Conservation Area.

As there is no drawdown within the alluvial groundwater sources due to the proposed workings, the proposed workings will not impact on high priority GDEs (either vegetation or stygofauna) or impact on any alluvial landholder bores. Therefore the predicted impacts are less than the Level 1 minimal impact considerations under the NSW AIP and are therefore considered to be acceptable.

As impacts due to the proposed mine workings do not extend to the alluvium, there will be no impact on alluvium groundwater quality due to the proposed workings. It is noted that groundwater quality monitoring, which has been undertaken at Newstan Colliery since 2005, does not show impacts on alluvial groundwater quality or beneficial use of groundwater due to mining over this period.

The beneficial use category of the alluvial groundwater is not expected to change within or outside the Project Application Area and the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

Cumulative impacts

Drawdown of the water table has occurred due to historical workings. Cumulative drawdown in the alluvium and regolith is centred on Newstan Colliery workings in the Great Northern seam, Cooranbong and Awaba workings. However, the proposed workings will not change (or worsen) the existing water table impacts from historical mining.

The existing beneficial use categories for alluvium are ‘environmental protection’ as well as ‘domestic’ and ‘agricultural use’.

It is not expected that cumulative drawdown will change these categories either within the Project Application Area or downstream. While no drawdown attributable to mining has been observed at alluvial groundwater monitoring locations, no impacts on groundwater quality have been observed at alluvial groundwater monitoring bores in the Project Application Area. Therefore, it is not expected that drawdown due to regional mining has impacted on groundwater quality.

Porous and fractured rock groundwater sources

The Narrabeen Sandstone and Illawarra Coal Measures groundwater sources are considered to be ‘less productive’ under the NSW AIP since the yields are typically less than 5 L/s and/or the groundwater salinity exceeds 1500 mg/L.

Incremental impacts

Drawdown attributable to the proposed workings will extend up to 2 km from the proposed workings in the West Borehole seam.

Limited drawdown attributable to the proposed workings is predicted in the Fassifern seam and the Great Northern seam, with drawdown remaining within 500 m of the Project Application Area.

164 private bores were identified in the radius of drawdown of the West Borehole seam attributable to mining in the Extension of Mining Area. Modelled drawdown due to proposed workings is less than 0.6 m at each of these bores at the end of mining.

Since there are no high priority vegetation GDEs within the radius of drawdown, and drawdown at landholder bores is less than 2 m, the predicted impacts are less than the Level 1 minimal impact considerations under the NSW AIP and are therefore considered to be acceptable.

Proposed mining at Newstan Colliery will have no impact on leakage out of the Eraring Ash Dam. Note that these predictions are not based on the SCT Operations Pty Ltd (2019) fracture height conceptualisation.

Proposed mining at Newstan Colliery will result in a slight reduction in groundwater inflows into the Awaba underground void. This reduction in inflows is due to groundwater drawdown of strata surrounding the Awaba Colliery workings.

Proposed mining at Newstan Colliery will have no impact on groundwater inflow into the Fassifern underground storage.

The predicted drawdown in the less productive porous and fractured rock groundwater sources is not expected to result in any change in groundwater quality. This is based on results of the existing groundwater monitoring program as well as the prediction that the proposed mining is not expected to change inter-aquifer connectivity and no change in leakage from the Awaba Colliery underground void or Eraring Ash Dam is predicted. Note that these predictions are not based on the SCT Operations Pty Ltd (2019) fracture height conceptualisation.

The beneficial use category of the fractured and porous rock groundwater source is not expected to change within or outside the Project Application Area and the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

Cumulative impacts

Drawdown in the West Borehole seam is centred on the Newstan Colliery workings. The radius of drawdown predominantly extends to the north, north-east and north-west of the workings. The radius of drawdown extends up to approximately 14 km to the south of the West Borehole seam workings.

164 private bores were identified in the radius of drawdown of the West Borehole seam attributable to mining in the Extension of Mining Area. Cumulative modelled drawdown is less than 2 m at the majority of these bores at the end of mining. At two private bores within Permian strata in the vicinity of the West Borehole seam subcrop to the west of the existing Newstan workings (GW052381 and GW061202), cumulative modelled drawdown exceeds 2 m due to existing mining.

The beneficial use categories for the fractured and porous rock are domestic and agricultural use. It is not expected that cumulative drawdown will change these categories either within the Project Application Area or downstream. While no drawdown attributable to mining has been observed at fractured and porous rock groundwater monitoring locations, no impacts on groundwater quality have been observed at fractured and porous rock groundwater monitoring bores in the Project Application Area. Therefore, it is not expected that drawdown due to regional mining has impacted on groundwater quality. The beneficial use category of the alluvial groundwater is not expected to change within or outside the Project Application Area and the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

Landholder bores

Landholder bores identified within the radius of drawdown of the West Borehole seam and attributable to the proposed workings were assessed for potential impacts.

There is no modelled drawdown in the alluvium or Triassic strata attributable to the proposed workings. Therefore the proposed workings will not result in any drawdown at landholder bores within these strata.

Of the bores identified, ten were found to be screened within Permian strata. Modelled drawdown due to proposed workings is less than 0.6 m at each of these bores at the end of mining.

Water sharing plan licensing requirements

The project is predicted to result in an increase in groundwater inflow into the mine workings. Groundwater inflows into the Newstan Colliery West Borehole seam workings are predicted to gradually increase over the period of proposed mining to a peak of 4.0 ML/day in 2029.

A Water Access Licence (WAL) will be required for the Sydney Basin – Lower Hunter / Central Coast Groundwater Source for the interception and extraction of groundwater from the proposed and existing workings in accordance with the *Water Management Act 2000*.

It is recommended that Centennial Newstan obtain a licence for 1,460 ML/year (4.0 ML/day multiplied by 365 days) for the Sydney Basin – North Coast Groundwater Source to licence groundwater inflows into the West Borehole seam workings.

Centennial Newstan has previously submitted applications under Part 5 of the *Water Act 1912* for Newstan Colliery. These licence applications include:

- GNS pump station – 2522 ML. The GNS pump extracts water from the Newstan Colliery Great Northern Seam workings.
- 19 cut through pump – 824 ML. The 19 cut through pump extracts water from the West Borehole seam workings.
- Fassi 1 Bore – 2575.5 ML. The Fasi 1 bore extracts water from the Fassifern underground storage.

Following determination of the above valid licence applications, Centennial Newstan anticipate that they will convert these licences to WALs under the *Water Management Act 2000* for the Sydney Basin – North Coast Groundwater Source.

Based on the predicted infiltration of surface water into the Fassifern Underground Workings, maximum total dewatering of underground workings is predicted to be 13 ML/day (4745 ML/year). This volume includes the modelled groundwater inflows of 4.0 ML/day into the West Borehole seam. Therefore the outstanding applications listed above will be sufficient, once granted, to licence the extraction of groundwater from the underground workings.

Additionally, Centennial Newstan has submitted a number of applications under Part 5 of the *Water Act 1912* for Awaba Colliery. Following determination of the above valid licence applications, Centennial Newstan anticipate that these licences they will convert to water access licences under the Water Manament Act 2000 with respect to the Sydney Basin – North Coast Groundwater Source

6.3.6 Mitigation and management

All groundwater impacts attributable to the project have been assessed to be less than the Level 1 impact considerations in the NSW AIP. Notwithstanding, Centennial Newstan acknowledges the hydraulic connectivity risks associated with Eraring Ash Dam, as identified by SCT Operations Pty Ltd (2019) (refer to Section 6.2). As such, Centennial Newstan proposes a range of highly conservative measures to avoid and mitigate potential groundwater impacts from the project.

Centennial Newstan proposes the following measures to mitigate potential impacts:

- No secondary extraction (i.e. total or partial extraction) will be carried out within a 35 degree angle of draw of the Western Saddle Embankment. The area of any first workings within a 35 degree angle of draw of the Western Saddle Embankment will be determined following the completion of detailed designs by Origin Energy and subject to approval from Dams Safety NSW.
- To mitigate the impacts of secondary extraction and the associated fracture network impacting on the effectiveness of the void fill, no secondary extraction (i.e. total or partial extraction) will be carried out within a 26.5 degree angle of draw of any proposed void filling areas. The area of any first workings within a 26.5 degree angle of draw of any proposed void filling areas will be determined following the completion of detailed design by Origin Energy and subject to approval from Dams Safety NSW.
- A program of field measurements will be undertaken in consultation with Origin Energy during and after the void filling program to confirm the effectiveness of void filling as a barrier to flow from the ash dam into Awaba Colliery and provide a base line against which to assess further impacts from mining within the West Borehole seam.

- A Water Treatment Management Plan will be developed during detailed mine closure planning that accommodates potential interactions between Awaba Colliery, Newstan Colliery and the Eraring Ash Dam.

Ongoing measures will also include a range of monitoring to validate groundwater model predictions and provide observation data for future model calibration.

Flow monitoring

The existing flow monitoring program at Newstan Colliery and Awaba Colliery will be continued. The following additional flow monitoring will be installed within 12 months of project approval:

- Inflow rates will be monitored on a panel by panel basis during extraction of the initial panels within the West Borehole seam to better estimate the likely inflow rates below the ash dam.
- The height of depressurisation above an extracted panel will be monitored to confirm consistency with the estimates made by SCT Operations Pty Ltd (2019).
- Water levels in Awaba underground void: an automated pressure transducer and data logger will be installed in at least one groundwater monitoring bore to provide continuous record of water levels in the Awaba underground void.
- 19 cut through and Fassi 1 bore: these existing flow meters will be recalibrated to improve confidence in the estimation and groundwater interception and surface infiltration.
- Any new dewatering pumps installed in the Extension of Mining Area will have individual flow meters installed.

Groundwater monitoring

The groundwater monitoring program at Newstan Colliery will be continued. This involves biannual monitoring of levels and quality (pH and EC). Groundwater level monitoring within alluvial bores will be improved with the installation of pressure transducers and loggers so that the response in groundwater level to rainfall events can be assessed. Continuous recording of water pressure at the existing vibrating wire piezometer (CN064) will continue.

Groundwater monitoring of landholder bore GW027563 will commence within 12 months of project approval. Note that monitoring of this bore will be dependent on Centennial Newstan negotiating an access agreement with the landholder. Groundwater monitoring at GW027563 will be undertaken on a quarterly basis and will include monitoring of groundwater level.

Although no groundwater impacts are predicted in the Awaba Biodiversity Conservation Area, additional groundwater monitoring within the Awaba Biodiversity Conservation Area will be undertaken to validate these predictions. Two additional alluvial monitoring bores will be installed to monitor for potential impacts on alluvial groundwater. Proposed locations for these additional monitoring bores are shown in Appendix J. Monitoring of these bores will commence within 12 months of project approval. Groundwater monitoring will continue at AE2 and AE3 to assist in identification of potential impacts on the shallow groundwater in this area.

Loggers will be installed in these bores for the continuous monitoring of groundwater levels. Quarterly monitoring of these bores will be undertaken. Quarterly monitoring will include manual gauging of groundwater levels and sampling of groundwater quality. Groundwater quality parameters will include electrical conductivity, pH, alkalinity, sulfate, chloride, magnesium, sodium, potassium, calcium, dissolved iron, nitrate, nitrite, total Kjedahl nitrogen, total oxidised nitrogen (NO_X), total nitrogen and total phosphorus.

Hydrogeological model

The hydrogeological model will be reviewed and revised if required every two years. The review of the hydrogeological model will include a comparison of modelling results against groundwater monitoring data and mine dewatering volumes.

Water management plans

A regional water management plan has been developed to provide an overview of the water management requirements across Centennial's northern operations in the Lake Macquarie catchment. Site-specific management plans for Newstan Colliery, Awaba Colliery and Northern Coal Services have also been developed to address specific water management requirements for each of the operations.

The water management plans ensure that each operation, with respect to water, meets all relevant regulatory requirements. The regional and site-specific water management plans are reviewed every three years or as a result of any regulatory requirements, any significant changes to water management practices or the development of new mining areas.

TARPs are provided in the site-specific water management plans. Additional TARPs will be developed as required to provide guidance on the immediate actions that should be taken in response to any impacts of the project identified as part of the monitoring program. Generally, responses include investigation and monitoring, determination of the risk of impact and remedial measures to be implemented.

Following approval of the project, the site-specific water management plan for Newstan Colliery and Awaba Colliery will be merged and updated to include the water management requirements of the project. The revised management plan will then be implemented.

Extraction Plans

Extraction plans will be developed and implemented for each extraction area prior to mining. Generally, extraction plans describe the applicable regulatory framework, mine planning and management and monitoring measures to be implemented to ensure the protection of all surface/subsurface natural and built features and the protection of public safety during extraction. Each extraction plan for the project will include a water management plan to manage potential subsidence-related impacts to water resources.

6.4 Surface water

A Surface Water Impact Assessment was prepared by GHD to assess the potential impacts of the project on the surface water environment. The information presented in this section is summarised from the Surface Water Impact Assessment (GHD, 2020c), which is presented in full in Appendix K.

The scope of the Surface Water Impact Assessment was designed to address the SEARs (refer to Appendix A) with regard to the assessment of surface water impacts.

6.4.1 Background

The project has the potential to impact on impact on surface water resources in the following ways:

- Catchment and drainage modifications from construction of infrastructure at Awaba Colliery Surface Site. However, this would be mitigated through all surface infrastructure for the project being located generally within pre-existing disturbed areas at the Awaba Colliery Surface Site and generally managed in accordance with the existing water management system.

- Changes to in-stream conditions above and downstream of the project.
- Changes to water quality during construction or operation of surface infrastructure, such as from erosion and sediment entrainment in surface runoff.
- Changes to receiving environments from any release of treated water to nearby watercourses (under licence).
- Changes to flow and quality of water seeping from the southern end of the recharged Awaba underground workings through a series of natural faults (the Awaba seepage).

To assess these potential impacts, the Surface Water Impact Assessment included:

- Reviewing existing assessments and data relevant to the project.
- Reviewing relevant statutory requirements.
- Establishing the existing and/or approved conditions for the surface water systems.
- Determining the water management requirements for the project.
- Undertaking an assessment of the potential impacts of the project on:
  - Water and salt balance.
  - Surface water flow.
  - Surface water quality.
  - Downstream water users, including licensed water users and basic landholder rights.
- Undertaking an assessment of the cumulative impacts of the project in association with other operations in the region.
- Identifying licensing requirements.
- Developing measures to avoid, minimise and mitigate potential impacts of the project and provide recommended management, monitoring and reporting requirements.

6.4.2 Methodology

Water and salt balance

A site water and salt balance model was developed to quantify the potential impacts under a range of rainfall conditions. The methodology, data, validation and results of the modelling are detailed in Appendix K.

The water and salt balance model considered the existing and proposed operations at Newstan Colliery, Newstan Colliery Surface Site, Awaba Colliery and Eraring Power Station.

For the purpose of this assessment, two scenarios were considered:

- **Baseline conditions**: this represents the continuation of care and maintenance at Awaba Colliery and continued approved operations at Newstan Colliery and Newstan Colliery Surface Site. The predicted groundwater inflows into the West Borehole seam for year 1 (2021) based on the Groundwater Impact Assessment (GHD, 2020a) were adopted as representative of both approved first workings and continued care and maintenance at Newstan Colliery. In baseline conditions, the existing discharge via LDP001 was assumed to be limited by the current conditions of EPL 395 limit to 11 ML/day and transfers from Awaba Colliery Surface Site to the Awaba underground void were assumed to still occur.

- **Proposed conditions**: this represents the proposed operations as part of the project. The year with the peak groundwater inflows, year 10 (2030), was reported, as this represents the highest potential off-site discharges. By this time, it was assumed that the Eraring Ash Dam augmentation was complete. Under proposed conditions, the discharge via LDP001 was simulated to be increased to the approved limit of 14.5 ML/day.

Water quality

A detailed assessment of existing surface water quality was undertaken to establish baseline water quality values for receiving watercourses. This water quality assessment was undertaken in accordance with the assessment framework and methodologies outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) and by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC, 2019).

The water quality assessment considered data from 18 locations that are part of the surface water monitoring networks for Newstan Colliery and Awaba Colliery. Monitoring locations are provided and described in Appendix K.

To characterise existing surface water quality, monitoring data have been compared to default guideline values (DGVs) recommended by the Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC & ARMCANZ, 2000) and ANZG (2018) for the protection of aquatic species.

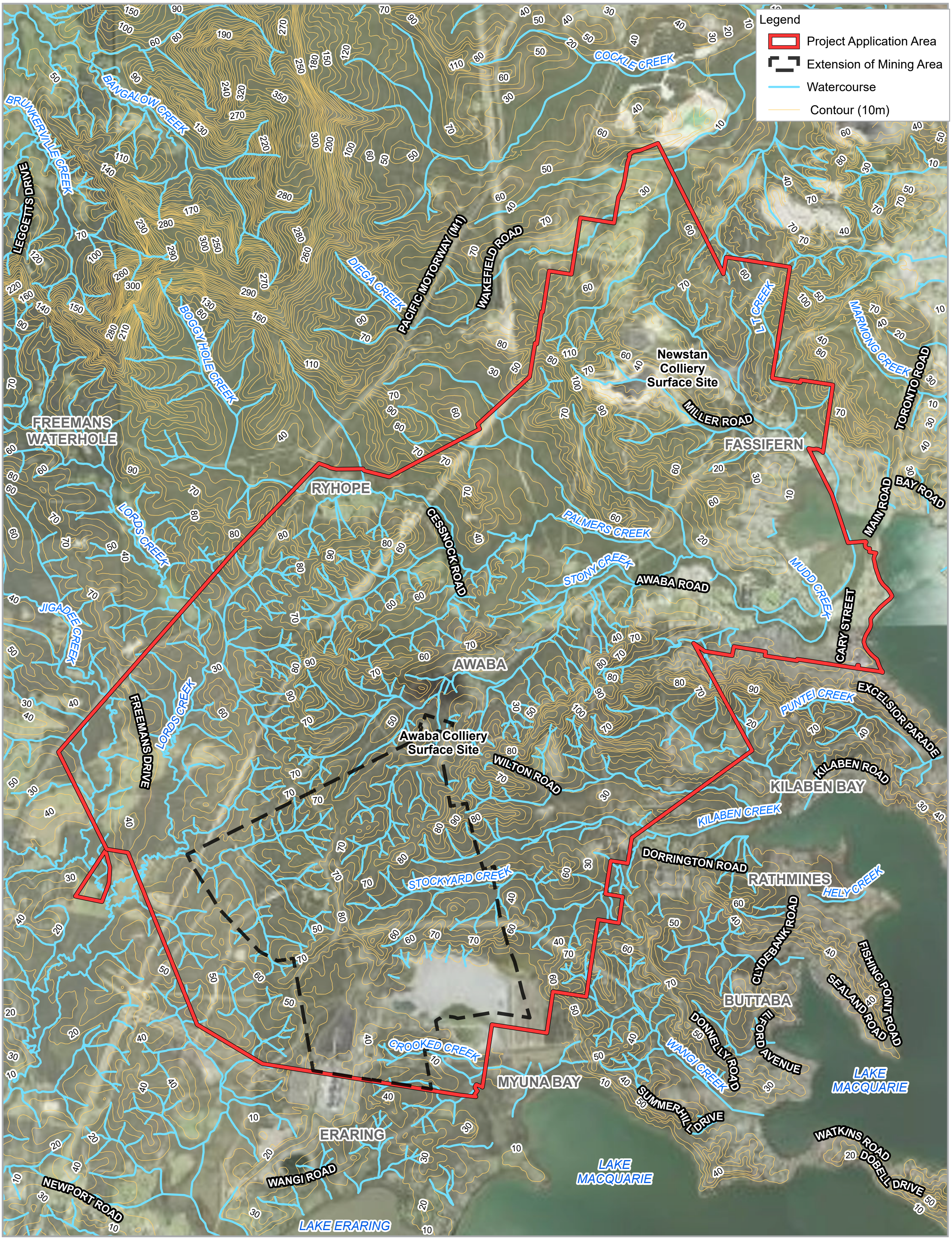
6.4.3 Existing environment

Hydrology

The Project Application Area is located within the catchment area of Lake Macquarie. Several watercourses traverse the Project Application Area; however, the area encompasses a small proportion of the catchment areas associated with these watercourses. The main creek systems that traverse the Project Application Area are:

- LT Creek, which flows in an easterly direction into Fennell Bay.
- Kilaben Creek and Stockyard Creek, which flow in an easterly direction into Kilaben Bay.
- Palmers Creek and Stony Creek, which flow in an easterly direction into Fennell Bay.
- Lords Creek, and its associated tributaries, which flows in a westerly direction into Jigadee Creek.
- Crooked Creek, which flows in a south-easterly direction into Lake Macquarie.

The hydrology of the Project Application Area is shown in Figure 6-8.



Paper Size ISO A4

0 0.4 0.8 1.2 1.6 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Centennial Newstan Pty Ltd
Newstan Mine Extension Project
Environmental Impact Statement

Project No.	22-20261
Revision No.	0
Date	09/06/2020

Topography and drainage

Figure 6-8

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Print date: 09 Jun 2020 - 04:16

Data source: Centennial: Consent boundary, 2016; LPI: DTDB / DCDB, 2017; sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: fmackay

Existing water management

The existing water management systems at Newstan and Awaba Collieries are described above in Section 6.3.4.

Licenced discharge points

Centennial Newstan holds EPL 395 for the Newstan Colliery Surface Site, with water licensed to be discharged from the site through the following licenced discharge points (LDPs):

- Newstan LDP001 – Located upstream of the Main Bywash Dam, which flows into the northern arm of LT Creek upstream of Newstan LDP002.
- Newstan LDP002 – Located at the emergency outlet of the Final Pollution Control Dam discharging into the northern arm of LT Creek downstream of Newstan LDP001.
- Newstan LDP017 – Located on the outlet of a pipeline that serves as an overflow point from the Fassifern underground storage, discharging into Stony Creek.
- Newstan LDP021 – Located at the emergency weir of Graunch's Dam Cell 2 upstream of the Main Bywash Dam and Newstan LDP001.

Water quality monitoring is also required by EPL 395 at a number of locations at the Newstan Colliery Surface Site. A volumetric discharge limit of 11 ML/day is specified by EPL 395 for Newstan LDP001, with no other volumetric limits specified for any other LDP. As part of the Northern Coal Logistics Project, a volumetric limit for Newstan LDP001 of 14.5 ML/day was approved, for which a variation to EPL 395 will be required.

Centennial Newstan also currently holds EPL 443 for the Awaba Colliery Surface Site. The Awaba Colliery Surface Site does not form part of the Northern Coal Logistics Project. EPL 443 licenses water to be discharged from the site through a number of LDPs, several of which have been decommissioned or are no longer in use. The following LDPs, are still either maintained or in use:

- Awaba LDP004 – Borehole located along Hawke Mount Road.
- Awaba LDP008 – Irrigation area from the wastewater maturation pond.
- Awaba LDP009 – Outlet from the Pollution Control Dam to Stony Creek.

LDP004 is not currently used, but is maintained in case it is required for management of water levels in the Awaba underground void. LDP008 is not currently used, as there are no staff permanently based at Awaba Colliery Surface Site.

Surface water quality

LT Creek

Water quality results for Newstan LDP001 between January 2016 and May 2019 indicate that median values for water quality parameters were all within the applicable EPL limits. The 95th percentile values for pH, bicarbonate alkalinity, ammonia and nitrate and nitrite exceeded the relevant EPL limits or the DGV.

No potentially ecotoxic metal or ammonia concentrations were observed in the Newstan LDP001 discharge. Nutrient concentrations in the discharge are generally low.

Stony Creek

Low salinity has generally been observed in Stony Creek, with no exceedances of the DGV for EC. Slightly acidic conditions were observed, which are likely attributable to natural organic acids.

Total suspended solids and turbidity have been occasionally elevated. This likely occurs as a result of rainfall events mobilising sediment, which is supported by the elevated aluminium and iron concentrations that have been observed in the creek. Both of these metals are prevalent in soils and can be released into the water column from suspended sediments.

95th percentile concentrations of the metals aluminium, chromium, cobalt, copper, iron and zinc exceeded the relevant DGVs. High nutrient concentrations were also observed, with median concentrations of total nitrogen and total phosphorus exceeding the relevant DGVs.

Lords Creek

Elevated EC was observed at Lords Creek during the monitoring period. This was associated with discharges from Awaba LDP004 in accordance with EPL 443 in late 2016 and is also likely to reflect inputs from saline groundwater.

pH is generally neutral to slightly acidic. The dominant major ions observed in Lords Creek are sodium and chloride.

Elevated aluminium and iron concentrations have been observed in Lords Creek. These metal concentrations are likely linked to the elevated total suspended solids concentrations and turbidity values. The 95th percentile metal concentrations of aluminium, copper, iron, zinc, chromium and cobalt exceeded the relevant DGVs.

Median total nitrogen and total phosphorus concentrations in Lords Creek exceeded the relevant DGVs during the monitoring period.

Kilaben Creek

Elevated EC has been observed in Kilaben Creek, with the median value exceeding the DGV, likely a result of saline groundwater inputs and potentially runoff from Wilton Road and a nearby off-road race track.

Water in Kilaben Creek is slightly acidic, with median pH values below the DGV. Median turbidity and total suspended solids values did not exceed the DGVs and dominant major ions are sodium and chloride.

Median dissolved aluminium concentrations exceeded the DGV, and iron concentrations were also elevated within Kilaben Creek. These observations are indicative of the influence of suspended sediments. In addition to aluminium and iron, 95th percentile concentrations of zinc and chromium also exceeded the DGV.

Nutrient concentrations in Kilaben Creek have generally been low, though occasionally elevated concentrations of ammonia, nitrite and nitrate, total nitrogen and total phosphorus have been observed, which may be associated with evaporative concentrations during periods of no surface flow.

Stockyard Creek

Median EC values in Stockyard Creek exceeded the DGV. pH values indicate generally slightly acidic conditions attributable to humic and fulvic acids with the median pH below the DGV range.

Elevated total suspended solids concentrations and turbidity values have been observed in Stockyard Creek. This is likely attributable to dispersive clays in runoff, and potentially the influence of the nearby access track.

Sodium and chloride were the dominant major ions within Stockyard Creek.

The influence of suspended sediments on dissolved aluminium and iron concentrations was also evident in Stockyard Creek, with higher concentrations of both metals observed where higher turbidity and total suspended solids values were observed.

95th percentile concentrations of aluminium, copper, iron, zinc and chromium exceeded the relevant DGVs. These elevated metal concentrations are likely reflective of the influence of local lithology.

The median total nitrogen concentration and total phosphorus concentration exceeded the DGV within Stockyard Creek.

The Stockyard Creek catchment abuts that of Kilaben Creek, and water quality in both creeks is largely similar, with elevated concentrations of aluminium, iron and zinc reflecting the influence of local lithology. However, it is noted that Kilaben Creek is generally slightly more saline than Stockyard Creek, and higher concentrations of total nitrogen and phosphorus are observed in Stockyard Creek.

Unnamed creek downstream of Awaba Waste Management Facility

Salinity has been consistently elevated at the unnamed creek downstream of Awaba Waste Management Facility, with all observations exceeding the DGV. This is indicative of the influence of leachate from the Awaba waste management facility. Slightly alkaline conditions also indicate the influence of leachate, though pH values have remained within the DGV range.

Elevated turbidity was observed, with the 95th percentile value exceeding the DGV. This is likely associated with the transport of sediments in runoff from a rainfall event.

The dominant major ions are sodium and bicarbonate, with high concentrations of potassium also observed. These observations indicate the impact of leachate on the water quality.

Elevated dissolved concentrations of the metals aluminium, arsenic, boron, chromium, cobalt, copper, iron, nickel and zinc have been observed, with the 95th percentile concentrations exceeding the relevant DGVs. The elevated concentrations of arsenic, boron, chromium, copper and nickel are all likely attributable to the influence of landfill leachate, whereas elevated concentrations of aluminium, iron and zinc have been observed in nearby catchments unaffected by leachate.

The influence of landfill leachate is most evident in the nutrient concentrations, with median concentrations of ammonia, nitrite and nitrate, total nitrogen and total phosphorus all exceeding the relevant DGVs. The median ammonia concentration was over 100 times greater than the DGV for ammonia as a toxicant, so some toxicity to aquatic life is likely to be associated with this parameter. The elevated concentrations of nitrite and nitrate and phosphorus likely promote nuisance algal blooms and eutrophication in the unnamed creek.

Low concentrations of cyanide have also been observed, which are likely associated with landfill leachate, though the concentrations have not exceeded the DGV.

Awaba seepage and unnamed tributary of Muddy Lake

Water quality results for surface water monitoring sites downstream of the Awaba seepage were compared with a comparison site on the unnamed tributary of Muddy Lake, upstream of the Awaba seepage.

The elevated salinity of the Awaba seepage was evident by the EC results downstream, with all observations exceeding the DGV.

The initial acidity of the Awaba seepage is evident based on the minimum pH values observed. The range of pH values observed, however, indicates that more recent monitoring at these sites has observed circumneutral to slightly alkaline water.

Elevated total suspended solids and turbidity have also been observed downstream of the Awaba seepage.

Elevated dissolved metal concentrations have been observed downstream of the Awaba seepage, with median values in exceedance of the relevant DGVs for cobalt, iron, nickel and zinc. Metal concentrations were generally higher in the seepage following its initial observation in 2013, and reduced since acid production in the void ceased.

Elevated nutrient concentrations have also been observed downstream of the Awaba seepage, though median concentrations did not exceed the DGVs, with the exception of ammonia.

Key differences between the water quality of the Awaba seepage and that of the upstream comparison site are notable based on the concentrations of major ions. The dominant major anion in the seepage is sulfate, and there is mixed dominance of cations, with elevated concentrations of sodium, calcium and magnesium. The dominant major ions at upstream of the Awaba seepage are sodium, chloride and bicarbonate.

Downstream surface water users

Licensed surface water users were identified by searching the *NSW Water Register* (WaterNSW, 2018) for all lots within a 10 km radius of the watercourses downstream of Newstan Colliery Surface Site and Awaba Colliery Surface Site.

Two surface water users were identified downstream of the project, both of which were downstream of the Extension of Mining Area, as identified in Table 6-8. There were no surface water users identified downstream of the existing LDPs proposed to be utilised by the project.

Table 6-8 Identified downstream surface water users

Location	Approval	Use purpose	WAL	Share components*	Water source
Lot 277, DP 755207	20CA209270	Irrigation	18737	132	North Lake Macquarie Water Source
Lot 10, DP 264503	20CA207240	Irrigation	17930	26	Dora Creek Water Source

6.4.4 Impact assessment

Proposed water management

No changes to the water management system at Newstan Colliery or the underground water management elements of Awaba Colliery are required as part of the project. Minor upgrades to the water management system at the Awaba Colliery Surface Site are proposed to support the underground mine operations for the project.

Groundwater inflows to the underground workings in the West Borehole seam will continue to be dewatered to the Fassifern underground storage and discharges to LT Creek through Newstan LDP001 via the Clean Water Plant at Newstan Colliery Surface Site. The existing dewatering infrastructure and Clean Water Plant at Newstan Colliery Surface Site has the capacity to dewater, treat and discharge up to 14.5 ML/day of water, as approved by the Northern Coal Logistics Project (SSD-5145). Currently, the discharge rate licensed by EPL 395 is limited 11 ML/day. A variation to EPL 395 is expected to be required to increase the volumetric limit to 14.5 ML/day, so that the groundwater intercepted in the Extension of Mining Area can be dewatered, treated and discharged to allow the safe operation of the mine and minimise the likelihood of potential discharge of untreated water via Newstan LDP017.

The Pollution Control Dam at the Awaba Colliery Surface Site will be upgraded and transfers of dirty water to the Awaba underground void will cease. The Awaba underground void will continue to be managed by pumping at the 10 South bore and Eraring groundwater manifold as required at Eraring Power Station.

A small number of administrative and maintenance staff (less than 10) will be located at the Awaba Colliery Surface Site. Potable water will continue to be supplied by Hunter Water Corporation. Effluent generated by on-site staff amenities will be serviced via a new connection to the Hunter Water Corporation reticulated sewer system.

Water balance and salt balance

Water balance

The project is likely to affect the water and salt balance of Newstan Colliery and Awaba Colliery. A site water and salt balance model was developed to quantify the potential impacts under a range of rainfall conditions. The methodology, data, validation and results of the modelling are detailed in Appendix K.

The water and salt balance model considered the existing and proposed operations at Newstan Colliery, Newstan Colliery Surface Site, Awaba Colliery and Eraring Power Station.

The annual average water balance for Newstan Colliery is summarised in Table 6-9.

Table 6-9 Annual average water balance – Newstan Colliery

Water management element	Baseline conditions (ML/year)	Proposed conditions (year 10) (ML/year)
INPUTS		
Groundwater inflows	1211	1495
Surface infiltration into underground workings	1331	1331
Transfers from Newstan Colliery Surface Site	1091	563
TOTAL INPUTS	3633	3388
OUTPUTS		
Transfers to Newstan Colliery Surface Site	3556	3364
Discharge to Stoney Creek outlet	66	25
TOTAL OUTPUTS	3622	3389
CHANGE IN STORAGE		
Underground water storages	11	-1
TOTAL CHANGE IN STORAGE	11	-1
BALANCE		
Inputs – outputs – change in storage	0	0

The key driver of change of the Newstan Colliery site water balance is the predicted increase in groundwater intercepted by the Extension of Mining Area. No change to surface infiltration to the Fassifern underground storage is expected as a result of the project.

A slight reduction in average water storage and discharge to Stony Creek under proposed conditions is forecast compared to baseline conditions. This indicates that existing infrastructure and approved daily discharge limit of 14.5 ML/day are sufficient to dewater the underground workings, without increasing the water levels in the Fassifern underground storage. Therefore, no increase in the likelihood of potential discharges via Newstan LDP017 are expected as a result of the project.

Transfers to Newstan Colliery Surface Site were modelled to remain similar under baseline and proposed conditions, but the transfers from Newstan Colliery Surface Site were modelled to decrease, corresponding to an overall increase in net transfers to the surface. This reflects the increase in discharges via LDP001 to the approved limit of 14.5 ML/day. Under proposed conditions, this allows water in excess of the low target operating level in the Fassifern underground storage to be discharged more promptly following heavy rainfall events, as opposed to baseline conditions, where continual recirculation of water between the surface and underground is required to temporarily store water on the surface prior to discharge.

The annual average water balance for Awaba Colliery is summarised in Table 6-10.

Table 6-10 Annual average water balance – Awaba Colliery

Water management element	Baseline conditions (ML/year)	Proposed conditions (year 10) (ML/year)
INPUTS		
Surface infiltration into underground workings	829	812
Infiltration from Eraring Ash Dam	0	17
Groundwater inflows	113	104
Awaba Colliery Surface Site direct rainfall	1	1
Awaba Colliery Surface Site catchment runoff	50	50
TOTAL INPUTS	993	984
OUTPUTS		
Awaba Colliery Surface Site evaporation	0	0
Discharge to Stony Creek via Awaba LDP009	5	51
Transfers to Eraring Power Station	500	461
Seepage to unnamed tributary of Muddy Lake	480	473
TOTAL OUTPUTS	986	986
CHANGE IN STORAGE		
Underground water storages	7	-2
TOTAL CHANGE IN STORAGE	7	-2
BALANCE		
Inputs – outputs – change in storage	0	0

No change to the direct rainfall, catchment runoff and evaporation at the Awaba Colliery Surface Site are expected as a result of the project. The increase in discharges to Stony Creek via Awaba LDP009 reflects the proposed change in water management, with transfers of dirty water to the Awaba underground void substituted with discharge of treated water to Stony Creek via LDP009.

Total average infiltration into the Awaba underground void is not expected to change as a result of the project. Eraring Ash Dam was assumed to be augmented for the purpose of the assessment. It was assumed that the infiltration rate for the part of the augmented Eraring Ash Dam overlying the Awaba underground void would be similar to the existing catchment. This change in catchment area would be small compared to the total surface infiltration catchment of the Awaba underground void.

Seepage and extraction from the Awaba underground void is forecast to decrease slightly as a result of the project. This reflects the influence of cessation of transfers from Awaba Colliery Surface Site to the Awaba underground void.

Salt balance

The annual average salt balance for Newstan Colliery is summarised in Table 6-11.

Table 6-11 Annual average salt balance – Newstan Colliery

Water management element	Baseline conditions (tonne/year)	Proposed conditions (year 10) (tonne/year)
INPUTS		
Groundwater inflows	2793	3455
Surface infiltration into underground workings	2229	2229
Transfers from Newstan Colliery Surface Site	1084	328
TOTAL INPUTS	6106	6012
OUTPUTS		
Transfers to Newstan Colliery Surface Site	5976	5976
Discharge to Stoney Creek outlet	98	38
TOTAL OUTPUTS	6074	6014
CHANGE IN STORAGE		
Underground water storages	32	-2
TOTAL CHANGE IN STORAGE	32	-2
BALANCE		
Inputs – outputs – change in storage	0	0

As groundwater inflows will increase relative to surface infiltration, the average salinity of water at Newstan Colliery, and hence discharges via Newstan LDP001, is expected to increase, but remain within the concentration limits of EPL 395.

No change to the salinity of potential discharges from Newstan LDP002, LDP021 or approved (but not commissioned) LDP003 are expected as a result of the project.

The annual average salt balance for Awaba Colliery is summarised in Table 6-12.

Table 6-12 Annual average salt balance – Awaba Colliery

Water management element	Baseline conditions (tonne/year)	Proposed conditions (year 10) (tonne/year)
INPUTS		
Surface infiltration into underground workings	2221	2176
Infiltration from Eraring Ash Dam	0	112
Awaba Colliery Surface Site direct rainfall	164	151
Awaba Colliery Surface Site catchment runoff	0	0
TOTAL INPUTS	13	12
OUTPUTS		
Awaba Colliery Surface Site evaporation	0	0
Discharge to Stony Creek via Awaba LDP009	1	13
Transfers to Eraring Power Station	1299	1194
Seepage to unnamed tributary of Muddy Lake	1247	1223
TOTAL OUTPUTS	2547	2429
CHANGE IN STORAGE		
Underground water storages	-149	22
TOTAL CHANGE IN STORAGE	-149	22
BALANCE		
Inputs – outputs – change in storage	0	0

The salinity of water within the Awaba underground void has the potential to increase slightly, due to potential for the additional relatively saline infiltration from the augmented Eraring Ash Dam. However, the change to salinity is not expected to be measureable within the year to year variation in seepage and extraction volumes.

Discharges to LT Creek and Stony Creek

No change to the frequency of potential discharges via Newstan LDP002, LDP021 and approved LDP003 are expected as a result of the project. However, changes are forecast for Newstan LDP001, Newstan LDP017 and Awaba LDP009.

Regular daily discharges via Newstan LDP001 will continue under the project, with the maximum discharge rate increased to the approved limit of 14.5 ML/day. On average, daily discharge volumes exceeding the current EPL 395 limit of 11 ML/day are only forecast to be required on about 30% of days during the project. Notwithstanding, during periods of above average rainfall, discharge volumes of up to 14.5 ML/day will be required to control the water levels in the Fassifern underground storage.

The magnitude of potential discharges via LDP017 are forecast to be slightly less the project compared to existing conditions. This reflects the fact that the 3.5 ML/day difference in the EPL 395 discharge limit of 11 ML/day and approved (under SSD-5145) discharge limit of 14.5 ML/day exceeds the predicted increase in groundwater inflows of 1.5 ML/day.

As part of the project, transfer of water from the Pollution Control Dam to the Awaba underground void will be substituted with controlled discharge via Awaba LDP009. Uncontrolled discharges currently occur as a result of rainfall that exceeds the design capacity of the dirty surface water storages. This will continue to be the case during the project, however, discharges will more often be the result of controlled dewatering of dirty water storages in compliance with EPL 443.

During the project, total discharges via Awaba LDP009 will increase compared to existing conditions. Additional discharge volumes will be controlled discharges of treated water. All controlled discharge via Awaba LDP009 will be compliant with EPL 443. During operations, with no disturbed area, coal handling or workshop areas, the likelihood of runoff from the Awaba Colliery Surface Site not complying with EPL 443 is considered low. Notwithstanding, infrastructure would remain in place to transfer water to the Awaba underground void if required in the unlikely event that water quality was not compliant.

The Flood Impact Assessment (EMM, 2020a) found that the additional discharge via Awaba LDP009 may increase the peak flow depth and velocity in Stony Creek slightly by 0.02 m and 0.02 m/s respectively. Overall, the discharge of water via Awaba LDP009 proposed as part of the project is unlikely to have any significant impact on Stony Creek. All discharges via LDP009 will be compliant with EPL 443.

Seepage to unnamed tributary of Muddy Lake

In the unlikely event the mitigation measures to minimise the hydraulic connection between the augmented Eraring Ash Dam and the Awaba underground void are not successful, the volume of water seeping to the unnamed tributary of Muddy Lake is forecast to increase slightly and there is potential for the salinity of the seepage to increase slightly. The small magnitude of these effects means that these potential changes are not expected to be measurable within natural year to year variation.

Security of water supply

The water supply available from the Clean Water Plant at Newstan Colliery Surface Site is expected to be sufficient to supply the water demands of mining operation at Newstan Colliery and coal handling and processing at Newstan Colliery Surface Site. The project is not expected to have any impact of the security of water supply for these operations.

Surface water flow

Subsidence due to underground mining of the proposed Extension of Mining Area has the potential to:

- Reroute watercourses and alter the longitudinal profile of watercourses, resulting in changes to watercourse stability.
- Alter patterns of surface water ponding (remnant ponding).
- Alter catchment boundaries, resulting in changes to catchment flow rates and volumes.

The watercourses potentially impacted by subsidence due to the project, include Stony Creek, Stockyard Creek, Kilaben Creek, Crooked Creek and Lords Creek. The predicted subsidence impacts on these creeks are discussed in Section 6.1.4.

Based on the predicted subsidence, the potential changes to flow depths, velocity and remnant ponding were assessed using a hydraulic model, as described in the Flood Impact Assessment (EMM, 2020a). The majority of watercourses were assessed as having negligible or low risk of impact from subsidence. The modelling results show that only a small additional area of remnant ponding may be experienced under subsided conditions.

The total catchment areas for the local watercourses were estimated for the existing and subsided conditions using a Digital Elevation Model (DEM). The relative change in the affected catchments is summarised in Table 6-13. The analysis indicates that the changes in the catchment areas due to the predicted subsidence are expected to be minor. As a result, it is considered that no appreciable changes to stream flows are likely to occur as a result of the project.

Table 6-13 Changes in catchment areas

Catchment	Existing area (ha)	Subsided area (ha)	Change (ha)
Eraring Ash Dam	226.96	227.52	+0.56 (+0.25%)
Crooked Creek	56.76	56.75	-0.01 (-0.02%)
Kilaben Bay	33.06	33.06	–
Kilaben Creek	84.72	85.13	+0.41 (+0.48%)
Lords Creek	265.97	265.90	-0.07 (-0.03%)
Muddy Lake	59.64	59.64	–
Myuna Bay	101.86	101.88	+0.02 (+0.02%)
Power Station	186.56	186.62	+0.06 (+0.03%)
Stockyard Creek	266.31	264.83	-1.48 (-0.56%)
Stony Creek	235.96	236.43	+0.47 (+0.20%)
Whiteheads Lagoon	98.75	98.79	+0.04 (+0.04%)

The Subsidence Impact Assessment (MSEC, 2019b) found that it is likely that some fracturing may occur along the watercourses above the Extension of Mining Area. However, adverse cracking of streambeds is unlikely to occur outside the extent of the existing workings at Awaba Colliery. In these areas, secondary extraction has been set back from third order sections of watercourses and therefore adverse fracturing of bedrock is considered unlikely.

Sinkholes have previously developed along some streams that are located above the existing workings at Awaba Colliery. According to the subsidence impact assessment for the project (MSEC, 2019b), there is potential for further sinkholes to develop in the headwaters of Stony Creek, Kilaben Creek and Stockyard Creek due to the existing conditions, regardless of the influence of the project. However, the project is not expected to increase the potential for sinkholes in the longer term compared to existing conditions.

Surface water quality

Awaba LDP009

Runoff from the disturbed areas at Awaba Colliery Surface Site is considered dirty water that may contain suspended sediment, oils, grease and hydrocarbons. No coal storage, transportation, handling or processing will be undertaken at the site. The most likely source of water quality degradation risk from the Awaba Colliery Surface Site is elevated suspended solids concentrations, especially during construction activities. No increased concentrations of metals, salinity or other contaminants are expected to be present in discharges from Awaba LDP009.

Newstan LDP001

The project is predicted to increase the amount of water and salt discharged from Newstan LDP001 due to the increased volume of groundwater intercepted in the proposed Extension of Mining Area. However, as water is treated at the Clean Water Plant prior to discharge via Newstan LDP001, the discharged water quality is expected to remain within the concentration limits of EPL 395 and be consistent with the potential impacts of the approved Northern Coal Logistics Project. Therefore, no change to water quality in LT Creek is expected. Increased salt loads will have a negligible impact on water quality in the receiving environment of Lake Macquarie.

A variation to EPL 395 is expected to be required to increase the volumetric discharge limit from 11 ML/day to 14.5 ML/day(consistent with what is already approved under the Northern Coal Logistics Project (SSD 5145)), so that the groundwater intercepted in the Extension of Mining Area can be dewatered, treated and discharged via Newstan LDP001.

The additional 15 years of licensed discharges from Newstan LDP001 to LT Creek due to the extended operational life of Newstan Colliery from the project would result in a corresponding continuation of water flow and quality impacts that would be comparable to impacts under existing conditions.

Newstan LDP017

The likelihood of discharges to Stony Creek via Newstan LDP017 is not predicted to increase as a result of the project. Discharges through Newstan LDP017 are in response to heavy rainfall, and any change to the water quality of Newstan LDP017 and the receiving environment of Stony Creek is predicted to be negligible and temporary.

Impacts of change to groundwater quality on licensed discharges

There is low potential for water from the Eraring Ash Dam to influence the quality of water extracted from West Borehole seam, which is ultimately treated at the Newstan Clean Water Plant and discharged to LT Creek via Newstan LDP001. Based on hydrogeological and geotechnical analysis, no direct hydraulic connection is expected between the Eraring Ash Dam and the West Borehole Seam and therefore the quality of water intercepted by the West Borehole Seam is expected to continue to reflect the quality of groundwater in the surrounding aquifers.

Subsidence related impacts

Subsidence related surface deformations in the catchments overlying the proposed workings could impact water quality through localised subsurface flow diversions and decreased surface water connectivity, which can lead to reduced dissolved oxygen (DO) concentrations and increased parameter concentrations through evaporative concentration. Additionally exposure of previously unweathered near-surface rock can release substances such as aluminium, iron, manganese, nickel and zinc into the surface water or shallow groundwater, resulting in elevated salinity and potentially ecotoxic metal concentrations. Elevated iron concentrations can also result in the consumption of DO and thick mats of orange-red precipitate associated with iron precipitation.

Muddy Lake

Based on the results presented in the Groundwater Impact Assessment (GHD, 2020a), the project is unlikely to have any significant influence of the water levels in the Awaba underground void, and, it is considered unlikely that the adverse impacts to water quality observed during the recharging of the Awaba underground void would reoccur.

Downstream surface water users

The project has the potential to reduce surface water flows and quality in Jigadee Creek, Kilaben Creek and Stockyard Creek, which may reduce the water available to downstream water users. However, with consideration of the proposed mining method, and the implementation of a range of proposed mitigation measures, neither additional surface water take nor a measurable decline in water quality is expected as a result of the project.

Cumulative impacts

Northern Coal Logistics Project

As part of the Northern Coal Logistics Project (SSD-5145), Northern Coal Services is approved to upgrade the coal handling and processing at the Newstan Colliery Surface Site. During the project, co coal handling or processing is proposed to occur at Newstan Colliery Surface Site, minimising water demands and maximising potential Newstan LDP001 discharges. Therefore, there are no cumulative adverse impacts expected as a result of the project and the approved upgrades to the Newstan Colliery Surface Site under the Northern Coal Logistics Project.

LT Creek and Stony Creek

The project has the potential to increase frequency and magnitude of discharges to LT Creek via Newstan LDP001 and Stony Creek via Newstan LDP017 and Awaba LDP009. No change to the frequency and magnitude of discharges via Newstan LDP002, LDP021 and approved LDP003 are expected as a result of the project. No other LDPs have been identified that contribute to LT Creek or Stony Creek. Therefore, no potential cumulative impacts are expected.

Based on the results presented in the Groundwater Impact Assessment (GHD, 2020a), no direct hydraulic connection between the Eraring Ash Dam and the Extension of Mining Area is expected to develop. Therefore, no cumulative impact of the Eraring Ash Dam augmentation and the project on the water quality of potential discharges via Newstan LDP001 and Newstan LDP017 are expected.

Awaba Waste Management Facility

The Awaba Waste Management Facility is outside of the extent of predicted subsidence of the proposed Extension of Mining Area and therefore no potential cumulative impacts are expected.

Muddy Lake

The project has the potential to affect the interaction between Awaba underground void and surface water features. The Eraring Ash Dam is approved to be augmented above the Awaba underground void and the project has the potential the result in enhanced infiltration of water from the Eraring Ash Dam to the Awaba underground void.

As the licensed discharge from Cooranbong Entry Site mixes with the water from the Awaba seepage prior to entering Muddy Lake, there is potential for altered interaction between the Awaba seepage and the licensed discharge.

The results of geochemical modelling (refer to Appendix K) have indicated that the interaction between the Eraring Ash Dam and the Awaba underground void has a minor influence on the water quality of inflows to Muddy Lake. These potential changes are within the potential minor changes expected because of cessation of discharges via Cooranbong LDP001 at the conclusion of mining at Mandalong Mine, which would occur regardless of the project.

Water quality is predicted to remain within the tolerances of the endangered Green and Golden Bell Frog (and its tadpoles), and maintain an EC which is likely to provide protection from the chytrid fungus.

Based on the results presented in the Groundwater Impact Assessment (GHD, 2020a), the project is unlikely to have any significant influence of the water levels in the Awaba underground void. The potential water quality impact associated with this scenario are unlikely to eventuate.

Licensing requirements

Harvestable rights

There is no interception of clean water by means of a dam on a first or second order stream proposed as part of the project. Existing dirty water management structures for the capture, containment and recirculation of water to prevent contamination of downstream watercourses will continue to be exempt from consideration under harvestable rights. Therefore, there are no harvestable rights entitlements or requirements relevant to the project.

Surface water licensing

The project has the potential to further enhance infiltration of surface water to the underground storages and voids formed by mining, however with implementation of the proposed mitigation measures, no additional surface water take is expected as a result of the project. Therefore there are no additional surface water entitlements expected to be required as a result of the project.

Both the Dora Creek and North Lake Macquarie water sources are fully allocated, with no unassigned water available from these sources. In the unlikely event that the project results in additional surface water take that is not able to be mitigated, Centennial Newstan will reallocate up to 750 ML/year from WAL 18735 from the Main Bywash Dam at the Newstan Colliery Surface Site, which is currently under-utilised. This reallocation would be subject to assessment and approval by NRAR.

Environment protection licences

The proposed water management system utilises the existing LDPs at Newstan Colliery Surface Site (under EPL 395) and Awaba Colliery Surface Site (under EPL 443). No additional LDPs are required for the project.

As the Extension of Mining Area is developed through the life of the project, the groundwater intercepted in the West Borehole seam will continue to be metered and monitored and the hydrogeological and site water balance will be updated annually. If the rate of groundwater interception is observed to exceed the existing rate of up 1.2 ML/day, or the updated hydrogeological model predicts that this may occur, the volumetric discharge limit of Newstan LDP001 will need to be increased to 14.5 ML/day (consistent with the volumetric limit approved under SSD-5145). This will allow for the safe operation of mining and minimise the potential for discharges of untreated water via Newstan LDP017 to Stony Creek.

Awaba LDP009 currently has a volumetric discharge limit of 8 ML/year. This is not appropriate for a rainfall based discharge point, as site operations do not control the volume of rainfall runoff reporting to the Pollution Control Dam and discharging via LDP009. The volumetric discharge limit on LDP009 should be removed and water quality concentrations limits should not apply when discharges occur as a result of water rainfall that exceeds the design criteria rainfall depth of 76.7 mm over 5 days. A requirement for the timely dewatering and periodic desilting of the dirty water surface storages should be stipulated by EPL 443.

The Awaba seepage is expected to continue to passively report to the unnamed tributary of Muddy Lake, and not be significantly impacted by the project. Notwithstanding, given the diffuse nature of the Awaba seepage, the current downstream monitoring location SP5, where flow is concentrated by an access road, is considered an appropriate location for the LDP. Discharges via this potential LDP are not controlled by operations and therefore a volumetric discharge limit is not appropriate.

6.4.5 Mitigation and management

Flow monitoring

The existing flow monitoring program at Newstan Colliery and Awaba Colliery will be continued, in particular the continued monitoring of the discharges via Newstan LDP001 and LDP017 and extractions from the Fassifern underground storage. To improve confidence in the site water balance model, the following additional flow monitoring will be installed within 12 months of project approval:

- Southern Reject Emplacement Area (SREA) decant pond: an automated water level sensor and data logger will be installed in the decant pond in order to provide a more accurate estimate of the flows into the Fassifern underground storage via the decant borehole.
- SP5: an automated water level sensor and data logger will be installed at the existing V-notch weir at SP5. The sensor and data logger will be appropriately shielded to prevent interference from the overhead high voltage transmission lines. The purpose of this monitoring is to provide a continuous record of stream flow that can be used to investigate potential changes to surface infiltration to the Awaba underground void.
- 10 South bore: a flow meter and data logger will be installed on dewatering line from the pump in the 10 South bore. The purpose of this monitoring is to provide a more accurate estimate of the extraction from the Awaba underground void.
- Water levels in Awaba underground void: an automated pressure transducer and data logger will be installed in at least one groundwater monitoring bore to provide continuous record of water levels in the Awaba underground void. The purpose of this monitoring is to provide a continuous record of water levels that can be used to investigate potential changes to surface infiltration to the Awaba underground void.

- 19 cut through and Fassifern dewatering bores: these existing flow meters will be recalibrated to improve confidence in the estimation and groundwater interception and surface infiltration.
- Any new dewatering pumps installed in the Extension of Mining Area will have individual flow meters installed.

Water quality

Water quality monitoring

The existing water quality monitoring sites detailed in Appendix K will continue to be monitored monthly during construction and operation of the project, with the following exceptions:

- Monitoring will be discontinued at WMP32, as the site has been inaccessible since 2015 and the water quality results obtained have indicated the impacts of leachate from the Awaba Waste Management Facility, which would likely make the detection of potential impacts from surface deformations within the catchment difficult.
- Monitoring at site WMP23 in the Lords Creek catchment will be discontinued, as the site has not contained sufficient water for sampling within the baseline monitoring period.
- Monitoring at Awaba seepage site SP3 will be discontinued, as monitoring has not been undertaken since 2014 and is not required due to the likely similarity of the water quality at this location to that at nearby site SP2.

In addition to the existing monitoring sites, monthly monitoring will commence at the following three sites (refer to Appendix K):

- WMP50 – located in the upper reaches of Lords Creek upstream of existing monitoring location WMP35.
- WMP51 – located on Stony Creek downstream of existing monitoring location WMP29.
- WMP52 – located on Stockyard Creek directly downstream of the Extension of Mining Area.

Site-specific guideline values

Site specific guideline values (SSGVs) will be derived in the water management plan (WMP) for the project and revised as necessary following the methodology recommended by ANZG (2018). These SSGVs will be defined for each of the catchments potentially affected by subsidence if sufficient data are available (at least 24 months of monthly data).

Awaba Colliery Surface Site

Water quality monitoring of the Pollution Control Dam will occur prior to any controlled discharges to ensure water quality is less than or within the concentration limits for Awaba LDP009.

If settling does not, or is not expected to, occur within the required five day management period, management of suspended solids within the Pollution Control Dam may be undertaken if required (i.e. if total suspended solids is greater than 50 mg/L). The application of coagulating and/or flocculating agents, such as gypsum, polyacrylamides and alum, may be necessary to enhance sediment removal prior to discharge. The application rate is required to be sufficiently high enough to remove suspended solids and allow discharge of water within an acceptable time without polluting receiving waters with the coagulating/flocculating agent itself.

Centennial Newstan undertake regular site inspections of the water management structures at the Awaba Colliery Surface Site. During operation of the project, site inspections will be completed weekly as a minimum as well as soon as practicable following rainfall events that exceed 40 mm over 24 hours. The Pollution Control Dam will be inspected for capacity, structural integrity and effectiveness. Sediment accumulated within the dam will be removed as required to maintain water storage capacity.

In the unlikely event that water quality was not compliant, infrastructure would remain in place to transfer water to the Awaba underground void. All discharges via LDP009 will be compliant with EPL 443.

Water and salt balance model

The water and salt balance model will be reviewed and revised annually. The average predicted water balance for the project will be included in the water management plan and the results for each year will be reported in the Annual Review for the project.

Management plans

Water management plans

Following approval of the project, the site-specific water management plan for Newstan Colliery and Awaba Colliery will be merged and updated to include the water management requirements of the project. TARPs are provided in the site-specific water management plans. Additional TARPs will be developed as required to provide guidance on the immediate actions that should be taken in response to any impacts of the project identified as part of the monitoring program.

The Centennial Northern Operations Discharge Management Plan will also be reviewed and revised as required to update the necessary discharge management requirements of the project. These revised management plans will then be implemented.

Extraction plans

Extraction plans will be developed and implemented for each extraction area prior to mining. Each extraction plan for the project will include a water management plan to manage potential subsidence-related impacts to water resources.

Sinkhole Rehabilitation Plan

The Sinkhole Rehabilitation Plan for Awaba Colliery was prepared in response to the formation of a number of sinkholes above the historical underground workings at Awaba Colliery. The plan outlines the methodology for the effective rehabilitation and maintenance of sinkholes.

Following approval of the project, the Sinkhole Rehabilitation Plan will be updated or integrated into the relevant subsidence management plans for the project and may consider the emerging availability of technology for monitoring of subsidence, including drones fitted with LiDAR units.

Erosion and sediment control plans

Erosion and sediment control will continue to be undertaken in accordance with the erosion and sediment control framework outlined in the Newstan Colliery Water Management Plan. All construction activities associated with the Project will have a detailed Erosion and Sediment Control Plan (ESCP) prepared based on specific construction methodologies.

6.5 Flooding

A Flooding Impact Assessment was prepared by EMM to assess the potential flooding impacts of the project. The information presented in this section is summarised from the Flooding Impact Assessment (EMM, 2020a), which is presented in full in Appendix L.

The scope of the Flooding Impact Assessment was designed to address the SEARs (refer to Appendix A) with regard to the assessment of flooding impacts.

6.5.1 Background

Subsidence may impact the form and extent of catchments and can alter or create new flow paths. It may also impact the timing, magnitude and total volume of flow within watercourses. Changes in catchment hydrology may result from the following mechanisms:

- Flattening of the landform, leading to slower catchment response and attenuation of flow (ie reduced and delayed peak flow).
- Steepening of the landform, leading to quicker catchment response and reduced attenuation of flow (i.e. increased and faster peak flow).
- Changes in surface storage within flow paths or undrained depressions in the catchment resulting in increased or decreased ponding of water.

These changes in catchment hydrology can result in hydraulic impacts on flood characteristics such as inundation extent, depth and velocity.

The primary objective of the Flood Impact Assessment was to evaluate the potential impacts of the project on existing hydraulic behaviour. The assessment considered:

- Impacts of the project on flood behaviour of other developments or land.
- Impacts to infrastructure within the study area with reference to flood behaviour.
- Potential changes to floodplain risk as a result of the project.
- Potential changes to watercourse hydraulic behaviour to assist in informing the Aquatic Ecology Impact Assessment (refer to Section 6.7).

The Flood Impact Assessment (EMM, 2020a) also considered the findings of a Watercourse Geomorphology Assessment completed by Soil Conservation Service (SCS) (2019). The primary objectives of the watercourse geomorphology assessment were to assess the impacts of project-related subsidence on the geomorphology of watercourses and to identify the level of risk to geomorphic integrity. It included:

- Assessment and mapping of geomorphic type and condition of watercourses.
- Assessment of watercourse response to potential gradient increases and decreases resulting from subsidence.
- Identification of potential threats to infrastructure from watercourse impacts.
- Development of measures to manage project-related impacts to watercourses.

6.5.2 Methodology

Flood models were developed to assess existing flood conditions as well as the impact of predicted subsidence on flood behaviour within the study area and downstream areas. Flooding conditions and impacts were assessed for a range of flood frequencies up to and including an extreme event approximating the probable maximum flood.

Results of the flood modelling were also utilised to inform the Watercourse Geomorphology Assessment (SCS, 2019), which forms Appendx A of the Flood Impact Assessment (EMM, 2020a)(provided in Appendix L), the Surface Water Assessment (GHD, 2020c)(refer to Section 6.4), and Aquatic Ecology Assessment (GHD, 2020d) (refer to Section 6.7).

Field survey

A field survey of the study area was undertaken by SCS and EMM in August 2019. The field survey focused on watercourses and watercourse structures with the greatest potential to be impacted as a result of predicted subsidence. Photographs and observations made during the site inspection are included in the Flood Impact Assessment report in Appendix L.

Hydrology model

A hydrology model was developed to assess design flows within the study area and adjacent catchments. The hydrology model was utilised to provide peak flow input into one-dimensional (1D) hydraulic models for select watercourse reaches within the predicted subsidence impact areas and to determine the critical storm events for assessment in a two-dimensional hydraulic model.

Hydraulic model

A regional two-dimensional hydraulic model was developed to inform a watercourse geomorphic assessment, quantify changes in peak flows leaving the subsidence impact areas and identify flooding impacts within the Extension of Mining Area including changes to remnant ponding. Six watercourse reaches were selected for 1D hydraulic modelling to provide more detailed inputs to the watercourse geomorphology assessment.

Key storm events

Storm events considred for the hydraulic assessment are listed in Table 6-14. As noted in Table 6-14, an extreme event was assessed as a proxy for the probable maximum flood (PMF) by factoring up the 1% annual exceedance probability (AEP) design rainfall depths by a multiple of four. This multiplication factor was determined from review of the Dora Creek Flood Study (WMAwater, 2015) and comparison of results for the 1% AEP and PMF events for nearby Jigadee Creek.

Table 6-14 Key storm events assessed

Storm event	Model approach	Assessment objective
2 exceedences per year (EY) event	1D modelling	• Utilised to assess impacts to watercourse velocity for frequent events. • Informs the Geomorphology Assessment.
0.5 EY event	1D modelling	• Utilised to assess impacts to watercourse velocity for frequent events. • Informs the Geomorphology Assessment.
	2D modelling	• Utilised to assess potential changes to watercourse alignment. • Utilised to assess potential changes to remnant ponding. • Informs Aquatic Ecology Assessment.

Storm event	Model approach	Assessment objective
1% AEP event	2D modelling	• Utilised to assess: – Impacts to flood behaviour of other developments or land – Impacts to infrastructure within the study area – Impacts to floodplain risk as a result of the project.
0.5% AEP event	2D modelling	• Utilised to assess flood impacts for larger storm events. • Utilised as a proxy for assessing a 10% increase in rainfall as a result of climate change.
0.2% AEP event	2D modelling	• Utilised to assess flood impacts for larger storm events. • Utilised as a proxy for assessing a 30% increase in rainfall as a result of climate change.
Extreme event	2D modelling	• Utilised as a proxy for the PMF event to estimate the upper limit of flooding within the study area.

6.5.3 Existing environment

Flood depth

Predicted existing conditions flood extent and depth mapping for the 0.5 EY, 1% AEP, 0.5% AEP, 0.2% AEP and extreme events are provided in Appendix L.

The flood extent and depth results indicate the following key hydraulic properties:

- A total flood inundation area (where peak flood depths are greater than 100 mm) of 84 hectares (ha) and 131 ha is experienced in the 0.5 EY and 1% AEP events respectively. The 1% AEP event results in a 56% increase in the flood inundation area compared to the 0.5 EY event.
- Flood depths of greater than 100 mm are typically confined to defined watercourses, with most of the study area experiencing flood depths of less than 100 mm.
- Flood depths of greater than 1 m are generally only experienced within:
  - The thalweg of larger watercourses such as WC8, WC9, Stony Creek and Stockyard Creek.
  - Upstream of assumed watercourse crossing areas where ponding occurs due to flow constrictions.
  - Within existing waterbodies such as the detention basins and dams associated with the Eraring Power Station.

Flood velocity

The flood velocity results for existing conditions, as shown in the mapping in Appendix L indicate the following key hydraulic properties:

- The majority of inundated areas within the study area are flowing at peak velocities less than 1.5 m/s.
- Peak velocities greater than 1.5 m/s generally occur in areas of steeper terrain, or in channel reaches that experience constrictions and/or sharp changes in longitudinal grade.

Existing geomorphic condition

Bed gradients

Bed gradients can be associated with watercourse type according to catchment position and valley confinement.

Bed gradients within the Extension of Mining Area ranged from 0.002 metres per metre (m/m) to 0.15 m/m, with the lowest gradients being associated with swamp and low sinuosity, fine grained systems and higher gradients being associated with headwater reaches.

Geomorphic condition

Watercourses were also assessed for geomorphic condition and categorised as good, moderate or poor condition. Geomorphic condition accounts for degradation from original condition, signs or potential for recovery, likelihood of ongoing degradation and river behaviour.

Good condition reaches (84% of assessed watercourse length) were the most common type due to the relatively undisturbed nature of the Extension of Mining Area. Moderate condition reaches (11% of assessed watercourse length) displayed signs of disturbance such as channel incision, bank erosion, degraded vegetation or increased sedimentation. Many moderate condition reaches displayed evidence of channel stabilisation and recovery from past disturbances.

Poor condition reaches (5% of assessed watercourse length) were uncommon within the Extension of Mining Area and were largely restricted to areas impacted by infrastructure such as road crossings, disused railway lines or drainage cuttings. Poor condition reaches frequently contained large headcuts (greater than 0.5 m) and presented signs of active erosion and continuing gully headcut retreat and gully wall expansion. These reaches have undergone shifts in geomorphic behaviour and type due to channel incision and expansion reducing overland flows and reducing surrounding water dependent ecosystems.

Reaches classified as ‘modified’ watercourses (4% of assessed watercourse length) were considered in poor condition due to the extreme reduction in geomorphic complexity and low ecosystem value. These reaches included those in recently rehabilitated sinkhole areas due to the uniform, canal-like channel design and evidence of instabilities.

The geomorphic condition of watercourses within the Extension of Mining Area are mapped in Appendix L.

Geomorphic stability

The majority of assessed watercourses were geomorphically stable due to low levels of disturbance and the types of watercourses present. In disturbed areas, many of the streams displayed geomorphic instability in the form of headcut retreat and bank erosion. Many reaches of poor or moderate condition showed signs of increasing stability through recovery processes such as bank stabilisation and revegetation, in-channel deposition and pondreformation.

6.5.4 Impact assessment

Flood depth

Changes to flood extent and depth for the 0.5 EY, 1% AEP, 0.5% AEP, 0.2% AEP and extreme events are mapped in Appendix L.

Key changes to flood extent and depth when compared to existing conditions are:

- The extent of flood inundation is similar to existing conditions with new areas of flooding (‘was dry now wet’) and areas that no longer experience flooding (‘was wet now dry’) generally being evenly distributed.
- Depth changes greater than 50 mm typically occur in isolated areas or in reaches where the predicted subsidence contours are adjacent to the watercourse. Depth changes are primarily experienced in the following locations:
  - WC8a and WC20 both upstream and downstream of the Newstan-Eraring Private Coal Haul Road
  - watercourses upstream of the Eraring Power Station
  - Stony Creek downstream of the predicted subsidence area and upstream of the Awaba Colliery Surface Site
  - within existing waterbodies such as the detention basins and dams associated with the Eraring Power Station
- Depth increases generally occur where drainage lines have been changed to have flatter or adverse longitudinal grades as a result of subsidence. This typically occurs in areas where subsidence predictions reduce between adjacent excavation on the downstream side of the potential subsidence area.
- Depth decreases generally occur where drainage lines are steepened as a result of subsidence. This typically occurs as a drainage line first enters an area of subsidence. Decreases in depth are also experienced along watercourses downstream of the predicted subsidence area, where flows have been reduced or delayed due to increased storage (eg Stony Creek upstream of the Awaba Colliery Surface Site).

In some areas, subsidence predictions result in a change to watercourse alignments. This typically occurs where a watercourse alignment is parallel to the subsidence contours, essentially redirecting flow from one side of the watercourse to the other.

The risk of realignment drying up a section of a watercourse decreases as the storm event increases in intensity, as there are greater flows available to fill the entire watercourse cross-sectional profile.

Flood velocity

The changes in flood velocity resulting from subsided conditions for the 0.5 EY, 1% AEP, 0.5% AEP, 0.2% AEP and extreme events are mapped in Appendix L.

Subsided conditions hydraulic model results show the following key changes to flood velocity compared to existing conditions:

- Subsided conditions generally reduce velocities within the study area with a greater area of negative velocity change (comparatively slower water) experienced compared to positive velocity change (comparatively faster water).
- Velocity changes greater than 0.05 m/s typically occur in isolated areas or in reaches where the predicted subsidence contours result in a change to the grade of a watercourse. Velocity changes are primarily experienced in the following locations:
  - WC8a and WC20 both upstream and downstream of the Newstan-Eraring Private Coal Haul Road.
  - Watercourses upstream of the Eraring Power Station.
  - The upper reaches of the Stony Creek and Stockyard Creek catchments.

- Within existing waterbodies such as the detention basins and dams associated with the Eraring Power Station.

- Velocity increases are generally below 0.5 m/s and typically occur along drainage lines where the terrain has been steepened due to predicted subsidence. Velocity increases are also experienced in areas where watercourse realignment has resulted in greater flows occurring in one portion of a channel cross section compared to another.
- A decrease in velocity generally occurs along drainage lines where subsided conditions have resulted in flatter or adverse longitudinal grades. This mainly occurs as flow paths exit the area of predicted subsidence (or at the point where potential subsidence decreases slightly between adjacent excavations).

Discharge

Discharge hydrographs for the 0.5 EY and 1% AEP events are presented in Figure 6-9 and Figure 6-10, respectively. The discharge hydrographs compare existing and subsidence conditions at key model outlets (WC9, Stockyard Creek and Stony Creek). The following changes to discharge are observed:

- Subsided conditions are shown to reduce peak flows discharging from the study area. The largest change in peak flow occurs at the WC9 outlet with a reduction of 0.4 cubic metres per second (m^3/s) (-2.4%) and 2.9 m^3/s (-3.8%) in the 0.5 EY and 1% AEP events, respectively. It should be noted that although peak flows at the outlet of the study area are reduced under subsided conditions, local discharge hydrographs within the study area may experience increased peak flow at some locations.
- The timing of the discharge hydrograph is delayed at some locations for subsided conditions. The magnitude of the delay is a function of the extent and degree of potential subsidence within each sub-catchment and how the predicted subsidence aligns with existing watercourses (ie whether the watercourse alignment is parallel or perpendicular to the subsidence contours).
- Although peak flows are reduced for subsided conditions, the delay in timing may increase flows on the falling limb of the discharge hydrograph compared to existing conditions. The maximum increase in discharge resulting from subsidence conditions occurs at the WC9 outlet with an increase of 0.2 m^3/s (+2.1%) and 1.3 m^3/s (+3.8%) in the 0.5 EY and 1% AEP events, respectively.

The reduction in peak flow and delayed hydrograph timing for subsided conditions is interpreted to be a result of increased attenuation due to a slower catchment response and additional catchment storage due to potential subsidence forming areas of ponding within drainage lines or undrained depressions within the catchment.

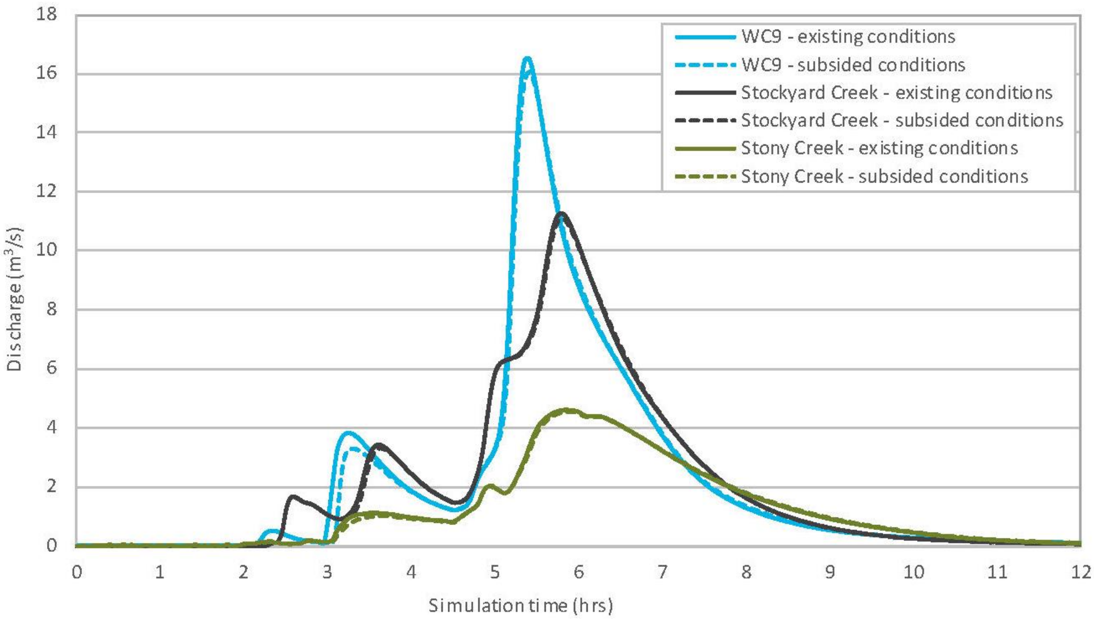

Figure 6-9 Comparison of discharge hydrographs – 0.5 EY event (EMM, 2020)

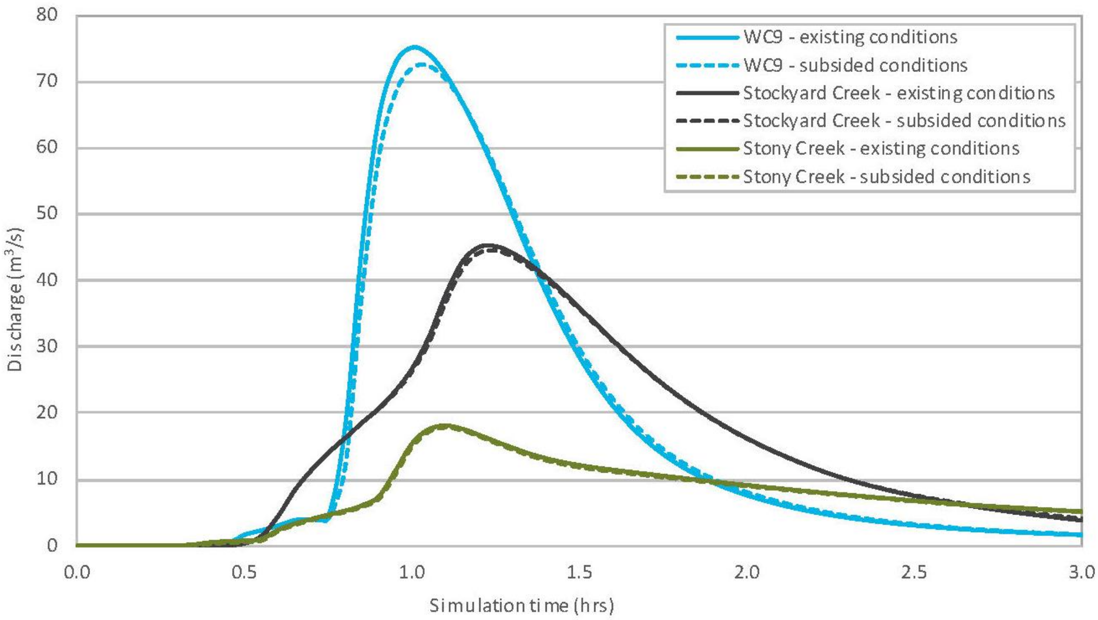

Figure 6-10 Comparison of discharge hydrographs – 1% AEP event (EMM, 2020)

The greatest discharge hydrograph impacts are experienced for WC9, which is a tributary of Lords Creek. The peak flows in Lords Creek for existing and subsided conditions are shown in Table 6-15. The Lords Creek 1% AEP event peak flow is reduced by 3.2 m^3/s for subsided conditions, which is similar to the 2.9 m^3/s reduction experienced at the outlet of the WC9 catchment. There is no change to peak flow for the 0.5 EY event as peak flow from the WC9 catchment does not coincide with the Lords Creek catchment peak for this storm event.

Table 6-15 Peak flows in Lords Creek

Storm event	Peak flow – existing conditions (m^3/s)	Peak flow – subsided conditions (m^3/s)	Difference (m^3/s)
0.5 EY	49.1	49.1	0.0
1% AEP	143.2	140.0	3.2

Remnant ponding

The hydraulic model results show that an additional 1.6 ha of remnant ponding may be experienced under subsided conditions. The areas expected to experience changes in remnant ponding as a result of the project are mapped in Appendix L.

Flooding impacts to infrastructure

The hydraulic results for the predicted subsided conditions identify the changes in flood characteristics have the potential to impact infrastructure within the study area. No material impacts to infrastructure are expected to occur downstream of the study area as subsided conditions have been shown to reduce peak flows discharging from the study area in all modelled watercourses and design storm events.

Potential flooding impacts to infrastructure within the study area are described in Table 6-16.

Table 6-16 Flooding impacts to infrastructure

Issue/ description	Potential impact	Relevant locations
Lowering of waterway structure upstream and/or downstream inverts	• Waterway structure may become structurally unstable. • Modifications to the hydraulic regime which may increase/decrease flows received downstream. • Modifications to the hydraulic regime which may result in additional ponding upstream of the waterway structure. • Modifications to the hydraulic regime which may increase outlet velocities and the risk of scour.	• Observed culverts beneath Newstan-Eraring Private Coal Haul Road). • Upstream end of culvert that drains beneath the Eraring Power Station site. • Other minor waterway crossings assumed to exist within the predicted subsidence area.
Lowering of existing waterbody embankments	• Embankment may become structurally unstable increasing risk of failure/overtopping. • More frequent overtopping due to lower spillway level and storage volume.	• Sediment dams along Newstan-Eraring Private Coal Haul Road. • Sediment dam downstream (but offline) of Hawkmount Quarry.
Changes to waterbody bathymetry	• Redistribution of stored water resulting in altered waterbody footprint. • Increased depth of stored water.	• Hawkmount Quarry and downstream sediment dam. • Sediment dams along Newstan-Eraring Private Coal Haul Road. • Eraring Energy site dam.
Nuisance ponding due to newly created localised low areas	• Reduced access during and after material storm events. • Increased driving hazard where ponding occurs on roads and access tracks.	• Sections of Newstan-Eraring Private Coal Haul Road. • Several access tracks north of Eraring Power Station. • Clean water diversions around Eraring Ash Dam.

Impacts to flood risk planning

Flood impacts are contained predominantly on undeveloped Crown land and private land holdings relating to the Eraring Power Station. Localised flood impacts in these areas relate to potential maximum subsidence predictions which are unlikely to occur at the same time due to staged extraction.

Peak flows of watercourses downstream of the study area are expected to decrease, causing a minor reduction in peak flood levels outside of the subsidence prediction extent. Comments on the impacts of flood risk planning are provided in the following sections.

Flood planning levels

Flood levels for the 1% AEP event are predicted to decrease across the subsidence impact area due to the reduction in landform levels. As such, flood planning levels have not been mapped as these are predicted to decrease. In addition to this, areas across the subsidence impact area are largely undeveloped, undulating natural bushland. As described above, peak flows of watercourses downstream of the study area are expected to decrease, causing a reduction in flood planning levels for any downstream properties. Flood affectation of properties is not expected to change as a result of the project.

Floodplain categorisation

Minor localised changes to the floodway, flood fringe and flood storage categories are expected within the subsidence impact area in accordance with minor shifts of the watercourse alignment. Localised changes to floodplain categorisation are not expected to impact existing development or infrastructure, as the subsidence impact area is largely undeveloped, undulating bushland. Outside of the subsidence impact area, minor reductions in the area of more severe floodplain categories is expected due to the reduction of peak flows leaving the subsidence impact area.

Flood hazard and emergency management

Localised changes in flood hazard are expected around watercourses where longitudinal stream gradients are locally altered due to land deformations. Localised changes to flood hazard are not expected to impact existing development or infrastructure, as the subsidence impact area is largely undeveloped, undulating bushland.

Downstream of the subsidence impact areas, flood hazard is expected to decrease due to minor attenuation of peak flows within the Extension of Mining Area. Emergency management arrangements are not expected to change as a result of the project.

Watercourse responses to increased gradient and flow velocities

The potential risk of geomorphic change occurring due to increases in gradient and flow velocities is dependent on the watercourse type and the ability for a watercourse to undergo geomorphic change as well as the severity of change in gradient or flow velocity.

The majority of watercourses were assessed to have a low risk of impact specifically as a result of subsidence increasing grade. This was due to the low severity of change in gradient or flow velocity. Several watercourse reaches of relatively short length were identified as being at moderate or high risk, including sections of Stockyard Creek and an unnamed tributary, and a number of unnamed watercourses.

The assessed geomorphic risk for the watercourses within the Extension of Mining Area is mapped in Appendix L.

Watercourse responses to decreased gradient and flow velocities

Watercourse types within the Extension of Mining Area are less susceptible to the effects of decreased gradient and flow velocities due to being predominantly fine grained, low energy systems. Localised predicted minimum flow velocities of 0.03 m/s could result in reduced sediment transport leading to increased rates of sediment deposition. However, the velocity of the majority of subsided areas is predicted to remain above 0.2 m/s and should be able to maintain suspended sediment transport and are unlikely to result in significant sediment deposition.

Increased remnant ponding predicted has the potential to affect the transport of water and sediment, particularly during periods of low flow. Increased sediment accumulation and water retention in these areas of ponding could result in impacts to in-channel vegetation due to longer periods of inundation.

Geomorphic impacts on infrastructure

Geomorphic impacts from subsidence may threaten key infrastructure if headcut retreat is initiated in reaches immediately below infrastructure. There is potential risk to the railway loop line (Ulan Rail Loop) from subsidence of the tributaries of Stockyard Creek that intersect or flow below the railway embankment. These reaches are currently swamp systems on the uppermost gradient for the watercourse type and therefore have low tolerance to increased gradients. There is a moderate to high risk that subsidence could initiate headcut erosion and retreat in these systems, resulting in undercutting or bank failure.

6.5.5 Mitigation and management

Targeted monitoring and management plans will be developed for watercourses with a moderate or high geomorphic risk rating. Regular visual inspections, and use of remote sensing technology where appropriate, will allow identification of problem areas and potential threats to nearby infrastructure, as well as development and implementation of appropriate stabilisation techniques as required. These measures would be captured as works associated with Extraction Plans.

6.6 Terrestrial ecology

A Biodiversity Development Assessment Report (BDAR) (RPS, 2020a) and Biodiversity Inventory Report (BIR) (RPS, 2020b) were prepared by RPS to assess the potential impacts to terrestrial ecology as a result of the project. The information presented in this section is summarised from the BDAR and BIR, which are presented in full in Appendix M. The BDAR and BIR were prepared to address and satisfy the relevant project SEARs (Appendix A) with regard to impacts to biodiversity.

6.6.1 Background

A BDAR is a specific type of biodiversity impact assessment report prepared in accordance with the Biodiversity Assessment Methodology (BAM) to assess terrestrial biodiversity impacts listed under the BC Act. The BAM is established by the *Biodiversity Assessment Method Order 2017* (OEH, 2017) under the provisions of Part 6, Division 2 of the BC Act.

The BDAR includes, but is not be limited to:

- Review of previous ecological investigations undertaken in proximity to the project.
- Mapping of Plant Community Types (PCTs) impacted by the project.

- Mapping of habitat used by 'Candidate Species' that are likely to be impacted by the project. Candidate species are species that are assessed for species credits under the BAM.
- Identification of impact avoidance, minimisation, mitigation and management measures as required.
- Calculation and collation of a credit ledger for Ecosystem and Species Credit Species impacted by the project.
- Reporting of the above and other relevant assessment matters specified in the BAM.

The primary purpose of the BIR is to document the biodiversity values of the study area, thus serve as a primary resource document for the BDAR. In addition, the BIR serves a dual purpose for assessing other regulatory matters not relevant to the prescribed content of a BDAR, including relevant State Environmental Planning Policies (SEPPs) and also serving as an accredited assessment to assess MNES identified under the EPBC Act.

Study area

The study area for the BDAR and BIR was determined based on the area that could be impacted by subsidence or vegetation clearing for construction of surface infrastructure and comprised 1440.26 ha, including the Extension of Mining Area, Awaba Colliery Surface Site and a buffer of approximately 100 m surrounding these areas. A 1,500 m buffered zone around the study area was also considered, in accordance with the BAM, for the assessment of landscape features.

6.6.2 Methodology

The project was assessed in accordance with the BAM *(OEH, 2017)*. The BAM sets out the requirements for a repeatable and transparent assessment of terrestrial biodiversity values on land in order to:

- Identify the biodiversity values on land subject to proposed development.
- Determine the impacts of proposed development.
- Quantify and describe the biodiversity credits required to offset the residual impacts of proposed development.

Key components of the assessment methodology are presented below. A detailed description of the assessment methodology is provided in Appendix M.

Desktop Assessment

A review of relevant information was performed to gain an understanding of the biodiversity values occurring or potentially occurring within the Study Area. Information sources reviewed for a 10 km radius of the Study Area (hereafter the 'locality') included:

- BAM Calculator candidate species output.
- Flora and Fauna records contained in the BCD (formerly OEH) Wildlife Atlas of NSW.
- Flora and Fauna records contained in the DAWE (formerly DotEE) Protected Matters Search Tool.
- Lake Macquarie Native Vegetation Community Map (Bell & Driscoll, 2015).
- Mitchell Landscapes (NPWS, 2003).

- Interim Biogeographic Regionalisation for Australia (IBRA) region and subregion mapping.
- Recent aerial imagery of the study area.
- Relevant literature and previous ecological reports prepared for the study area.

The list of threatened species, populations and ecological communities identified as potentially occurring within the study area was used to guide field survey investigation methods and effort.

Field survey

Flora surveys were undertaken in accordance with the BAM to identify the vegetation communities existing on site. The Lake Macquarie Vegetation Community Mapping (Bell & Driscoll, 2015) was used as the basis for a preliminary analysis of vegetation patterns within the study area. Preliminary PCTs were assigned to areas of relatively homogenous land cover and revised following completion of field surveys. PCT extent was then calculated to determine the number of BAM plots required and implementation of other survey methods.

Forty-one floristic plots were undertaken in accordance with the BAM to measure the vegetation integrity (i.e. composition, structure and functional components) of the sites' native vegetation cover.

Targeted flora searches were conducted with the aim of locating threatened flora species identified as Candidate Species or those not identified but have a moderate or greater likelihood of occurring in the study area.

Fauna surveys were carried out based on the identified threatened fauna species listed under the BC Act and/or EPBC Act that may occur within the study area. Survey techniques included ground trapping, hair tubes, infrared cameras, spotlighting, call playback, Anabat recordings, point sampling for avifauna and opportunistic sightings.

Habitat surveys were undertaken to assess the condition and value of habitat across the study area. Significant fauna habitat features, including hollow-bearing trees, hollow logs and termite nests, were identified and noted.

6.6.3 Existing environment

Landscape features

The Project Application Area is within the Sydney Basin Bioregion and Wyong Sub-bioregion and is located within the Gosford-Cooranbong Coastal Slopes Mitchell Landscape (NPWS, 2003).

The BAM prescribes a 1,500 m buffered zone around the study area for the assessment of landscape features. Approximately 3,266.07 ha of vegetation occurs within a 1,500 m buffer of the study area (70.7% of the buffer area). Within the buffer area, vegetation clearing has occurred associated with mining activities, power generation, ash dam disposal activities, transport (i.e. public roads and rail), agriculture (e.g. poultry farms, horse stables and livestock), past forestry activity, low-density residential housing and powerline easements. Approximately 29.29 % (1,353.35 of 4,619.42 ha) of the 1,500 m buffer area is cleared.

The study area drains via Stoney Creek, Kilaben Creek, Stockyard Creek, Lords Creeks and Crooked Creek. These tributaries ultimately drain into Lake Macquarie, which is at its nearest point, approximately 1km southwest of the study area.

0.23 ha of Freshwater Wetlands on Coastal Floodplains was identified within the study area as PCT 1737.

In terms of connectivity features, considerable clearing of vegetation has occurred within the locality. The native vegetation patch size associated with the study area is approximately 1,036.16 ha, which extends into tracts of bushland to the east and north. This vegetation tract incorporates part of the Awaba State Forest and Sugarloaf State Conservation Area. The M1 Pacific Motorway and Main Northern Railway corridor present a potential barrier for fauna moving west. Primarily housing development prevents a barrier to connectivity to Lake Macquarie.

There are no karst, caves, crevices, cliffs or other areas of geological significance within the study area.

Native vegetation

Native plant species

Approximately 340 flora species were detected within during field survey; 322 native and 18 exotic species. Of these, six were threatened plants listed under the *Biodiversity Conservation Act* 2016 (BC Act) or *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act), including:

- *Acacia bynoeana* (BC Act: Endangered, EPBC Act: Vulnerable)
- *Angophora inopina* (BC Act: Vulnerable, EPBC Act: Vulnerable)
- *Corybas dowlingii* (BC Act: Endangered)
- *Genoplesium insigne* (BC Act: Critically Endangered, EPBC Act: Critically Endangered)
- *Grevillea parviflora* subsp. *parviflora* (BC Act: Vulnerable, EPBC Act: Vulnerable)
- *Tetratheca juncea* (BC Act: Vulnerable, EPBC Act: Vulnerable)

For a full list of species see Appendix M.

High threat weeds

A list of high threat weed species detected within the study area during field surveys is provided in Table 6-17.

Table 6-17 High threat weeds detected within the study area

Scientific Name	Common Name	BAM High Threat Weed	Weed of National Significance (WONS)	Duty under Biosecurity Act (2015)
Ageratina riparia	Mistflower	Yes	No	N/A
Axonopus fissifolius	Narrow-leafed Carpet Grass	Yes	No	N/A
Cinnamomum camphora	Camphor Laurel	Yes	No	N/A
Ehrharta erecta	Panic Veldtgrass	Yes	No	N/A
Lantana camara	Lantana	Yes	Yes	General Biosecurity Duty Must not be imported into the State or sold
Must not be imported into the State or sold				N/A

Scientific Name	Common Name	BAM High Threat Weed	Weed of National Significance (WONS)	Duty under Biosecurity Act (2015)
Ligustrum sinense	Small-leaved Privet	Yes	No	N/A
Ochna serrulata	Mickey Mouse Plant	Yes	No	N/A
Rubus fruiticosus sp. agg	Blackberry	Yes	Yes	General Biosecurity Duty Prohibitions on dealings – must not be imported into the State or sold. Regional Recommended Measure for the Hunter region - The plant should not be bought, sold, grown, carried or released into the environment. Land managers should mitigate the risk of the plant being introduced to their land. Land managers should mitigate spread from their land. Land managers to reduce impacts from the plant on priority assets.

Plant community types

During field survey nine PCTs were identified within the study area. The vegetation condition of each PCT was classified as good, moderate, derived or poor. Detailed definitions of each criteria are presented in Appendix M. The identified PCTs are summarised in Table 6-18.

Table 6-18 PCTs within the study area

PCT	Condition	Area (ha)
PCT 1588 Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast;	Moderate	30.23
PCT 1598 Forest Red Gum grassy open forest on floodplains of the Lower Hunter;	Moderate	0.11
PCT 1619 Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands;	Moderate	421.2
PCT 1627 Smooth-barked Apple – Turpentine – Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast;	Moderate	108.81
PCT 1636 Scribbly Gum – Red Bloodwood – Angophora inopina heathy woodland on lowlands on the Central Coast;	Moderate	408.1
PCT 1638 Smooth-barked Apple – Red Bloodwood – Scribbly Gum grass – shrub woodland on lowlands of the Central Coast	Moderate	46.82
PCT 1716 Prickly-leaved Paperbark forest on the coastal lowlands of the Central Coast and Lower North Coast;	Moderate	5

PCT	Condition	Area (ha)
PCT 1718 Swamp Mahogany – Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	Moderate	15.77
PCT 1737 Typha rushland	Moderate	0.23
Total		**1036.27***

*The inconsistency with the study area size (1036.16 ha) is due to rounding.

Groundwater dependent ecosystems

The potential for Groundwater Dependent Ecosystems was explored using the Groundwater Dependent Ecosystems Atlas (GDE Atlas) (BoM, 2019). A map of likely groundwater dependent ecosystems for the study area was generated and is provided in Appendix M.

The primary source of groundwater in the region, owing to the underlying sandstone, is likely to be a sedimentary rock groundwater system.

All PCTs identified in Appendix M in these areas have a moderate or greater potential to be a GDE.

Fauna and fauna habitat

Sixteen native species of mammals were detected within the study area. Of these, the Squirrel Glider (*Petaurus norfolcensis*) is listed as vulnerable under the BC Act.

Twelve species of Microbat were positively identified within the study area. Of these species, the following threatened microbats were identified:

- *Miniopterus australis* (Little Bentwing-bat; BC Act: Vulnerable; EPBC Act: Not Listed).
- *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat; BC Act: Vulnerable; EPBC Act: Not Listed).
- *Micronumus norfolkensis* (East coast Free-tailed Bat; BC Act: Vulnerable; EPBC Act: Not Listed).
- *Scoteanax rueppellii* (Greater Broad-nosed Bat; BC Act: Vulnerable; EPBC Act).

A total of 120 species of birds were observed during the avifauna census and by opportunity. Of these, the following threatened birds were detected:

- *Calyptorhynchus lathami* (Glossy Black Cockatoo; BC Act: Endangered; EPBC Act: Not Listed).
- *Ninox strenua* (Powerful Owl; BC Act: Vulnerable; EPBC Act: Not Listed).
- *Haliaeetus leucogaster* (White-bellied Sea-Eagle; BC Act: Vulnerable; EPBC Act: Not listed).
- *Glossopsitta pusilla* (Little Lorikeet; BC Act: Vulnerable; EPBC Act; Not listed).
- *Daphnoenositta chrysoptera* (Varied Sittella; BC Act: Vulnerable; EPBC Act; Not listed).

Seven species of reptile and 11 species of frog were detected within the study area. None of the frogs or reptiles identified within the study area were listed as threatened under either the BC Act or EPBC Act.

As there was no rainfall event in the appropriate season that reached the calling trigger for *Litoria brevipalmata* (Green-thighed Frog; BC Act: Vulnerable; EPBC Act; Not listed), no adequate presence or absence surveys could be conducted for this species. As such, it was assumed that this species would be present within PCTs it is known to associate with. Green-thighed Frog habitat is assumed to encompass PCT 1588, as well as PCTs 1638, 1627, 1716, 1718 and 1737. In total, the potential habitat for the Green-thighed Frog was determined to be 206.86 ha.

Key habitat features identified within the study area for habitat specialists included sandstone rock (typically less than 1 m diameter) and 1257 hollow-bearing trees. Locations of these hollow-bearing trees are provided in Appendix M.

Ecosystem and species credit species

All ecosystem credit species identified as being associated with the PCTs present within the study area are provided in Appendix M. Of these ecosystem credit species, the following were detected within the Study Area:

- Climacteris picumnus victoriae (Brown Treecreeper).
- Callocephalon fimbriatum (Gang-gang Cockatoo).
- *Calyptorhynchus lathami* (Glossy-black Cockatoo).
- Glossopsitta pusilla (Little Lorikeet).
- Tyto novaehollandiae (Masked Owl).
- *Ninox strenua* (Powerful Owl).
- Daphoenositta chrysoptera (Varied Sittella).
- *Haliaeetus leucogaster* (White-bellied Sea Eagle).
- *Artamus cyanopterus* (Dusky Woodswallow).
- *Micronomus norfolkensis* (Eastern Coastal Free-tailed Bat).
- *Scoteanax rueppellii* (Greater Broad-nosed Bat).
- Miniopterus orianae oceanensis (Large Bent-winged Bat).
- *Miniopterus australis* (Little Bent-winged Bat).
- No ecosystem credit species were excluded from assessment based on habitat constraints or geographic limitations.

A total of 66 candidate species were predicted to occur within the study area, 16 of which were identified as being present within the study area:

- *Acacia bynoeana* (Bynoe's Wattle).
- *Angophora inopina* (Charmhaven Apple).
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo).
- *Corybas dowlingii* (Red-hooded Orchid).
- *Genoplesium insigne* (Variable Midge Orchid).
- Grevillea parviflora subsp. parviflora (Small-flower Grevillea).
- *Haliaeetus leucogaster* (White-bellied Sea-Eagle).
- *Litoria brevipalmata* (Green-thighed Frog).
- *Miniopterus australis* (Little Bent-winged Bat).

- Miniopterus orianae oceanensis (Large Bent-winged Bat).
- *Ninox strenua* (Powerful Owl).
- Pandion cristatus (Eastern Osprey).
- Petaurus norfolcensis (Squirrel Glider).
- *Pteropus poliocephalus* (Grey-headed Flying-fox).
- *Tetratheca juncea* (Black-eyed Susan).
- Tyto novaehollandiae (Masked Owl).
- Full details of species credit species are provided in Appendix M.

6.6.4 Impact assessment

The BDAR assessed the project impacts in accordance with the prescribed steps in Stage 2 of the BAM by first reviewing the avoidance and mitigation strategies proposed for the project and then assessing the residual impacts of the project.

Prescribed biodiversity impacts

The BC Regulation (clause 6.1) identifies actions that are prescribed as impacts to be assessed under the Biodiversity Offsets Scheme. Prescribed impacts identified in the study area include:

- Impacts to rocks.
- Impacts on water quality, water bodies and hydrological processes that sustain threatened species and threatened ecological communities.
- Impacts of vehicle strikes on threatened species of animals or on animals that are part of a TEC.

Surface cracking, fracturing and plug failures are predicted to occur within the study area (refer to Section 6.1.4). Minimal surface cracking on steep slopes is not likely to have significant impacts on biodiversity as most species occupying these habitats can avoid those cracks. If the cracks are large enough and occur in habitats designated as suitable for the Stephen’s Banded Snake (*Hoplocephalus stephensii*), there is a low likelihood of fauna mortality. Whilst isolated incidents may occur to an individual, it is not likely to create a significant impact to a local population of a threatened species.

Where small rocks are disturbed by surface infrastructure, they will be relocated in adjacent bushland to retain their habitat value for any rock-associated threatened species. Based on the small number and size of rocks predicted to be disturbed, when compared to the abundance of rock and rock outcrops in the local area, it is expected that the Project is unlikely to be significant for the local and bioregional persistence of the suite of any threatened species or community likely to use such habitat.

Increased ponding has the potential to occur along sections of streams within the study area (refer to Section 6.1.4). In addition to ponding, the project has the potential to lead to cracking and sinkholes along riparians zones as a result of subsidence. This can lead to changed waterflow conditions. Ponding and changed water flow conditions has the potential to either enhance or impacts to terrestrial vegetation.

Subsidence may impact the timing, magnitude and total volume of flow within watercourses (EMM, 2020a). Changes in catchment hydrology may result from the following mechanisms;

- Flattening of the landform, leading to slower catchment response and attenuation of flow (i.e. reduced and delayed peak flow).

- Steepening of the landform, leading to quicker catchment response and reduced attenuation of flow).
- Changes in surface storage within flow paths or undrained depressions in the catchment resulting in increased or decreased ponding of water.

Ecological communities and species potentially subject to the impacts from ponding include those that were recorded or predicted to occur within riparian areas, as follows:

- Swamp Sclerophyll Forest on Coastal Floodplains.
- Freshwater Wetlands on Coastal Floodplains.
- *Corybas dowlingii* (Red-helmet Orchid).
- Grevillea parviflora subsp. parviflora (Small-flowered Grevillea).
- *Tetratheca juncea* (Black-eyed Susan).
- *Litoria brevipalmata* (Green-thighed Frog).

Ponding has the potential to either enhance or to be detrimental to the species and ecological communities listed above.

No additional access tracks are proposed to be constructed as part of the project, however, vehicle presence and movement is likely to increase. The risk of vehicle strike on threatened species was assessed as generally low, with the exception of *Daphnoenositta chrysoptera* (Varied Sittella), which has a moderate likelihood of being struck by vehicles as it forages diurnally, potentially along access tracks.

Residual impacts

Direct impacts will be incurred through the proposed installation of infrastructure at Awaba Colliery Surface Site. Approximately 0.35 ha of native vegetation will be cleared for ancillary facilities. This includes an area approximately 0.15 ha of PCT 1718 which is commensurate with Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC.

Other direct impacts will be avoided by limiting surface infrastructure installation to pre-disturbed areas at Newstan Colliery Surface Site and Awaba Colliery Surface Site.

The project has the potential to lead to indirect impacts to threatened plants and ecological communities from cracking, sinkholes, plug-failures and ponding. As these impacts are uncertain, an adaptive management plan will be implemented to determine the occurrence of impacts and appropriate management measures (refer to Section 6.6.5).

Serious and irreversible impacts

A Serious and Irreversible Impact (SAII) may occur when the following entities are impacted:

- Species or ecological community currently in a rapid rate of decline.
- Species or ecological communities with very small population size.

One potential SAII species was recorded during field survey; *Genoplesium insigne* (Variable Midge Orchid).

Eighty-eight individuals *Genoplesium insigne* were detected during targeted surveys within the power line easement to the north west of the study area. This species is also considered to have additional potential habitat of 902.9 ha within the study area. A BMP will aim to determine whether the project has an impact on this species (refer to Section 6.6.5).

Requirement to offset

Approximately 0.35 ha of native vegetation will be cleared for ancillary facilities. This includes an area approximately 0.15 ha of PCT 1718 which is commensurate with Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions EEC. The credit liability associated with this loss of native vegetation is presented in Table 6-19. This credit liability would be offset in accordance with the NSW Biodiversity Offset Scheme.

Table 6-19 Offset liabilities for clearing of native vegetation

PCT	Area to be cleared	Credit liability
1588 – Grey Ironbark – Broad-leaved Mahogany – Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast	0.1 ha	4
1619 – Smooth-barked Apple – Red Bloodwood – Brown Stringybark – Hairpin Banksia heathy open forest of coastal lowlands	0.1ha	4
1718 – Swamp Mahogany – Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	0.15 ha	8

The majority of the potential impacts related to the project are indirect impacts such as cracking, sinkholes and plug-hole failures. In order to accurately determine the credit liability incurred by mining related impacts on threatened species or ecological communities, it is proposed that LIDAR be utilised to detect the potential impacts of the project (i.e. sinkholes, cracking and plug-failures) (refer to Section 6.6.5).

Groundwater dependent ecosystems

The project has potential to impact upon the identified potential GDEs through subsidence, however the location and extent of these impacts are uncertain given the potential interactions with existing workings in the Great Northern seam (MSEC, 2019b).

Koala habitat

Of the 41 floristic plots across the study area, five contained koala feed trees including *Eucalyptus microcorys* (Tallowwood) and *Eucalyptus robusta* (Swamp Mahogany). Four plots contained over 15% koala feed trees, constituting 'Potential Koala Habitat' under SEPP 44. However, there have been no reported sightings of Koalas within the study area, with the closest and most recent reported sightings made in 2012 within the M1 Pacific Motorway corridor, approximately 600 m to the east. Given the low levels of Koala activity evidenced within the study area, the study area is not considered to constitute 'Core Koala Habitat' as defined under either SEPP 44 or SEPP (Koala Habitat Protection) 2019, and hence no further provisions of these policies apply to the project.

Environmental Protection and Biodiversity Conservation Act 1999

The BIR serves as an accredited assessment to assess MNES listed under the EPBC Act. Twenty-seven nationally listed migratory terrestrial and wetland species were recorded or are considered to have potential habitat available within 10 km of the study area (refer to Appendix M). The proposed works are unlikely to impact on any area considered to be 'important habitat' for these migratory species or impact a significant proportion of a migratory population.

Sixty-seven nationally threatened species have been recorded or may occur within 10 km of the study area. Only 36 of these species are deemed as having a moderate or greater likelihood of occurring within the study area. These species are listed in Appendix M. Threatened species identified as having a moderate or greater likelihood of occurring within the study area were subjected to an EPBC Assessment of Significance and significant impacts were determined to be unlikely (refer to Appendix M).

An analysis was performed for the study area in accordance with the referral guidelines for the Koala (DotE, 2014). Based on this assessment, the study area contains habitat critical to the survival of the koala. However, since the project is proposing to clear less than 2 ha of habitat containing koala feed trees, a referral for the project is not recommended under the referral guidelines (DotE, 2014).

Based on the potential for the project to have a significant impact on threatened species listed under the EPBC Act, a referral was submitted to DAWE (formerly DotEE). The EPBC referral decision indicated that there is likely to be a significant impact on listed threatened species and communities, including *Tetratheca juncea* (Black-eyed Susan). It was determined that the proposal had the potential to significantly impact on 26 threatened species (listed in Appendix M) at the time of referral with further analysis required, including additional species surveys and refinement of the project footprint, to determine the likely significance of the impacts.

Subsequent survey efforts, and as detailed in the BIR, have revealed additional information as to the likelihood of significant impacts. An EPBC Assessment of Significance with regards to potential for significant impacts on *Tetratheca juncea* determined those impacts to be low. Furthermore, additional assessments of significance (Appendix M) of the identified threatened species determined that significant impacts were unlikely.

A robust BMP will aim to identify potential impacts to threatened species and ecological communities. If potential impacts are identified, an offset liability report will be produced within 3 months in line with the BAM (and EPBC requirements if no bilateral agreement is in place) and it will contain a proposed offset strategy.

6.6.5 Mitigation and management

Impacts requiring an offset

Mining impacts

Extensive flora and fauna surveys have been undertaken for the project in line with the BAM, resulting in a comprehensive baseline dataset which can be utilised to inform the initial commencement of individual monitoring programs. In order to determine the occurrence of mining related impacts on threatened species or ecological communities, it is proposed that LIDAR be utilised to detect the potential impacts of the project (i.e. sinkholes, cracking and plug-failures).

If impacts are detected, the extent of those impacts will be quantified by comparison to the baseline dataset. Where insufficient baseline data is available, presence of threatened species will be assumed if they are considered likely to occur and potentially impacted.

Following potential impacts, an offset liability report will be prepared to both quantify the impacts and outline the offset strategy that will be adopted to address those impacts. The offset liability report will be prepared with reference to the BAM and provided within three months of any impacts being identified.

Vegetation clearing impacts for infrastructure

The 0.35 ha of native vegetation to be cleared for ancillary facilities at Awaba Colliery Surface Site will be offset in accordance with the NSW Biodiversity Offset Scheme.

Adaptive management strategy

In accordance with Section 9.4.2 of the BAM, an adaptive management plan is required where impacts are uncertain.

The project has the potential to lead to impacts to threatened plants and ecological communities from cracking, sinkholes, plug-failures and ponding. In order to effectively quantify the mining related impacts to the threatened flora and ecological communities, an area-based assessment will be undertaken with reference to areas where threatened species and ecological communities have been recorded or predicted to occur within the study area (refer to Figures 5 - 11 of the BDAR (RPS, 2020a), provided in Appendix M).

In the case of impacts occurring, adaptive management will occur via the review of monitoring programs and investigation of causation to ensure any future impacts can be readily identified and predicted. Where impacts are identified, they will be offset in accordance with State and federal policies. These monitoring measures and TARPs will be detailed within the BMP prepared as part of the Extraction Plan process post consent. The TARP contained within the BMP will contain a framework for adaptive management, which should include; mitigation, remediation and changes to the mine design.

6.7 Aquatic ecology

An Aquatic Ecology Impact Assessment was prepared by GHD to assess the potential impacts to aquatic ecology as a result of the project. The information presented in this section is summarised from the Aquatic Ecology Impact Assessment (GHD, 2020d), which is presented in full in Appendix N. The Aquatic Ecology Impact Assessment was prepared to address and satisfy the relevant project SEARs (Appendix A).

6.7.1 Background

The project has the potential to cause impacts to aquatic ecology through changes to licensed discharges of water and through subsidence. Therefore the study area for the Aquatic Ecology Impact Assessment was determined based on waterways overying and downstream of the Extension of Mining Area and waterways that received licenced discharges, including:

- Lords Creek.
- Kilaben Creek.
- Stockyard Creek.
- Stony Creek.
- Unnamed tributary of Muddy Lake.
- LT Creek.
- Pourmalong Creek (reference site not impacted by the project).

In order to assess the potential impacts of the project on aquatic ecology within these waterways, the Aquatic Ecology Impact Assessment included:

- Describing the project and Newstan Colliery water management.
- Identifying components of the project with potential to impact the aquatic ecology of the receiving environment.

- Characterise the existing condition (ecosystem value) of waterways that may be impacted by the project (based on outcomes of the field survey and desktop assessment).
- Undertaking biodiversity database searches relating to aquatic species and identifying threatened aquatic species relevant to the study area.
- Undertaking an assessment of the potential impacts of the project on aquatic biota.
- Develop measures to avoid, minimise and mitigate the potential aquatic ecology impacts of the project.

6.7.2 Methodology

Desktop study

A desktop review was undertaken to help determine the conservation significance of the waterways within the study area and to identify threatened species, populations and ecological communities listed under the BC Act and FM Act. A search for MNES listed under the EPBC Act that may occur in the area based on previous records, known distribution ranges, and habitats present was also undertaken.

The biodiversity databases and literature pertaining to the study area that were reviewed included:

- The DAWE (formerly DotEE) Protected Matters Search Tool (PMST), for MNES (threatened and migratory biota) known or predicted to occur in the study area.
- The BCD (formerly OEH) BioNet Atlas database for records of threatened species, populations and endangered ecological communities listed under the BC Act that have been recorded in the study area.
- The key fish habitat map for the Lake Macquarie Local Government Area (DPI, 2019).
- DPI Freshwater threatened species distribution maps (DPI, 2019).
- Key threatening processes (KTPs) within the EPBC Act, the FM Act and the BC Act.

Field survey

Fifteen freshwater sites and three estuarine sites were assessed in autumn and spring 2019. Full details of these sites are provided in Appendix N. The field survey program included sites sampled previously during routine aquatic ecology programs for Newstan and Awaba collieries, and new sites selected for the purpose of this project.

Six sites were selected for this assessment due to their location on waterways upstream, downstream or within the Project Application Area and were sampled only in autumn and spring 2019.

A further 12 sites included in the assessment have historically been sampled biannually for the Newstan and/or Awaba Colliery aquatic ecology monitoring programs.

Field descriptions were recorded by qualified and experienced aquatic ecologists based on visual estimates of the habitat characteristics of each site in accordance with the *Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual 2004* (Turak, Waddell, & Johnstone, 2004).

The following in situ physical and chemical parameters were measured at each sampling site:

- Temperature (°C).
- pH (pH units).
- Electrical conductivity (µS/cm).
- Dissolved Oxygen (DO) (mg/L and % saturation).

One water sample was collected at each site prior to the collection of sediment and macroinvertebrate samples for chemical analysis of water quality parameters including metals, major ions, nutrients, total dissolved solids, total suspended solids, turbidity, and dissolved organic carbon (DOC). Water quality results were compared to the default guideline values (DGVs) from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000; ANZG, 2018) to assess water quality.

Sediment grab samples were collected from each site and analysed for metals, nutrients and total organic carbon (TOC). Sediment quality results were compared to the revised toxicant DGVs for sediment quality (ANZG, 2018).

Macroinvertebrate samples were collected and analysed from each freshwater site in accordance with AUSRIVAS procedures and analysed for:

- Taxonomic richness – the number of different taxa contained in a sample.
- EPT richness – the number of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) families present in a sample. Macroinvertebrate families belonging to these orders are considered to be sensitive to changes in their environment, and therefore EPT taxa richness can be used to assess habitat and water quality.
- SIGNAL-2 (Stream Invertebrate Grade Number – Average Level) (Chessman, 1995) is a simple scoring system for macroinvertebrates of Australian rivers for assessing pollution sensitivity.

Macroinvertebrate samples were collected and analysed from each estuarine site using a sediment corer and analysed for:

- Taxonomic richness.
- Abundance – the number of individuals of each taxon.

6.7.3 Existing environment

Matters of national conservation significance

The DAWE (formerly DotEE) Protected Matters Search Tool was used to produce an EPBC Act Protected Matters Report for Lords Creek, Stony Creek, Stockyard Creek, Kilaben Creek and the unnamed tributary of Muddy Lake, including the surface water sampling points relevant to the Extension of Mining Area. A summary of the Protected Matters Search results is provided in Table 6-20.

Table 6-20 EPBC Act protected matters search results relevant to aquatic environments

Protected matter	Matter located within search radius	Comments
Wetlands of international significance (Ramsar sites)	None	No Wetland of international significance within the search radius
Listed threatened aquatic species	• Black Rockcod, Black Cod, Saddled Rockcod (*Epinephelus daemelii*)	Has not been observed in Lake Macquarie by Lake Macquarie City Council (2019a). Does not inhabit freshwater though can inhabit estuaries.

Protected matter	Matter located within search radius	Comments
Listed aquatic migratory species	• Loggerhead Turtle (*Caretta caretta*) • Green Turtle (*Chelonia mydas*) • Leatherback Turtle, leathery Turtle, Luth (*Dermochhelys coriacea*) • Hawksbill Turtle (Eretmochelys imbricate) • Flatback Turtle (*Natator depressus*)	• *C. caretta* has been observed in Lake Macquarie by Lake Macquarie City Council (2019a) • *C. mydas* has been observed in Lake Macquarie by Lake Macquarie City Council (2019a) All of these species are marine turtles.

Matters of state conservation significance

The search of the OEH BioNet Wildlife Atlas database for records of threatened species listed under the BC Act, did not identify any records of threatened aquatic species in the waterways in the study area. The fish present in these waterways have not been surveyed.

The Key Fish Habitat map for Lake Macquarie Local Government Area (DPI, 2019) indicates that Lords Creek, Stony Creek, Stockyard Creek, Kilaben Creek and the unmapped tributary of Muddy Lake are Key Fish Habitat, however, fish are likely to be scarce within the study area, given the ephemeral nature of the waterways.

The DPI Freshwater threatened species distribution maps (DPI, 2019) indicated no threatened fish species within the study area.

Key threatening processes

Of the 21 KTPs listed under the EPBC Act, none are relevant to the project.

There are currently eight KTPs listed under Schedule 6 of the FM Act and 38 KTPs listed under Schedule 3 of the BC Act, of which the following are potentially relevant to the project due to the potential for subsidence and licenced discharges to alter natural flow regimes:

- Installation and operation of in-stream structures and other mechanisms that alter natural flow regimes of rivers and streams (FM Act).
- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (BC Act).

Key aquatic habitat attributes

Waterways within the study area are generally characterised by narrow channels, with most sites consisting of isolated pools with low flow. Instream habitats generally include submerged woody habitat, overhanging or trailing vegetation, leaf litter and detritus. Macrophytes are also present within Stockyard creek and LT Creek. Detailed descriptions of each sampling site are provided in Appendix N.

Water quality

pH at Lords Creek sites was generally neutral, and within the DGV range, while slightly acidic conditions were encountered at Kilaben Creek, Stockyard Creek and Stony Creek, likely associated with decomposition of organic matter. pH at the unnamed tributary of Muddy Lake was neutral to slightly alkaline, while elevated alkalinity was observed in LT Creek with pH being above 8 and exceeding the DGVs at several sites. The elevated alkalinity within LT Creek is likely a result of Newstan LDP001 discharge (which is limited to a pH of 8.5) combined with photosynthesis from vegetation, which can remove carbon dioxide from the water column, increasing pH.

Electrical conductivity was within the DGVs at all sites within Lords Creek, Kilaben Creek, Stockyard Creek and Stony Creek. Elevated EC was observed at all LT Creek sites, which is likely attributable to the salinity of the Newstan LDP001 discharge. Moderate to high EC was observed within the unnamed tributary of Muddy Lake, which is attributable to the Awaba seepage, which has alkalinity and salinity reflective of the water in the Awaba underground void.

Dissolved oxygen (DO) was generally low and below DGVs at all sites within Lords Creek, Kilaben Creek, Stockyard Creek, Stony Creek and the unnamed tributary of Muddy Lake. This is likely a result of DO consumption associated with organic matter decomposition, and the lack of flow in the waterway reducing re-aeration. DO in LT Creek was generally high and within DGVs, indicating the aeration provided by the consistent flows in the creek, and the effect of submerged photosynthesis.

pH at all estuarine sites ranged between 7.42 and 8.00, which is within the expected range for carbonate buffered marine waters. Electrical conductivity was high at all sites, exceeding 45,000 µS/cm, which indicates the dominance of marine water at each site. DO was low at all sites, with no temporal or spatial pattern indicated.

Sediment quality

Metal concentrations in sediments at Lords Creek, Kilaben Creek, Stockyard Creek and Stony Creek are not likely to have any adverse effects on aquatic life, as no exceedances of the DGVs were observed.

Lead concentrations at one site in LT Creek in spring exceeded the DGV. This was attributable to the historical discharges from Newstan LDP001 prior to the commissioning of the clean water plant (CWP). Prior monitoring has observed similar lead concentrations at this site (GHD, 2019b). Based on the persistence of the lead observed in sediments at this site, it is considered unlikely that the lead is bioavailable, and therefore unlikely that there have been adverse effects on aquatic biota as a result of metal concentrations in LT Creek.

Exceedances of the DGVs for nickel and zinc were observed in the unnamed tributary of Muddy Lake in autumn and spring. The zinc and nickel concentrations exceeded the DGV, which indicates the potential for biological effects. These nickel and zinc concentrations are associated with the Awaba seepage, and are unlikely to increase as a result of the seepage under the current conditions (GHD, 2018).

Cadmium concentrations in estuarine sediments exceeded the DGV in autumn and spring. These concentrations are associated with potential biological effects, though are not attributable to discharges from either LDP001 or LDP017, as sediment monitoring data for freshwater sites has indicated that cadmium concentrations in sediments closer to the discharges are not elevated.

Macroinvertebrates

Freshwater

Average taxanomic richness was generally higher and more consistent at LT Creek sites and at sites where permanent water is available.

At ephemeral sites, average taxanomic richness was generally higher in spring than in autumn, likely due to the higher rainfall preceding spring sampling.

EPT richness and SIGNAL-2 scores were generally low at all sites except LT Creek sites These results are consistent with the limited water availability and isolated pools available at most sites At LT Creek sites, flows and water chemistry are regulated by the discharges from Newstan LDP001 which has created stable water levels and allowed for formation of permanent habitat and connectivity between sites. This is likely the reason for the higher EPT richness at LT Creek sites.

Overall, the macroinvertebrate community was in poor to moderate condition based on moderate diversity (richness) and low to moderate pollution sensitivity (EPT richness and SIGNAL-2). The macroinvertebrate communities in LT Creek were generally in the best condition of the assessed sites. The stable water levels and permanent habitat and connectivity which results from the LDP001 discharge result in relatively stable macroinvertebrate metrics results.

There were no consistent differences observed in the community composition of freshwater macroinvertebrates between catchments, with the exception of LT Creek sites which have a distinct macroinvertebrate community composition, with several taxa observed only at LT Creek sites. This is likely due to the regulatory influence of discharges from Newstan LDP001, which result in increased flows, altered water chemistry and permanent water and associated habitat such as macrophytes.

Estuarine

Of the three assessed estuarine sites, two sites (LT Creek and Stony Creek) were selected on the basis of having potential to be impacted by the project, while the remaining site (Pourmalong Creek) was included as a reference site. Estuarine macroinvertebrate abundance and richness observed at the three sites during autumn and spring 2019 was compared with the long-term median calculated from monitoring results from 2015 to 2018.

The abundance of macroinvertebrates was low in autumn and spring 2019 at Pourmalong Creek (2 in autumn 2019 and 13 in spring 2019) and Stony Creek (8 in autumn 2019 and 13 in spring 2019), with counts below the long-term median (29 at Pourmalong Creek and 16 at Stony Creek). At LT Creek, abundance of macroinvertebrates in autumn 2019 (24) was higher than the long-term median (22), while abundance in spring 2019 (9) was less than the long-term median by more than 50 percent.

The long-term median taxonomic richness was 4.7 at all three sites. In autumn 2019, taxonomic richness was very low (less than three) at all sites. In spring 2019, taxonomic richness at LT Creek (4.3) and Pourmalong Creek (4) was only slightly below the long-term median, while taxonomic richness at Stony Creek (2.3) was approximately half the long-term median.

At all sites, taxanomic richness was higher in spring 2019 than in autumn 2019.

The macroinvertebrate community at the reference site at Pourmalong Creek was similar to that of Lt Creek and Stony Creek, indicating that here has been no apparent impact of discharges via Newstan LDP001 or LDP017 on estuarine macroinvertebrate communities at the sites in LT Creek or Stony Creek.

6.7.4 Impact assessment

Awaba LDP009 discharges to Stony Creek

As part of the project, the Pollution Control Dam at the Awaba Colliery Surface Site will be upgraded and transfers of dirty water to the Awaba underground void will cease. As such, discharges to Stony Creek via LDP009 are predicted to increase.

The most likely source of water quality degradation risk from the Awaba Colliery Surface Site is elevated suspended solids concentrations, especially during construction activities. No increased concentrations of metals, salinity or other contaminants are expected to be present in discharges from Awaba LDP009, and discharges would not exceed the concentration limits specified by EPL 443. An additional sediment control dam is proposed upstream of the Pollution Control Dam to allow suspended solids to settle prior to discharges via LDP009.

Elevated suspended solids concentrations could be observed in LDP009 discharges, which would have the potential to adversely affect macroinvertebrate communities through smothering of benthic substrate. This can also limit light penetration, which can affect photosynthetic productivity and the health of aquatic plants, leading to potential impacts to the quality and availability of habitat for macroinvertebrates and fish.

Given the ephemeral nature of the catchment and the dominance of fine sediments, elevated turbidity is a common occurrence in Stony Creek. Additionally, the catchment area of the Pollution Control Dam is less than 0.03 percent of the Stony Creek catchment area (GHD, 2020c), so it is unlikely that the contribution of suspended solids in discharges from the Awaba Colliery Surface Site would be significant compared to the sediment transport within the greater catchment.

Newstan LDP017 discharges to Stony Creek

The frequency of discharges to Stony Creek via LDP017 is likely to increase as a result of the project. As discharges through Newstan LDP017 are in response to heavy rainfall, any change to the water quality in the receiving environment of Stony Creek is predicted to be negligible and temporary, and unlikely to adversely affect freshwater aquatic communities. The influence of increased volumes of fresh water on benthic macroinvertebrates in the intertidal zone of Stony Creek is unlikely to be discernible from the response of the community to seasonal variation and long term climate variability.

Newstan LDP001 to LT Creek

LDP001 discharge rates of up to 14.5 ML/day will be required for the project, which is the maximum rate of discharge is already approved under the Northern Coal Logistics Project (SSD-5145). This would involve an increase in discharge of 3.5 ML/day above the EPL 395 limit of 11 ML/day, which would result in increases to flow depths and velocities in LT Creek.

Increased flow rates in LT Creek have the potential to affect macroinvertebrate community composition. However, hydraulic modelling undertaken for the Surface Water Impact Assessment (GHD, 2020c) indicated that there is no significant increase in flow velocities expected as a result of the increased discharge rate. As such, these potential impacts on macroinvertebrate communities in LT Creek are unlikely.

As water will continue to be treated at the Clean Water Plant (CWP) prior to discharge via Newstan LDP001, there is no adverse change to water quality in LT Creek predicted (GHD, 2020c). It was found by GHD (2020e) that any interaction between the Eraring Ash Dam (EAD), the Awaba Colliery underground void, and the Extension of Mining Area would be unlikely to have any adverse effect on the water quality of LDP001, due to the low potential contribution of water from the EAD compared to the volume of water treated at the CWP. As such, no adverse effect on aquatic communities in LT Creek is expected as a result of a change in water quality.

Subsidence related impacts

Over 20 mm of subsidence is predicted to occur in areas of the following catchments (refer to Section 6.1):

- Lords Creek.
- Stony Creek.
- Kilaben Creek.
- Stockyard Creek.

Less than 20 mm of subsidence is predicted in the catchment of the unnamed tributary of Muddy Lake.

The following impacts could occur as a result of subsidence within the catchments of the assessed watercourses:

- Reduced habitat availability.
- Fragmentation of habitat/ponding.
- Impacts on water quality.
- Impacts on sediment quality.
- Increases in flow velocity as a result of increased gradients.

Reduced habitat availability

Subsidence impacts may result in a reduced water availability within waterways leading to reduced diversity of macroinvertebrate groups and potential loss of communities if there is complete loss of habitat in a waterway, or section of a waterway.

Although Lords Creek, Stony Creek and Kilaben Creek were mapped as Key Fish Habitat, fish are likely to be scarce within the study area, given the ephemeral nature of the waterways. Macroinvertebrate communities in the sections of the waterways potentially impacted by subsidence would be largely those that can subsist in isolated pools, as water is generally available in these minor drainage lines only for short periods following rainfall.

The risk of reduced habitat availability impacts was assessed as moderate for Stony Creek and Kilaben Creek due to the potential for subsurface flow diversion and loss of surface flows.

Impacts on water and sediment quality

Subsidence related surface deformations in the catchments overlying the proposed workings could impact water and sediment quality through localised subsurface flow diversions and decreased surface water connectivity, which can lead to reduced dissolved oxygen (DO) concentrations. Additionally exposure of previously unweathered bedrock can release substances such as aluminium, iron, manganese, nickel and zinc into the surface water, resulting in elevated salinity and potentially ecotoxic metal concentrations. Elevated iron concentrations can also result in the consumption of DO and thick mats of orange-red precipitate associated with iron precipitation. This can result in smothering of benthic substrate and loss of habitat for benthic macroinvertebrates. These potential impacts can have adverse effects on aquatic communities.

The risk of water and sediment quality impacts was assessed as moderate for Lords Creek and Stockyard Creek, and high for Stony Creek and Kilaben Creek, based on the amount of subsidence expected within these catchments.

Increases in flow velocity

There is the potential for localised increases in flow velocities as a result of subsidence induced increases in gradient in relatively short watercourse reaches within the catchments of Stockyard Creek and Lords Creek. Increased flow velocities have the potential to affect macroinvertebrate community composition by making existing slow-flowing habitats unsuitable for taxa which prefer lentic water. Such impacts could result in a change in community condition in these creeks, however the macroinvertebrate communities at the downstream monitoring sites in Stockyard Creek and Lords Creek are not expected to be affected by the predicted changes to flow velocities in the upstream catchments.

6.7.5 Mitigation and management

Licensed discharges

Water quality monitoring and regular site inspections of the Pollution Control Dam will occur prior to any controlled discharges to ensure water quality is within the concentration limits for Awaba LDP009. The Proposed Sediment Control Dam upstream of the Pollution Control Dam will be designed and constructed in accordance with the Blue Book Volume 2E (Landcom, 2004).

Aquatic ecology monitoring

Continuation of the aquatic ecology monitoring program developed for this assessment will be undertaken following approval of the project. This monitoring will be undertaken twice a year, in autumn and spring AUSRIVAS seasons (Turak, Waddell, & Johnstone, 2004). Reporting will be undertaken annually, and will assess water quality monitoring data collected by Centennial Newstan in addition to the water quality and sediment quality data collected during the aquatic ecology monitoring program.

6.8 Air quality and greenhouse gas

An Air Quality and Greenhouse Gas Assessment was prepared by SLR Consulting Australia Pty Ltd to assess the predicted incremental and cumulative air quality and greenhouse gas (GHG) impacts of both construction and operation of the project. The information presented in this section is summarised from the Air Quality and Greenhouse Gas Assessment (SLR Consulting, 2020a), which is presented in full in Appendix O.

6.8.1 Background

The key air emissions from the project with potential for off-site impacts would occur during the construction activities at the Awaba Colliery Surface Site, operation of the ventilation fans at Newstan Colliery Surface Site and Awaba Colliery Surface Site and operation of the gas flares to be located at the Awaba Colliery Surface Site.

The continued operation and decommissioning of the existing mine ventilation fans at Newstan Colliery Surface Site are currently approved under DA 73-11-98. Additionally, project activities around the Newstan Colliery Surface Site are only transitory in nature and will not result in significant cumulative contributions to emissions. Therefore only sensitive receptors in proximity to the Awaba Colliery Surface Site have been assessed.

6.8.2 Methodology

Air quality

Emissions from the project have been modelled using the CALPUFF (Version 6.267) modelling system. CALPUFF is one of the air dispersion modelling tools accepted by the NSW EPA. It is a transport and dispersion model that breaks emission plumes into ‘puffs’ of material emitted from modelled sources. The model utilises terrain and meteorological data to predict the trajectory of these puffs, simulating dispersion and transformation processes along the way. Detailed information regarding the dispersion modelling methodology is presented in Appendix O.

Ambient air quality criteria

Air quality impact assessment criteria for the project have been established based on the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*’ (EPA, 2017) (hereafter referred to as ‘the Approved Methods’). The adopted air quality criteria are presented in Table 6-21 and are consistent with the air quality criteria specified in the relevant existing project approvals and the *Voluntary Land Acquisition and Mitigation Policy* of the NSW Government for State Significant Mining, Petroleum and Extractive Industry Developments (DP&E, 2018a).

Table 6-21 Adopted project air quality goals

Pollutant	Averaging Period	Criteria (µg/m³)	Source
Total suspended particulates (TSP)	Annual	90 µg/m³	EPA, 2017
PM_{10}	24 hours	50 µg/m³	EPA, 2017
	Annual	25 µg/m³	EPA, 2017
$PM_{2.5}$	24 hours	25 µg/m³	EPA, 2017
	Annual	8 µg/m³	EPA, 2017
Deposited dust	Annual	2 g/m²/month (maximum increase in deposited dust level) 4 g/m²/month (maximum total deposited dust level)	EPA, 2017
Odour	1 hour	4 OU	EPA, 2017
Nitrogen Dioxide (NO_2)	1 hour	246 µg/m³	EPA, 2017
	Annual	62 µg/m³	EPA, 2017
Carbon monoxide (CO)	15 minutes	100 mg/m³	EPA, 2017
	1 hour	30 mg/m³	EPA, 2017
	8 hours	10 mg/m³	EPA, 2017

Modelled scenarios

Two scenarios were quantified to assess the pollutant emissions due to the construction and operational activities of the project.

Scenario 1 (construction)

This scenario assessed the emissions due to construction activities associated with establishment of surface infrastructure at the Awaba Colliery Surface Site. The construction activities are proposed to be conducted in phases with the overall time for the construction estimated to be approximately ten months. For the purposes of the modelling assessment, it has been assumed that the construction will go on for 12 months, to assess the worst case impacts due to seasonal variations over a full year.

Particulate emissions (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) from the construction activities have been calculated using default emission factors, sourced from the US EPA AP-42 Emission Factor Handbook (USEPA, 1995) for heavy construction industries.

Scenario 2 (operation)

This scenario assesses the impacts from gas flares in conjunction with the operations of mine ventilation fans at the Awaba Colliery Surface Site.

The emissions from the gas flaring units have been estimated using emission factors from the *National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual*, *Oil and Gas Exploration and Production* (DEWHA, 2010)

Coal seam gas is generally relatively pure with negligible sulfur content (DEWHA, 2008). It has therefore been assumed that no SO_2 is formed when the drainage gas is flared.

Oxides of nitrogen (NO_X), comprised of nitric oxide (NO) and nitrogen dioxide (NO_2), is formed in most combustion processes. NO will dominate the emissions but will eventually react in the presence of ozone and volatile organic compounds into NO_2. NO_2 is considered to have the largest impact on human health. The rate of transformation depends on a number of factors. In accordance with Method 1 prescribed by the Approved Methods, it has been conservatively assumed that 100% of emitted NO_X will form NO_2 by the time it reaches sensitive receptors.

Results of the monitoring of the particulate (TSP, PM_{10} and $PM_{2.5}$) and odour emissions from the existing ventilation fans located at Centennial's Mandalong Mine (SLR Consulting, 2012a) and (SLR Consulting, 2012b) have been adopted to assess potential impacts from the proposed new ventilation fans at the Awaba Colliery Surface Site, which will be operating under similar geological conditions.

A summary of the emission sources assessed in the two scenarios is shown in Table 6-22.

Table 6-22 Summary of assessed scenarios

Scenario	Site	Pollutants
Construction (Scenario 1)	Construction activities at the Awaba Colliery Surface Site (includes construction of proposed ventilation fans and gas flares)	TSP, PM_{10}, $PM_{2.5}$ and deposited dust
Operations (Scenario 2)	Awaba surface facilities	No operational emissions
	Awaba ventilation shaft (proposed ventilation fan site)	TSP, PM_{10}, $PM_{2.5}$, deposited dust and odour
	Centralised gas drainage (x2 gas flares)	CO, NO_x

Greenhouse gas

A quantitative GHG assessment has been performed to assess the potential impact of the project on GHG emissions. In accordance with standard practice, this assessment has been guided with reference to the requirements of the GHG Protocol Initiative (WRI, 2004), Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2013) and National Greenhouse Accounts Factors (DotEE, 2018) calculation methodologies.

Scope definition

Emissions of GHG can be termed as being Scope 1, Scope 2 or Scope 3, and 'direct' or 'indirect' emissions.

Direct emissions of GHG are termed Scope 1 emissions and are produced from sources within the boundary of an organisation and as a result of the organisation's activities.

Scope 2 indirect emissions are generated in the wider economy as a consequence of an organisation's activities but are physically produced by the activities of another organisation. The most important category of indirect emissions relate to the GHG emissions from the generation of purchased electricity consumed in project-owned or controlled equipment or operations. In Australia, this is primarily from coal fired power generation.

Scope 3 indirect emissions are related to the upstream emissions generated in the extraction and production of fossil fuels and in the emissions from contracted/outsourced activities. Scope 3 emissions are generally Scope 1 or 2 emissions for other companies. For example, in general, diesel use by contractors is a Scope 3 emission, yet is referred to as a Scope 1 emission in the GHG inventory of the contractor. Combustion of coal to produce electricity will result in a Scope 1 emission at the power station or a Scope 2 emission for industry or householders.

The identified emission sources for the project are discussed in Section 6.8.4.

Definition of project boundary

The geographical and operational boundary set for the GHG assessment includes the Newstan Colliery underground workings and delivery of the coal to the Newstan Colliery Surface Site. Fugitive emissions of CO_2 and CH_4 from the Newstan Colliery ventilation system are included, however additional fugitive CH_4 emissions that arise during post-mining activities, such as transportation and stockpiling of the coal, due to the release of residual gases not released during the mining process, are not included. These residual emissions form part of the GHG inventory for the Northern Coal Logistics Project.

Scope 3 GHG emissions associated with production of fuels used on site have also been estimated, along with emissions associated with international shipping of the coal.

Boundaries of a GHG assessment can be chosen to include/exclude sources as long as the process of definition is transparent and the inventory for the selected boundary is as complete as possible (WRI, 2004)

6.8.3 Existing environment

Air quality

Sensitive receptors

The majority of the project activities are proposed to occur in the vicinity of Awaba Colliery Surface Site, with some intermittent project activities also proposed to occur in the vicinity of Newstan Colliery Surface Site. The two existing ventilation fans at the Newstan Colliery Surface Site will be utilised during development of the first workings. During this development phase, new fans will be installed at the existing ventilation shaft at the Awaba Colliery Surface Site and the existing fans at Newstan Colliery Surface Site decommissioned.

Dispersion modelling has only been conducted for the receptors around the Awaba Colliery Surface Site, as the activities around the Newstan Colliery Surface Site are only transitory in nature, and unlikely to have any cumulative impact at the receptors around the Awaba Colliery Surface Site. Therefore only sensitive receptors in proximity to the Awaba Colliery Surface Site have been assessed. A list of the identified sensitive receptors in the vicinity of the Awaba Colliery Surface Site are listed in Table 6-23.

Table 6-23 Sensitive receptor locations

Receptor ID	Location	Location (m, UTM)	
		Easting	Northing
R1	9 Olney Street, Awaba	363,733	6,346,064
R2	15 Evans Street, Awaba	363,203	6,346,323
R3	51 Puddy Lane, Awaba	363,220	6,346,274
R4	1A Olney Street, Awaba	363,547	6,346,080

Existing air quality

Ambient air quality in the vicinity of the project is influenced by emissions generated by a range of sources from both within and outside of the local area, including:

- Pollutant levels in the immediate vicinity of the project.
- Regional air quality without the influence of major industrial sources in the local area.
- Emissions from power stations in the local area, such as Eraring and Vales Point power stations.

Awaba Colliery Surface Site

Awaba Colliery has had a dust monitoring program in place since March 2015. A summary of the dust deposition monitoring results for the year 2018 is listed in Table 6-24**.**

Table 6-24 Summary of dust deposition monitoring results at Awaba Colliery

Dust Gauge	Annual (2018) Average Dust Deposition (g/m²/month)	Long Term Average (g/m²/month)
DG1	1.0	0.6
DG2	1.1	1.2
DG3	1.0	3.2
DG4	1.1	1.1
Overall Average	1.05	1.3

The long term average dust deposition rates shown in Table 6-24 include the contribution of operations at Awaba Colliery Surface Site and background dust levels, as such a conservative background dust deposition rate of 2 g/m^2/month has been adopted for use in this assessment.

Regional background air quality

The nearest Air Quality Monitoring Station (AQMS) maintained by the NSW EPA measuring continuous PM_{10} and $PM_{2.5}$ concentrations is located in Wallsend, approximately 12 km northeast of Newstan Colliery Surface Site, and 18 km northeast of Awaba Colliery Surface Site. The area surrounding the Wallsend AQMS is predominantly urban/residential in nature and PM_{10} concentrations recorded by this station are likely to be influenced by vehicle exhaust emissions and residential activities. Given the much lower population density in the region surrounding Newstan Colliery Surface Site, emissions from these types of sources will be much less significant and the Wallsend measurements are likely to provide a conservative estimate of regional background particulate levels.

Carbon Monoxide (CO) concentrations are not measured at the Wallsend AQMS, as such, CO concentrations recorded at Newcastle AQMS (located approximately 18 km east-northeast of the Awaba Colliery Surface Site) were adopted as the background concentrations.

No site specific odour monitoring has been performed at Newstan Colliery. However, an odour monitoring program was conducted at the existing Mandalong Mine ventilation fan (SLR Consulting, 2012b), located approximately 20 km south-west of Newstan Colliery. The characteristics of the odour from the ventilation fans were identified as yeast, exhaust and metallic. It is considered that there are no similar odour sources in the vicinity of Awaba Colliery Surface Site with any potential to have cumulative impacts. Therefore, the background odour concentration is assumed to be negligible.

Emissions from power stations in the local area

Dispersion modelling has been performed using publicly available information to determine the contribution from power station emissions to particulate concentrations to background air quality and at the identified sensitive receptors.

The maximum modelled 24-hour average PM_{10} and $PM_{2.5}$ concentrations at the Wallsend AQMS from power station operations was predicted to be 0.8 µg/m^3 and 0.01 µg/m^3 respectively. It is therefore concluded that the PM_{10} and $PM_{2.5}$ monitoring data from Wallsend AQMS does not include a significant contribution from power station operations.

For each sensitive receptor location, the predicted incremental particulate concentrations from modelling of the power stations was added to the regional background particulate data from Wallsend AQMS.

The site-specific background ambient air quality concentrations adopted for use in this assessment are summarised in Table 6-25.

Table 6-25 Adopted background air quality concentrations

Pollutant	Averaging Period	Regional Background	Notes
TSP	Annual	38.8 µg/m^3	Assumed to be twice the monitored PM_{10} concentrations at Wallsend AQMS
PM10	24-hour	Daily varying	As monitored at Wallsend AQMS during 2018
	Annual	19.4 µg/m^3	As monitored at Wallsend AQMS during 2018
PM2.5	24-hour	Daily varying	As monitored at Wallsend AQMS during 2018
	Annual	7.5 µg/m^3	As monitored at Wallsend AQMS during 2018
Deposited dust	Annual	2 g/m_2/month	Estimated from on-site monitoring programme
Odour	1-hour	0 ou	Assumed
NO2	1-hour	65.8 µg/m^3 (maximum hourly)	As monitored at Wallsend AQMS during 2018
	Annual	12.1 µg/m^3	As monitored at Wallsend AQMS during 2018
CO	1-hour	1.4 mg/m^3	As monitored at Newcastle AQMS during 2018
	8-hour	1.2 mg/m^3	As monitored at Newcastle AQMS during 2018
	15-minute	1.85 mg/m^3	Calculated using Turner equation (Turner 1974)

Greenhouse gas

A review of the DAWE (formerly DotEE) Australian Greenhouse Emission Information System revealed that Australia's net GHG emissions totalled 610.6 Mt CO_{2-e} in 2017. The energy sector accounted for over 65% of the total national emissions with energy generation through the combustion of fossil fuels accounting for 65% of the national energy sector emissions. Fugitive emissions accounted for approximately 10% of energy sector emissions.

The reported 2017 total NSW emissions of 160.7 Mt CO_{2-e} accounted for approximately 26% of national GHG emissions. The energy sector contributed 117.7 Mt CO_{2-e} which is approximately 73% of the state emission total. Fugitive emissions account for approximately 15% of NSW total energy sector emission total.

6.8.4 Impact assessment

Air quality

The key air emissions from the project with potential for off-site impacts would occur during the construction activities at the Awaba Colliery Surface Site, and the operation of the ventilation fans at Newstan Colliery Surface Site and Awaba Colliery Surface Site and gas flares to be located at the Awaba Colliery Surface Site.

Dispersion modelling predictions of TSP, PM_{10}, $PM_{2.5}$, dust deposition rates, CO, NO_2, and odour concentrations at the identified sensitive receptors attributable to the project are summarised below and presented in full in Appendix O. Pollutant contour plots are also provided in Appendix O which show the maximum predicted incremental (attributable to the project only) concentrations and deposition rates of the pollutants assessed.

Total suspended particulates

Cumulative annual average TSP concentrations at all nominated residences/properties nominated for the project are predicted to be well below the criterion of 90 µg/m^3.

Particles as PM_{10} – Maximum 24-hour average

The maximum incremental and cumulative 24-hour average PM_{10} concentrations predicted at each of the identified receptors during the project construction (Scenario 1) and operation (Scenario 2) are presented in Table 6-26 and Table 6-27, respectively.

Table 6-26 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 1 (Construction)

Receptor ID	Maximum 24-Hour Average PM_{10} Concentrations (µg/m^3)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 1)	Maximum Cumulative (Total Background + Scenario 1)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	136.5	2.6	14.3	136.5	28.7 (14.3)
R2	136.5	2.8	9.8	136.5	27.8 (17.4)
R3	136.5	2.8	10.9	136.5	28.9 (17.4)
R4	136.5	2.8	16.5	136.5	30.8 (14.3)
Criterion				50	50

* Total Background on day of maximum increment from project shown in brackets

Table 6-27 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 2 (Operation)

Receptor ID	Maximum 24-Hour Average PM_{10} Concentrations (µg/m³)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 2)	Maximum Cumulative (Total Background + Scenario 2)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	136.5	2.6	0.9	136.5	2.7 (0)
R2	136.5	2.8	1.3	136.5	17 (14.1)
R3	136.5	2.8	1.5	136.5	17.3 (14.1)
R4	136.5	2.8	1.2	136.5	2.8 (0)
Criterion				50	50

* Total Background on day of maximum increment from project shown in brackets

The maximum increment from construction of the project (16.5 µg/m³) is predicted to occur at receptor 'R4', while the maximum increment from the operation of the project (1.5 µg/m³) is predicted to occur at receptor 'R3'.

The maximum 24-hour average cumulative PM_{10} concentrations during construction and operation are predicted to exceed the criterion of 50 µg/m³ at all identified sensitive receptor locations, however this is due to the maximum background concentration of 136.5 µg/m³ recorded at Wallsend in November 2018 due to a dust storm.

The predicted exceedances of the 24-hour average PM_{10} criterion occur on days of high backgrounds when the assessment criterion is already exceeded, and the incremental impact of the project is relatively low. A sensitivity analysis was conducted to show that the modelling year selected (ie 2018) has an unusually high number of exceedances, and that there would be no additional exceedances at any of the sensitive receptors, if any another year between 2014 to 2017 had been selected in lieu of 2018 and that predicted exceedances correspond to the number of exceedances in the background data set. Therefore, it is concluded that the project is highly unlikely to cause any additional exceedances of the 24-hour average PM_{10} criterion at the identified receptor locations.

Particles as PM_{10} – Annual average

Annual average PM_{10} concentrations at all nominated residences/properties nominated for the project are predicted to be well below the criterion of 25 µg/m³.

Particles as $PM_{2.5}$ – Maximum 24-hour average

The maximum increment from construction of the project (8.3 µg/m³) is predicted to occur at receptor 'R4', while the maximum increment from the operation of the project (0.8 µg/m³) is predicted to occur at receptor 'R3'.

The maximum 24-hour average cumulative $PM_{2.5}$ concentrations during construction and operation are predicted to be below the criterion of 25 µg/m³ at all identified sensitive receptor locations.

Particles as $PM_{2.5}$ – Annual average

The annual average incremental and cumulative $PM_{2.5}$ concentrations predicted at each of the identified receptors during the project are presented in Table 6-28.

Table 6-28 Predicted annual average PM2.5 concentrations

Receptor ID	Annual Average PM2.5 Concentrations (µg/m³)					
	Background		Scenario 1 (Construction)		Scenario 2 (Operations)	
	Regional	Power Stations	Increment	Cumulative	Increment	Cumulative
R1	7.5	<0.1	0.7	8.3	<0.1	<7.7
R2	7.5	<0.1	0.4	8.0	<0.1	<7.7
R3	7.5	<0.1	0.5	8.1	<0.1	<7.7
R4	7.5	<0.1	0.7	8.3	0.1	<7.7
Criterion				8		8

Annual average $PM_{2.5}$ concentrations for the project are predicted to exceed the criterion of 8 µg/m³, at receptors 'R1', 'R3', and 'R4' during construction. These exceedances are predicted because the background annual average $PM_{2.5}$ concentration recorded at Wallsend AQMS in 2018 was very close to the criterion. The incremental impacts predicted due to the estimated emissions from the project are very low and represent a negligible contribution to the total cumulative concentrations.

Annual average $PM_{2.5}$ concentrations during operation are predicted to be below the criterion of 8 µg/m³ at all identified sensitive receptor locations.

Dust deposition

Incremental and cumulative annual average dust deposition rates at all nominated sensitive receptors are predicted to be well below the criterion of 2 g/m²/month (incremental increase in dust deposition) and below 4 g/m²/month (cumulative dust deposition) during both construction and operation.

Nitrogen dioxide

Maximum 1-hour average and annual average NO_2 concentrations are predicted to be well below the project criterion of 246 µg/m³ and 62 µg/m³ respectively at all the sensitive receptors during operation.

Carbon monoxide

The predicted maximum 15-minute average, 1-hour average and 8-hour average cumulative CO concentrations are well below the respective project criteria.

Odour

The only odour source from the project operations is the mine ventilation fans to be located at the Awaba Colliery Surface Site. The 99th percentile 1-hour average odour concentration is predicted to be below the project criterion of 4 ou at all identified sensitive receptors.

Summary

A summary of the predicted air quality impacts in relation to the adopted air quality criteria is presented in Table 6-29.

Table 6-29 Summary of air quality predictions

Pollutant	Compliance with project criteria		Comment
	Construction	Operation	
TSP – annual average	✓	✓	
PM_{10} – Maximum 24-Hour	×	×	The predicted exceedances are entirely due to the maximum background concentration of 136.5 µg/m³ recorded at Wallsend in November 2018 due to a dust storm. Sensitivity analysis (as described above) concluded that the project is highly unlikely to cause any additional exceedances of the 24-hour average PM_{10} criterion than those related to exceedances in the background concentration.
PM_{10} – Annual Average	✓	✓	
$PM_{2.5}$ – Maximum 24-Hour	✓	✓	
$PM_{2.5}$ – Annual Average	×	✓	The predicted exceedances are due to the high annual average $PM_{2.5}$ regional background concentrations. The incremental impacts predicted due to the estimated emissions from the project are very low and represent a negligible contribution to the total cumulative concentrations
Dust Deposition – Incremental Increase	✓	✓	
Dust Deposition - Cumulative	✓	✓	
Nitrogen Dioxide (NO_2)	NA	✓	
Carbon monoxide (CO)	NA	✓	
Odour	NA	✓	

Greenhouse gas

Emission sources

The proposed changes to the Newstan Colliery operations associated with the project that will contribute to GHG emissions from the site have been identified as follows:

- Scope 1:
  - Diesel use in equipment used to mine 25.9 Mt of ROM coal over approximately 15 years (assuming the project will commence on 1 January 2021 and run until expiry on 31 December 2036).

– CO_2 emissions from the gas drainage system after flaring to convert fugitive CH_4 to CO_2.
– Consumption of oils during the 15 year period.

- Scope 2:
  – Electricity consumption associated with the underground mine during the 15 year period.
- Scope 3:
  – Emissions associated with the production and transport of diesel and oil consumed at the site during the 15 year period (upstream).
  – Rail transport of product coal (downstream).
  – Shipping of product coal overseas (downstream).
  – End use (combustion) of the product coal produced (downstream).

The following activities/sources also have the potential to generate minor emissions of GHGs, however it is considered that they would contribute less than 5% of the total project emissions and can be deemed to be immaterial:

- Scope 1:
  – Treatment and disposal of sewage and solid waste generated on site during the 15 year period.
- Scope 3:
  – Fuel consumption associated with transporting workers and raw materials to site during the 15 year period.
  – Transmission losses associated with the electricity consumed at the site.

Projected activity data for the proposed the project operations have been estimated based on historical operations at Newstan Colliery and are presented in Table 6-30.

Table 6-30 Projected activity data

Parameter	Newstan Colliery Historical Data			Estimate for the Project	
	November 2008	April 2009	Average Per Month	Total (15 years)	Per Annum
ROM throughput (tonnes)	193,746	141,325	167,536	25,900,000	1,730,000
Diesel consumption (kL)	44.05	14.00	29.03	4,487	299
Oil consumption (kL)	0.0	0.0	0.0	0.0	0.0
CO_2 emissions vented (1,000 m^3)	342.3	305.6	324.0		
CH_4 emissions vented (1,000 m^3)	1,654.3	1,473.5	1,563.9		
CO_2 emissions flared (1,000 m^3)				50,082	3,339
CH_4 emissions flared (1,000 m^3)				241,770	16,118
Electricity consumption (MWh)	-	-	-	254,350	16,957

Parameter	Newstan Colliery Historical Data			Estimate for the Project	
	November 2008	April 2009	Average Per Month	Total (15 years)	Per Annum
Product coal transported to Port of Newcastle (t)	-	-	-	24,900,000	3,850,000
Product coal transport to Kembla Port (t)	-	-	-	1,000,000	150,000
Product coal shipped (t)	-	-	-	25,900,000	4,000,000

Estimated emissions

The estimated GHG emissions for the project were mostly calculated based on the emission factors sourced from the National Greenhouse Accounts Factors workbook (DotEE, 2018). However, the emission factors for transport of the product coal by rail and ship were sourced from the GHG assessment completed for the Port Waratah Coal Services Terminal 4 Project (Environ, 2012).

Estimated emissions are shown in Table 6-31 and have been compared to the annual emission rates estimated for first workings in the GHG assessment for the recent modification (MOD 8) to DA 73-11-98, which permits first workings within the West Borehole seam in the southern portion of the Newstan Colliery mining lease area (SLR Consulting, 2018).

Table 6-31 GHG emission inventory

Activity/Source	Estimated GHG Emissions (tonnes CO_2-e)		
	First Workings (MOD8)	Newstan Mine Extension Project	
	Maximum Per Annum	Total (15 Years)	Maximum Per Annum
Scope 1			
Diesel consumption	630	12,159	811
Fugitive	217,284	93,203	6,214
Flaring	0	470,593	31,373
(Venting)*	-	(4,193,614)*	(279,574)*
Sub-total – Scope 1	*217,914*	*575,955*	*38,398*
Scope 2			
Electricity consumption	10,938	208,567	13,904
Sub-total – Scope 2	*10,938*	*208,567*	*13,904*
Scope 3			
Diesel and oil production	32	624	42
Product coal transport (rail)	-	24,605	3,800
Product coal transport (sea freight)	-	1,450,400	224,000
Product coal combustion	-	63,097,839	9,744,840
Sub-total – Scope 3	*32*	*64,573,839*	*9,972,682*
Total	**228,884**	**65,358,361**	**10,024,984**

*The venting emissions are shown for comparison purposes only and do not form part of the Scope emissions as all gas is proposed to be flared

The annual Scope 1 and Scope 2 GHG emissions from the project are estimated to be 0.03 tonnes of CO_{2-e} per tonne of ROM coal produced. The main contributor to the estimated emissions of the project is flaring of fugitive CH_4, which accounts for 60% of the total combined Scope 1 and Scope 2 emissions. Fugitive CO_2, electricity and diesel fuel consumption are estimated to account for 11.9%, 26.6% and 1.5% respectively.

The total indirect (Scope 3) emissions from mining coal, transport, and end us of the product coal are estimated to be 9,972,682 t CO_2-e/annum, out of which approximately 98% are attributed to the end use of the product coal.

The annual Scope 1 and Scope 2 GHG emissions from the project operations are significantly less than the annual emissions estimated for MOD 8. This is due to the proposed introduction of flaring of the fugitive CH_4 emissions, rather than venting it direct to atmosphere. The global warming potential for CH_4 is 28 times higher than CO_2, thus flaring these emissions prior to release results in a significant reduction on CO_2-e emissions.

The contributions of the predicted annual Scope 1 and 2 emissions resulting from the project to Australian and NSW total emissions are detailed in Table 6-32. As can be seen, the emissions are a relatively small proportion of both the Australian and NSW total emissions, accounting for less than 0.01% of total Australian GHG production. As such, the relatively small amount of GHG emissions generated by the project will have an undetectable effect on global climate change.

Table 6-32 Project emission contribution to State and National annual emission totals

	Newstan Mine Extension Project Scope 1 and 2	Total Emissions (2017)	
		Australia	NSW
Newstan Mine Extension Project Operations (Mt $CO_{2-e/annum}$)	0.052	610.6	160.7
Newstan Mine Extension Project as a percentage of National/State inventory	-	0.009%	0.03%

The estimated GHG emissions for the project may also be assessed in relation to Australia's national GHG emissions reduction target set out in the Paris Agreement, i.e. a 26-28% reduction on 2005 levels by 2030. This translates into a range of 435-447 Mt CO_2-e/annum (including land use, land-use change, and forestry - LULUCF) allowed emissions in 2030. Under both these emission scenarios, the project would represent approximately 0.012% of Australia's national emissions. On this basis, it is concluded that the project will have a minimal impact on Australia's ability to meet its emission reduction target.

6.8.5 Mitigation and management

Air quality

Construction phase air quality mitigation and management measures will be outlined in the CEMP for the project construction.

Operational air quality mitigation and management measures will be implemented in accordance with the Air Quality and Greenhouse Gas Management Plan for Northern Region (AQGGMP). The AQGGMP will be updated to incorporate the operations at the Awaba Colliery Surface Site.

Air quality monitoring

Dust deposition monitoring and High Volume Air Sampling (PM_{10}) is currently performed around the Awaba Colliery Surface Site. This monitoring is proposed to be continued during construction and operation of the project.

The details of the monitoring program will be incorporated into the Northern Reqion Air Quality and Greenhouse Gas Management Plan (AQGHGMP), following project approval.

Greenhouse gas

The most significant measure proposed for the abatement of emissions from the project is the capture of Newstan ventilation air and redirection to a centralised gas drainage abatement and utilisation plant, including two new flares to be installed at the Awaba Colliery Surface Site. The gas flares will be installed and operational prior to the commencement of secondary extraction. Flaring CH_4 emissions from the ventilation system of Newstan Colliery through the Awaba Colliery Surface Site flaring system will result in considerable reductions in the project's total GHG emissions, saving an estimated 82% of total emissions or 3,629,819 t $CO_{2\text{-}e}$ across the life of the project.

6.9 Noise and vibration

A Noise and Vibration Impact Assessment was prepared by EMM to assess the predicted noise and vibration impacts of both construction and operation of the project. The information presented in this section is summarised from the Noise and Vibration Impact Assessment (EMM, 2020b) which is presented in full in Appendix P.

6.9.1 Background

The project has the potential to result in noise and vibration impacts associated with construction and operation of new surface facilities at the existing Awaba Colliery Surface Site, and through generation of any additional road traffic.

The Noise and Vibration Impact Assessment prepared for the Northern Coal Logistics Project (SSD-5145) (SLR Consulting, 2014) assessed noise emissions from relevant infrastructure at the Newstan Colliery Surface Site. As no new acoustically significant infrastructure is proposed for the Newstan Colliery Surface Site as part of the project, it has not been assessed in this EIS. The ongoing operation of the existing infrastructure at the Newstan Colliery Surface Site is approved under SSD-5145 for the Northern Coal Logistics Project.

It is also noted that operation of the Newstan-Eraring private haul road, which runs directly south of the Awaba Colliery Surface Site, is approved under the Northern Coal Logistics Project (SSD-5145) and does not form part of the project.

As such, only the Awaba Colliery Surface Site has been assessed with respect to potential noise impacts from the project with assessment locations determined as the nearest noise sensitive receptors to Awaba Colliery Surface Site as identified in Table 6-38.

6.9.2 Methodology

Operational noise assessment

Noise predictions were carried out using the iNoise noise modelling software. 'iNoise' calculates total noise levels at assessment locations from concurrent operation of multiple noise sources. The model considers factors such as the lateral and vertical location of plant, source-to-receptor distances, ground effects, atmospheric absorption, topography of the site and surrounding area and applicable meteorological conditions.

Proposed operations that have been modelled at the Awaba Colliery Surface Site include:

- Use of three new ventilation fans at the existing ventilation shaft.
- In-seam gas drainage.
- A new gas flaring facility to be located within the existing disturbance footprint.

Acoustically significant fixed and mobile equipment items considered in the noise model are provided for expected day, evening and night operations in Table 6-33. Equipment sound power levels have been adopted from those provided in the previous *Northern Coal Logistics Project - Noise and Vibration Impact Assessment* (SLR Consulting, 2014) or the *Mandalong Mine Access Methane Flare Noise Impact Assessment* (Heggies Australia, 2006) which were based on measurements undertaken at the respective sites.

Table 6-33 Acoustically significant plant and equipment for noise modelling

Item (location)	Sound power level per item (dBA)	Operating during this period		
		Day	Evening	Night
Awaba Colliery Surface Site				
Ventilation fan (x3)	107	✓	✓	✓
Pumps (x3)	95	✓	✓	✓
Methane flare	96	✓	✓	✓

The operational noise model considered a representative snapshot of surface operations with equipment placed at locations representing a realistic operational scenario.

Operational noise criteria

The NPfI provides a methodology for the assessment of noise from existing industrial sites, which includes establishing relevant project noise trigger levels (PNTLs). PNTLs establish a benchmark level against which to compare measured or predicted noise levels in order to assess the need to consider feasible and reasonable noise mitigation measures.

Both the increase in noise level above background levels (ie the intrusiveness of a source) as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. To ensure both of these factors are considered, the EPA provides two separate noise trigger levels: intrusiveness and amenity. The fundamental difference being intrusiveness noise levels apply over 15 minutes in any period (day, evening or night), whereas the amenity noise levels apply to the entire assessment period (day, evening or night).

Intrusiveness

The intrusiveness criteria require that $L_{Aeq,15\ minute}$ noise levels from industrial sites during the relevant operational periods (ie day, evening and night) do not exceed the relevant RBL by more than 5 dB.

Results of the unattended noise monitoring, as outlined in Table 6-39, indicate RBLs ranging from 30 dB to 35 dB in Awaba village. Results of ambient noise monitoring have been used to establish relevant intrusive noise goals (Table 6-34).

Amenity

Assessment locations within Awaba village have been categorised in the rural amenity category in accordance with the NPfI definition of a rural receiver type (ie an area with an acoustical environment that is dominated by natural sounds and generally characterised by low background noise levels).

Due to the potential for other industrial developments to contribute to noise emissions in the area, the project amenity noise level for the subject development is the recommended amenity noise level (outlined in the NPfI) minus 5 dB (Table 6-34).

Project noise trigger levels

The project noise trigger levels (PNTLs) determined for the project are summarised in Table 6-30.

Table 6-34 Project noise trigger levels

Receptor	Type	Period[1]	Adopted RBL(dB)	Project intrusive noise level, $L_{Aeq,15\ minute}$ (dB)	Project amenity noise level[2], $L_{Aeq,15\ minute}$ (dB)	Project noise trigger level, $L_{Aeq,15\ minute}$ (dB)
R1, R4	Residential – rural	Day	35	40	48	40
		Evening	32	37	43	37
		Night	30	35	38	35
R2, R3	Residential – rural	Day	35	40	48	40
		Evening	33	38	43	38
		Night	33	38	38	38

Notes:

1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: 10 pm–7 am.
2. The project amenity noise level has been determined from the recommended amenity minus 5 dB and has also been adjusted by 3 dB, as per the NPfI, to convert from LAeq,period to LAeq,15 minute.

Sleep disturbance

Historic operations at the mine occurred during the night-time period (10 pm–7 am) as will the proposed operations. Hence, an assessment of the potential for sleep disturbance is required.

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where night-time noise levels at a residential location exceed:

- $L_{Aeq,15\ minute}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater).
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP provides the following conclusions from the research on sleep disturbance:

- Maximum internal noise levels (LAmax) below 50 to 55 dB are unlikely to awaken people from sleep.
- One or two noise events per night, with maximum internal noise levels (LAmax) of 65 to 70 dB, are not likely to affect health and wellbeing significantly.

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60–65 dB calculated at the facade of a residence are unlikely to awaken people according to the RNP. The adopted sleep disturbance screening criteria are presented in Table 6-35.

Table 6-35 Sleep disturbance screening criteria at residences

Assessment location	Adopted night RBL (dB)	Night-time noise level event screening criteria (dB)	
		$L_{Aeq,15\ minute}$	L_{Amax}
R1, R4	30	40	52
R2, R3	33	40	52

Voluntary Land Acquisition and Mitigation Policy

The *Voluntary Land Acquisition and Mitigation Policy* (VLAMP) (NSW Government, 2018a) describes the NSW Government's policy for voluntary mitigation and land acquisition actions undertaken to address noise (and dust) impacts from State significant mining, petroleum and extractive industry developments.

Voluntary land acquisition and mitigation rights in VLAMP are assigned to privately-owned dwellings based on the level of predicted noise above the NPfI project noise target (ie the PNTLs).

The characterisation of the noise impacts (as outlined in VLAMP) are generally based around the human perception to changes in noise levels, defined as negligible, marginal, moderate or significant. The VLAMP defines significant noise impacts as those that exceed the PNTLs by more than 5 dB and the total cumulative industrial noise level is greater than the recommended amenity noise levels.

- As identified in Section 6.9.4, the predicted noise levels for operation of the project do not trigger the VLAMP.

Construction noise assessment

Proposed construction activities that have been modelled at the Awaba Colliery Surface Site include:

- The installation of three new ventilation fans at the site of the existing approved ventilation shaft.
- The construction of a gas flaring facility within the existing disturbance footprint of the Awaba Colliery Surface Site.
- The drilling of service and gas boreholes into the workings for the supply of bulk materials, gas drainage, infrastructure, electricity, compressed air and water.
- The construction of a new sediment control dam adjacent to the proposed gas flaring facility.

Proposed activities associated with construction of the ventilation fans, methane gas flares and associated infrastructure at the Awaba Colliery Surface Site are detailed in Appendix P together with the sound power level of acoustically significant plant and equipment associated with each construction area. Sound power level data has been obtained from an EMM database of similar equipment. Adopted locations of construction plant and equipment at the Awaba Colliery Surface Site are provided in Appendix C of Appendix P.

Construction noise criteria

DPIE – Planning and Assessment generally requires that noise emissions from construction associated with mining projects be assessed under the operational noise policy. This is normally because noise from construction activity associated with such projects is similar in nature to that generated by the operation of the project particularly for open-cut mining operations.

In the case of the project, noise from construction activities (ie construction of the ventilation fans, methane flares and ancillary infrastructure) will be different in nature to the operations. Thus, it is considered appropriate to apply construction noise criteria in accordance with the ICNG to those elements.

The ICNG provides a qualitative or quantitative methodology to assess construction noise emissions. The quantitative approach is suited to major construction projects with a typical duration of more than three weeks and has been adopted for the purpose of this assessment.

This method requires noise emission predictions from construction activities at the nearest assessment locations and assessment against ICNG recommended noise levels.

Proposed construction activity will occur during standard construction hours as per the ICNG. The NMLs for standard construction hours adopted for this assessment were derived in accordance with the ICNG for all assessment locations and are presented in Table 6-36.

Table 6-36 Construction NMLs for ICNG standard hours

Assessment location	Representative logging location	RBL, dB(A)	NML, $L_{Aeq.15\ minute}$, dB
R1, R4 – Rural Residential	L1	35	45
R2, R3 – Rural Residential	L2	35	45

Road traffic noise criteria

The principle guidance for the assessment of road traffic noise impact on assessment locations is the RNP. Traffic routes for construction and operational traffic related to the project consist of Wilton Road, Wangi Road, Awaba Road and Cessnock Road. These are categorised as arterial/sub-arterial roads as per the categories provided in the RNP.

Table 6-37 presents the road traffic noise assessment criteria for noise sensitive receptors reproduced from Table 3 and Table 4 of the RNP for road categories relevant to the construction and operation of the project.

Table 6-37 Road traffic noise assessment criteria for residential land uses

Receiver type	Road category	Type of project/development	Assessment criteria (dB)	
			Day (7am – 10pm)	Night (10pm – 7am)
Residence	Freeway/arterial /sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,15\ hour}$ 55 (external)
	Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,15\ hour}$ 55 (external)	$L_{Aeq,15\ hour}$ 50 (external)

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB where all feasible and reasonable noise mitigation is considered.

6.9.3 Existing environment

Sensitive receptors

The nearest noise sensitive receptors (herein referred to as assessment locations) are described in Table 6-38 and shown in Appendix P.

Table 6-38 Assessment locations

Receptor	Address	Type	Easting	Northing
R1	9 Olney Street, Awaba	Residential	363733	6346064
R2	15 Evans Street, Awaba	Residential	363203	6346323
R3	51 Puddy Lane, Awaba	Residential	363220	6346274
R4	1A Olney Street, Awaba	Residential	363547	6346080

Existing noise levels

To establish the ambient noise levels in the area, both unattended and short-term operator-attended noise surveys were conducted at representative monitoring locations in general accordance with the procedures described in Australian Standard AS 1055-2018 - *Acoustics - Description and Measurement of Environmental Noise*.

Unattended noise monitoring

Unattended noise monitoring was undertaken at two residential properties representative of those potentially most-affected by noise from proposed operation and construction of the project. The noise monitoring locations were selected after a desktop review and inspection of the area surrounding the Awaba Colliery Surface Site, giving due consideration to other noise sources which may influence the readings (eg domestic air conditioning units), the proximity of assessment locations to the site, security issues for the noise loggers and gaining permission to access properties from the residents or landowners. Two noise loggers were deployed as follows:

- L1 – Logger 1 was placed at 2 Olney Road, Awaba and is representative of assessment locations R1 and R4.
- L2 – Logger 2 was placed at 8 Wyong Street, Awaba and is representative of assessment locations R2 and R3.

The loggers were in place from 5–19 September 2019 (ie 14 consecutive days).

The noise loggers were programmed to record statistical noise level indices continuously in 15-minute intervals, including the L_{Amax}, L_{A1}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}.

Weather data for the survey period was obtained from Centennial Coal’s on-site weather station located at the Awaba Colliery Surface Site. Wind speed and rainfall data were used to exclude noise data during periods when the average wind speed was in excess of 5 m/s and/or during rainfall events in accordance with NPfI methods.

A summary of existing RBLs and ambient L_{Aeq} noise levels is provided in Table 6-39.

Table 6-39 Summary of existing background and ambient noise levels

Monitoring location	Assessment period[1]	RBL[2](dB)	Measured $L_{Aeq,period}$ noise level[3] (dB)
L1 – 2 Olney Road, Awaba7	Day	34	53
	Evening	32	50
	Night	30	49
L2 – 8 Wyong Street, Awaba	Day	35	54
	Evening	33	47
	Night	33	47

Notes:

1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Morning shoulder: 6 am–7 am Monday to Saturday, 6 am–8 am Sundays and public holidays; Night: remaining periods.
2. RBL is an NPfI term and is used to represent the background noise level.
3. The energy averaged noise level over the measurement period and representative of general ambient noise.

Attended noise monitoring

Operator attended 15-minute noise measurements were conducted on 4 September 2019 at each logger location (L1 and L2) to identify noise sources contributing to the ambient noise environment. Meteorological conditions throughout the survey period were relatively calm with no winds above 5 m/s and no rain.

The ambient noise environment was found to be dominated by natural sounds such as bird noise, wind in trees and dogs barking, with local and distant road traffic as well as occasional rail noise.

Meteorology

Noise propagation over distance can be significantly affected by meteorological conditions. Of most interest are source-to-receiver winds, the presence of temperature inversions and drainage flow (katabatic winds), as these conditions can enhance received noise levels. To account for these phenomena, the NPfI specifies two options in regard to meteorological data analysis procedures to determine the presence of significant meteorological conditions, as follows:

1. Adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur.
2. Determine the significance of noise-enhancing conditions. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

Winds

The NPfI recommends consideration of wind effects if source-to-receiver wind speed (measured at 10 m above ground level) is 3 m/s or less and occurs for 30% of the time in any assessment period and season.

An analysis of wind data recorded by the on-site weather station located at the Awaba Colliery Surface Site was undertaken for 2018 (one calendar year). No winds were identified to trigger the NPfI 30% threshold in any direction.

Temperature inversions

The NPfI states that the assessment of noise impact with influence from temperature inversions (F or G stability class) be confined to the night-time assessment period when they typically occur.

The frequency of temperature inversions was determined based on data obtained from the on-site weather station located at the Awaba Colliery Surface Site. It was found that F stability class temperature inversions did occur for 30% or greater of the night period.

Drainage winds

The NPfI states that a default drainage wind value should be applied where noise sources at the development are at significantly higher altitude than the assessment location(s) and no intervening topography is present. All assessment locations are at a similar or higher elevation than the Awaba Colliery Surface Site and therefore drainage winds were found not to be relevant to this assessment.

Modelled meteorological conditions

F stability class temperature inversions were identified as being prevailing in the vicinity of the Awaba Colliery Surface Site; however, winds were not. Notwithstanding the preceding, a conservative approach has been adopted for the purpose of predicting noise emissions. This assessment has adopted standard and noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes, in accordance with the NPfI. Noise levels from the Awaba Colliery Surface Site have been predicted at all assessment locations based on the meteorological parameters shown in Table 6-40.

Table 6-40 Meteorological parameters adopted for noise modelling

Assessment period[1]	Meteorological condition	Air temperature	Relative humidity	Wind speed	Wind direction	Stability category
Day	Standard	20°C	70%	0.5 m/s	Nil	D class
	Noise enhancing – Wind	20°C	70%	3 m/s	All	D class
Evening	Standard	10°C	90%	0.5 m/s	Nil	D class
	Noise enhancing – Wind	10°C	90%	3 m/s	All	D class
Night	Standard	10°C	90%	0.5 m/s	Nil	D class
	Noise enhancing – Wind	10°C	90%	3 m/s	All	D class
	Noise enhancing – Temperature inversion	10°C	90%	2 m/s	All	F class

Notes:

1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: remaining periods.

Existing mine noise

Awaba Colliery operates under the conditions of Development Consent PA 10_0038 and Environment Protection Licence (EPL) 443, which include noise limits for operation of the Awaba Colliery Surface Site. Additionally, the ventilation fan site at Awaba, and associated noise limits, is approved under the Newstan Colliery consent (DA 73-11-98 Mod 8). These noise limits are provided in Table 6-41.

Table 6-41 Noise criteria for Awaba Colliery Surface Site and ventilation fan

Location	Day	Evening	Night	
	LAeq(15min)	LAeq(15min)	LAeq(15min)	LA1(1min)
PA 10_0038				
R4 – 1A Olney Street, Awaba	37	36	36	46
All other privately-owned residences	35	35	35	45
DA 73-11-98				
All privately-owned residences	38	40	36	-

The Awaba Colliery has been in care and maintenance since August 2014. A review of noise compliance monitoring reports undertaken from February 2013 through to August 2014 was undertaken to gain an understanding of noise emissions from Awaba Colliery prior to it being placed onto care and maintenance.

Results of quarterly noise monitoring show that Awaba Colliery's noise emission levels were at or below (ie complied with) relevant noise limits in accordance with PA 10_0038 and EPL 443 throughout the entire review period.

6.9.4 Impact assessment

Operation

Predicted noise levels for operation of the project (namely operation of additional equipment at the Awaba Colliery Surface Site) are presented in Table 6-42 for all assessment locations. Standard and noise-enhancing weather conditions have been considered as per Table 6-40 and the highest predicted noise level is presented for each period.

Table 6-42 Predicted operational noise levels

Assessment locations	Period	Predicted $L_{Aeq,15\ minute}$ noise level (dB)		PNTL $L_{Aeq,15\ minute}$ (dB)
		Standard	Noise-enhancing	
R1	Day	<40	<40	40
	Evening	<35	<35	37
	Night	<35	<35	35
R2	Day	<40	<40	40
	Evening	<35	36	38
	Night	<35	36	38
R3	Day	<40	<40	40
	Evening	<35	37	38
	Night	<35	37	38
R4	Day	<40	<40	40
	Evening	<35	37	37
	Night	<35	37	35

Operational noise emissions are predicted to satisfy the PNTLs at all assessment locations during standard weather conditions. During noise-enhancing weather conditions, a negligible exceedance of the PNTLs (up to 2 dB) is predicted during the night-time period at assessment location R4.

The NPfI defines a ‘negligible’ exceedance as a predicted noise level which is ≤2 dB above the designated PNTL. Negligible exceedances are generally not discernible by the average listener and therefore do not warrant receiver based treatments or controls (refer Table 3.3). Given that this exceedance is considered to be ‘negligible’, there is no requirement to consider VLAMP or additional noise mitigation measures.

Sleep disturbance

Typical maximum noise level events at the Awaba Colliery Surface Site would include continual ventilation fan noise or methane flaring. These events represent the likely highest maximum noise level events from the Awaba Colliery Surface Site. It is noted that these sources may operate at any time, including the night-time period. Operation of these sources produces a relatively steady-state noise and, as such, maximum noise events are unlikely to occur, and otherwise would not be dissimilar to predicted average operational LAeq noise levels. On this basis, and the fact that predicted operational noise levels are significantly below the noise criteria, sleep disturbance impacts are also unlikely to occur. Hence, as per the NPfI requirements, a detailed maximum noise level event assessment is not required.

Construction

Predicted noise levels for construction activities at the Awaba Colliery Surface Site are presented in Table 6-43 for all assessment locations during ICNG standard construction hours. These predictions conservatively assume that the worst-case construction activity for each construction area at the Awaba Colliery Surface Site is occurring concurrently. Standard and noise-enhancing weather conditions have been considered as per Table 6-40.

Table 6-43 Predicted construction noise levels

Assessment locations	Period	Predicted $L_{Aeq,15\ minute}$ noise level (dB)		NML $L_{Aeq,15\ minute}$ (dB)
		Standard	Noise-enhancing	
R1	Day	<35	36	45
R2	Day	42	45	45
R3	Day	43	45	45
R4	Day	40	43	45

Construction noise emissions are predicted to satisfy the relevant NMLs at all assessment locations under both standard and noise-enhancing meteorological conditions.

Road traffic

Proposed road traffic volumes and routes associated with construction and operation of the project are described in Section 6.10.

The Federal Highway Traffic Noise Model (FHWA) (US Department of Transportation) method was used to predict road traffic noise levels along routes associated with the project.

Construction-related traffic will primarily be to and from the Awaba Colliery Surface Site along Wilton Road via either Wangi Road, Cessnock Road or Awaba Road. The total construction period is expected to be 11 months.

The predicted daily construction traffic generation for the project is provided in Table 6-44.

Table 6-44 Project-related daily construction traffic – worst case construction period

Activity	Light vehicles (LV)	Heavy vehicles (HV)	LV/HV movements
Awaba Colliery Surface Site construction activities	50	5	100/10
Total	**50**	**5**	**100/10**

The proposed construction traffic routes and distribution of light vehicles are described as follows:

- 20% via Wilton Road and Wangi Road (north).
- 30% via Wilton Road and Wangi Road (south).
- 30% via Wilton Road and Awaba Road.
- 20% via Wilton Road and Cessnock Road.

Heavy vehicles will access the Awaba Colliery Surface Site via Wilton Road and Wangi Road (ie the southern approach) to avoid the Awaba township. There are no directly affected residential assessment locations along this heavy vehicle route.

The nearest potentially affected residential façade locations on Wilton Road are situated approximately 15 m from the road kerb/edge. Existing daily traffic on Wilton Road is estimated at between 2,415 and 2,590 light vehicle movements (refer to Section 6.10.3).

During construction, the workforce is expected to arrive at the Awaba Colliery Surface Site between 6:00 am and 7:00 am (ie during the NPfI defined night-time period) and depart between 3:00 pm and 4:00 pm. As such, it is assumed that the construction traffic movements will be split evenly between the daytime and night-time periods.

Based on the above traffic volumes, the predicted road traffic noise levels at the nearest potentially affected residence on Wilton Road are provided in Table 6-45.

Table 6-45 Road traffic noise results

Road	Receiver type (distance from road)	Existing noise levels, dB		Future[1] noise levels, dB		Criteria, dB		Increase between existing and future, dB	
		Day[2] $L_{Aeq,15 hour}$	Night[2] $L_{Aeq,9 hour}$	Day $L_{Aeq,15 hour}$	Night $L_{Aeq,9 hour}$	Day $L_{Aeq,15 hour}$	Night $L_{Aeq,9 hour}$	Day	Night
Wilton Road	Residence (15 m)	62.5	56.7	62.5	56.8	60	55	+0.0	+0.1

Road traffic noise level predictions demonstrate a 0.1 dB increase between 'existing' and 'existing + proposed' $L_{Aeq,period}$ noise levels for night-time construction traffic (ie early morning arrivals between 6:00 am and 7:00 am).

There was no predicted increase in daytime traffic noise levels. Predictions also demonstrate that existing traffic noise levels on Wilton Road are already above RNP criteria for both daytime and night-time periods.

The RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB. Road traffic noise levels from the project's construction activities therefore satisfy RNP criteria.

Operational road traffic volumes associated with the Awaba Colliery Surface Site are not proposed to increase as a result of the project and therefore have not been considered as part of this assessment.

The Noise and Vibration Impact Assessment for the Northern Coal Logistics Project (SSD-5145) (SLR Consulting, 2014), assessed road traffic volumes and routes associated with construction and operation of the Newstan Colliery Surface Site. Overall, employee numbers and subsequent traffic volumes are to remain below levels already approved under SSD-5145 for the Northern Coal Logistics Project. As such, road traffic noise for the Newstan Colliery Surface Site has not been assessed as part of this assessment.

Operational and construction vibration

Vibration-generating activities will occur during the construction phase of the project including the operation of mobile equipment. Given the minimum separation distance of approximately 650 m between proposed construction activities and the nearest potentially affected residential locations, ground-borne vibration levels from these activities are expected to be negligible and below levels of human perception at the nearest residential receivers.

During operations, the main vibration-generating activities will be from the ventilation fans. Given the minimum separation distance of approximately 650 m between the ventilation fans and the nearest potentially affected residential locations, ground-borne vibration levels from these activities are predicted to be negligible and below levels of human perception at the nearest residential receivers. Furthermore, vibration levels generated by the project will remain largely unchanged from those generated by existing infrastructure at the Awaba Colliery Surface Site.

6.9.5 Mitigation and management

Construction phase noise mitigation measures will be outlined in the CEMP for the project construction.

Operational noise emissions from the project will continue to be managed in accordance with the Northern Region Noise Management Plan (NMP).The NMP will be updated as necessary to account for the approved project.

In addition, Centennial Newstan will undertake a noise monitoring program to validate the assumptions made in this assessment including the sound power level of on-site plant and equipment and off-site noise emissions.

6.10 Traffic and transport

A Traffic Impact Assessment (TIA) was prepared by EMM to assess the predicted traffic impacts of both construction and operation of the project. The information presented in this section is summarised from the TIA (EMM, 2019), which is presented in full in Appendix P.

This section addresses all of the traffic and transport issues relating to the project, in accordance with the relevant SEARs (refer to Appendix A).

6.10.1 Background

Potential traffic impacts from the project could occur through light and heavy vehicle movements associated with deliveries of equipment and consumables as well as employee, contractor, service provider and visitor movements to and from the Newstan Colliery Surface Site and Awaba Colliery Surface Site. As such the TIA study area included the the local road network and the six key intersections in proximity to the Newstan Colliery Surface Site and Awaba Colliery Surface Site. These intersections include:

- Wakefield Road/Miller Road.
- Miller Road/Newstan Colliery Surface Site access road.
- Macquarie Road/Fassifern Road/Miller Road.
- Toronto Road/Macquarie Road/Bay Road.
- Awaba Road/Cessnock Road/Wilton Road.
- Wangi Road/Wilton Road.

6.10.2 Methodology

Traffic volumes

Baseline daily traffic volumes for Awaba Road and Wangi Road were determined from published RMS daily traffic surveys. RMS traffic data was not available for the remainder of the roads relevant to the project, as such, traffic surveys were conducted at the six key intersections within the study area in August 2019 to determine average peak hourly traffic volumes and daily traffic volumes. Peak hourly traffic volumes have been assumed to be 10% of daily traffic volumes, in accordance with historical RMS traffic data.

The baseline traffic volumes and existing road widths for each road were compared with the Austroads *Guide to Road Design* (Austroads, 2016) standards to determine whether the existing road network complies with the relevant capacity standards.

Key intersection performance

Baseline intersection performance was assessed using the current RMS intersection level of service (LOS) standards for traffic analysis (refer to Table 6-46). The assessment was undertaken using SIDRA traffic analysis software for intersections.

Table 6-46 Intersection Level of Service (LOS) standards

Level of Service	Average Delay (seconds per vehicle)	Traffic Signals, roundabout	Priority intersection (‘Stop’ and ‘Give Way’)
A	<14	Good operation	Good operation
B	15-28	Good operation with acceptable delays	Acceptable delays and spare capacity
C	29-42	Satisfactory	Satisfactory, but accident study required
D	43-56	Operating near capacity	Near capacity and accident study required
E	57-70	At capacity. At traffic signals, incidents will cause extensive delays. Roundabouts require other control mode.	At capacity; required other control mode
F	>71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; required other control mode

Impact assessment

Once baseline traffic conditions were established, future traffic conditions were calculated based on estimated levels of construction and operational traffic movements for the project. The predicted future traffic conditions were then compared with the relevant standards as identified above to determine if an impact to traffic and transport would occur.

6.10.3 Existing environment

Overview of the existing road network

The road network relevant to the project can be divided into two routes: the Newstan Colliery transport route and the Awaba Colliery transport route. These routes are described in the following subsections.

Newstan Colliery transport route

Miller Road

Miller Road is a 5 km long two-way sealed local road that provides access to the Newstan Colliery Surface Site. It connects Wakefield Road to the north and Macquarie Road/Fassifern Road to the south. Both ends of the road are standard T-junction type intersections. Miller Road also intersects with School Road; Rosina Road; Jefferson Road and McCanns Road. An active private spur line (level crossing) intersects with Miller Road, approximately 400 m to the west of the Macquarie Road/Fassifern Road/Miller Road intersection. This level crossing is controlled by flashing lights and boom gates.

The centre line is generally marked on this road, while the edge line is not marked. The general road width is between 7 m and 10 m (7 m width generally to the west of Newstan Colliery Surface Site access point), and when approaching the Newstan Colliery Surface Site access road, the road width widens to 15 m–16 m with an additional bypass lane to allow through traffic movements. The speed limit on Miller Road is generally 80 km/h and reduces to 60 km/h when approaching the level crossing. A school zone speed limit of 40 km/h is also applicable to the eastern section of Miller Road, between the level crossing and the Macquarie Road/Fassifern Road/Miller Road intersection, during the morning and afternoon school peak hours. Miller Road is not an approved B-Double route.

Wakefield Road

Wakefield Road is a 10.5 km long two-way sealed road, connecting the Charlton Street/Appletree Road/Northville Drive roundabout to the north and Palmers Road/Cessnock Road to the south. The southern section of the road runs almost parallel to the M1 Pacific Motorway and passes through a number of non-residential land uses.

The road width is generally 9 m; however, some sections of the road have extended shoulder width which makes the total road width up to 13 m. The speed limit on Wakefield Road is limited to 80 km/h northbound and 90 km/h southbound towards the south and 80 km/h towards the north. Wakefield Road intersects with The Broadway; Rhondda Road; School Road; Miller Road; Rosina Road; Archery Road; Quarry Trail and Bushrock Road. Wakefield Road is not an approved B-Double route.

Macquarie Road

Macquarie Road is a 2 km long two-way sealed local road, connecting the Miller Road/Fassifern Road intersection to the west and the Toronto Road/Bay Road intersection to the east. The road passes through residential land uses in Fassifern and Fennell Bay. The road alignment is generally level with bends at either ends. The road width is generally 12 m in the residential area and reduces to 7 m outside of residential area. Street parking is generally permitted on both sides of the road. The sign posted speed limit is 60 km/h and reduces to 40 km/h when approaching the school zone during the morning and afternoon school peak hours.

Macquarie Road also intersects with Brighton Street; Brougham Avenue; Lake Road/Potter Close; Sandra Street; Margaret Street; Harrington Street; and Prince Street. All intersections provide access to residential areas in the locality. Macquarie Road is not an approved B-Double route.

Fassifern Road

Fassifern Road is an 850 m long two-way sealed local road, connecting the Macquarie Road/Miller Road intersection to the north and becomes Fassifern Street 850 m to the south. Fassifern Street goes on for approximately 950 m to the south through to the South Parade/Todd Street intersection.

The sign posted speed limit on this road is generally 60 km/h and reduces to 40 km/h when approaching the school zone during the morning and afternoon school peak hours. The general road width varies between 9 m and 13 m with the majority of the road width being greater than 10 m. Between Ashley Street and Todd Street there are designated cycling paths. Fassifern Road is not an approved B-Double route.

Awaba Colliery transport route

Wilton Road

Wilton Road is a 5 km long two-way sealed local road, which provides access to the Awaba Colliery Surface Site. The northern section of the road generally runs parallel to the railway line, then runs south after passing the Awaba train station and then east towards Rathmines. The road connects Cessnock Road/Awaba Road to the north and Wangi Road to the south. The sign posted speed limit is 80 km/h eastbound and 60 km/h westbound. General road width of Wilton Road is 7 m–9 m. Wilton Road is an approved 25/26 m B-Double route.

Awaba Road

Awaba Road is a 3.4 km long two-way sealed local road. It connects Cessnock Road/Wilton Road to the west and The Boulevarde/Jindalee Street to the east. Both the centre line and edge lines are marked along the road corridor. The sign posted speed limit is 60 km/h eastbound and 80 km/h westbound. Road width is generally 10 m with some sections widening up to 17 m when approaching intersections. A school zone speed limit of 40 km/h is applicable on this road during the morning and afternoon school peak hours. Awaba Road is an approved 25/26 m B-Double route.

Cessnock Road

Cessnock Road is a 4.2 km long two-way sealed local road, connecting Wakefield Road/Palmers Road to the west and Wilton Road/Awaba Road to the east. The sign posted speed limit is 90 km/h. The general road width varies between 10 m and 12 m, with extended road width when approaching various intersections. Cessnock Road is an approved 25/26 m B-Double route.

Wangi Road

Wangi Road is a 13 km long two-way sealed road, connecting Mount Waring Road/Ridge Road, near Toronto, to the north and Douglass Street, near Dora Creek, to the south. The sign posted speed limit of the road is 80 km/h and 90 km/h travelling southbound and 60 km/h travelling northbound. Road width varies between approximately 9 m and 13 m (expanding up to 15 m at some locations). Wangi Road is an approved 25/26 m B-Double route.

Baseline traffic volumes

Baseline traffic volumes for each road within the study area are shown in Table 6-47.

Table 6-47 Projected daily traffic volumes

Road	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Miller Road (east of Wakefield Road)	110.5	1,105
Miller Road (west of Newstan Colliery Surface Site access road)	77.5	775
Miller Road (east of Newstan Colliery Surface Site access road)	151.5	1,515
Miller Road (west of Macquarie Road/Fassifern Road)	174.5	1,745
Wakefield Road (north of Miller Road)	300	3,000
Wakefield Road (south of Miller Road)	225	2,550
Fassifern Road (south of Miller Road)	451.5	4,515
Macquarie Road (north of Miller Road)	404	4,040
Macquarie Road (west of Toronto Road)	560	5,600
Wilton Road (west of Awaba Road/Cessnock Road)	241.5	2,415
Wilton Road (west of Wangi Road)	259	2,590
Awaba Road (north of Wilton Road)	592	5,920
Cessnock Road (south of Wilton Road)	746.5	7,465
Wangi Road (north of Wilton Road)	1,416.5	14,165
Wangi Road (south of Wilton Road)	1,591.5	15,915

The existing road width measurements and conditions for each road network are shown in Table 6-48. The existing local road network generally meets the Austroads (2016) *Road Design Guide* standards to accommodate existing baseline traffic volumes.

Table 6-48 Daily traffic volumes and corresponding Austroads design standards

Road	Daily traffic volume	Relevant Austroads threshold band	Relevant Austroads design standard	Road width	Compliance?
Miller Road	775 – 1,745	1,000 – 3,000	Minimum 9 m wide seal	Generally, 7 m–10 m wide seal.	Generally, yes
Wakefield Road	2,550 – 3,000	1,000 – 3,000	Minimum 9 m wide seal	Generally, 9 m wide seal.	Yes
Fassifern Road	4,515	> 3,000	Minimum 10 m wide seal	9 m – 13 m wide seal.	Generally, yes
Macquarie Road	4,040 – 5,600	> 3,000	Minimum 10 m wide seal	Generally, 12 m wide seal in residential area; and, generally, 7 m wide seal outside of residential area.	Generally, yes

Road	Daily traffic volume	Relevant Austroads threshold band	Relevant Austroads design standard	Road width	Compliance?
Wilton Road	2,415 – 2,590	1,000 – 3,000	Minimum 9 m wide seal	7 m – 9 m wide seal.	Generally, yes
Awaba Road	5,920 – 6,899	> 3,000	Minimum 10 m wide seal	Generally, 10 m wide seal.	Yes
Cessnock Road	7,465	> 3,000	Minimum 10 m wide seal	10 m – 12m wide seal.	Yes
Wangi Road	14,165 – 20,784	> 3,000	Minimum 10 m wide seal	9 m – 13 m wide seal.	Generally, yes

Key intersections

The major road intersections that will be used by project related traffic and their existing performance is described in the following subsections.

Wakefield Road/ Miller Road

The Wakefield Road/Miller Road intersection is a T-junction. There is a channelised right turn (CHR) treatment and an auxiliary left turn (AUL) treatment on Wakefield Road based on Austroads (2017) Part 4 Intersection Design Standards. Additional road width is provided at the intersection to provide better visibility and to ensure smoother turns for heavy vehicles. The intersection design currently satisfies the minimum Austroads requirements for a rural intersection with additional CHR and AUL turning lanes. An aerial view of the intersection is shown in Figure 6-11.

Figure 6-11 Intersection of Wakefield Road and Miller Road

The intersection of Wakefield Road and Miller Road currently operates at a LOS A during morning and afternoon peak times. Degree of saturation is generally around 8 percent in the morning and 7 percent in the afternoon. The 95th percentile back of queue length is 0.3 in the morning peak hour and 0.4 in the afternoon peak hour. A summary of intersection traffic is included in Table 6-49.

Table 6-49 Average traffic volumes for Wakefield Road and Miller Road

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Wakefield Road (north of Miller Road)	Northbound	192.5	1,925
	Southbound	109.5	1,095
Wakefield Road (south of Miller Road)	Northbound	148	1,480
	Southbound	122	1,220
Wakefield Road (east of Miller Road)	Westbound	53	530
	Eastbound	57.5	575

Miller Road/ Newstan Colliery Surface Site

The Miller Road/Newstan Colliery Surface Site access road intersection is a T-junction. There is a CHR treatment and an AUL treatment on Miller Road based on Austroads (2017) Part 4 Intersection Design Standards. Additional road width is provided at the intersection to provide better visibility and to ensure smoother turns for heavy vehicles. The intersection design currently satisfies the minimum Austroads requirements for a rural intersection with additional CHR and AUL turning lanes. An aerial view of the intersection is shown in Figure 6-12.

Figure 6-12 Intersection of Miller Road and Newstan Colliery Surface Site

The intersection of Miller Road and Newstan Colliery Surface Site currently operates at LOS A during morning and afternoon peak times. The degree of saturation is generally around 3 percent in both the morning and afternoon. The 95th percentile back of queue length is 0.1 in the morning and afternoon peak hours. A summary of intersection traffic is included in Table 6-50.

Table 6-50 Average Traffic Volumes for Miller Road and Newstan Colliery Surface Site

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Miller Road (west of Newstan Colliery Surface	Westbound	62.5	625
	Eastbound	70.5	705
Miller Road (east of Newstan Colliery Surface	Westbound	69.5	695
	Eastbound	82	820
Newstan Colliery Surface Site access road (east of Miller Road)	Northbound	16	160
	Southbound	20.5	205

Macquarie Road/ Fassifern Road/ Miller Road

The intersection of Macquarie Road, Fassifern Road and Miller Road is and urban unsignalised T-Junction shown in Figure 6-13.

Figure 6-13 Intersection of Macquarie Road, Fassifern Road and Miller Road

The intersection of Macquarie Road, Fassifern Road and Miller Road currently operates at a LOS A during morning and afternoon peak times. The degree of saturation is generally around 9 percent in the morning and 16 percent in the afternoon. The 95th percentile back of queue length is 0.3 in the morning peak hour and 0.7 in the afternoon peak hour. A summary of intersection traffic is included in Table 6-51.

Table 6-51 Average traffic volumes for Macquarie Road, Fassifern Road and Miller Road

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Macquarie Road (north of Miller Road)	Northbound	217	2,170
	Southbound	187	1,870
Fassifern Road (south of Miller Road)	Northbound	229.5	2,295
	Southbound	222	2,220
Miller Road (west of Macquarie Road/ Fassifern Road)	Westbound	76	760
	Southbound	98.5	985

Toronto Road/ Macquarie Road/ Bay Road

The intersection of Toronto Road/Macquarie Road/Bay Road is a signalised urban intersection with pedestrian crossings on all directions shown in Figure 6-14.

Figure 6-14 Intersection of Toronto Road, Macquarie Road and Bay Road

The intersection of Toronto Road, Macquarie Road and Bay Road currently operates at a LOS B in the morning and afternoon. The degree of saturation is generally around 78 percent in the morning and 76 percent in the afternoon. The 95th percentile back of queue length is 16.1 in the morning peak hour and 19.2 in the afternoon peak hour. A summary of intersection traffic is included in Table 6-52.

Table 6-52 Average traffic volumes for Toronto Road, Macquarie Road and Bay Road

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Toronto Road (north of Macquarie Road)	Northbound	1,373.5	13,735
	Southbound	1,104.5	11,045
Toronto Road (south of Macquarie Road)	Northbound	1,192.5	11,925
	Southbound	1030.5	10,305
Macquarie Road (west of Toronto Road)	Westbound	266	2,660
	Eastbound	294	2,940
Bay Road (east of Toronto Road	Westbound	227	2,270
	Eastbound	148	1,480

Awaba Road/ Cessnock Road/ Wilton Road

The Awaba Road/Cessnock Road/Wilton Road is a T-junction. There is a CHR treatment and an AUL treatment on Awaba Road/Cessnock Road based on Austroads (2017) Part 4 Intersection Design Standards. Additional road width is provided at the intersection to provide better visibility and to ensure smoother turns for heavy vehicles. The intersection design currently satisfies the minimum Austroads requirements for a rural intersection with additional CHR and AUL turning lanes. An aerial view of the intersection is shown in Figure 6-15.

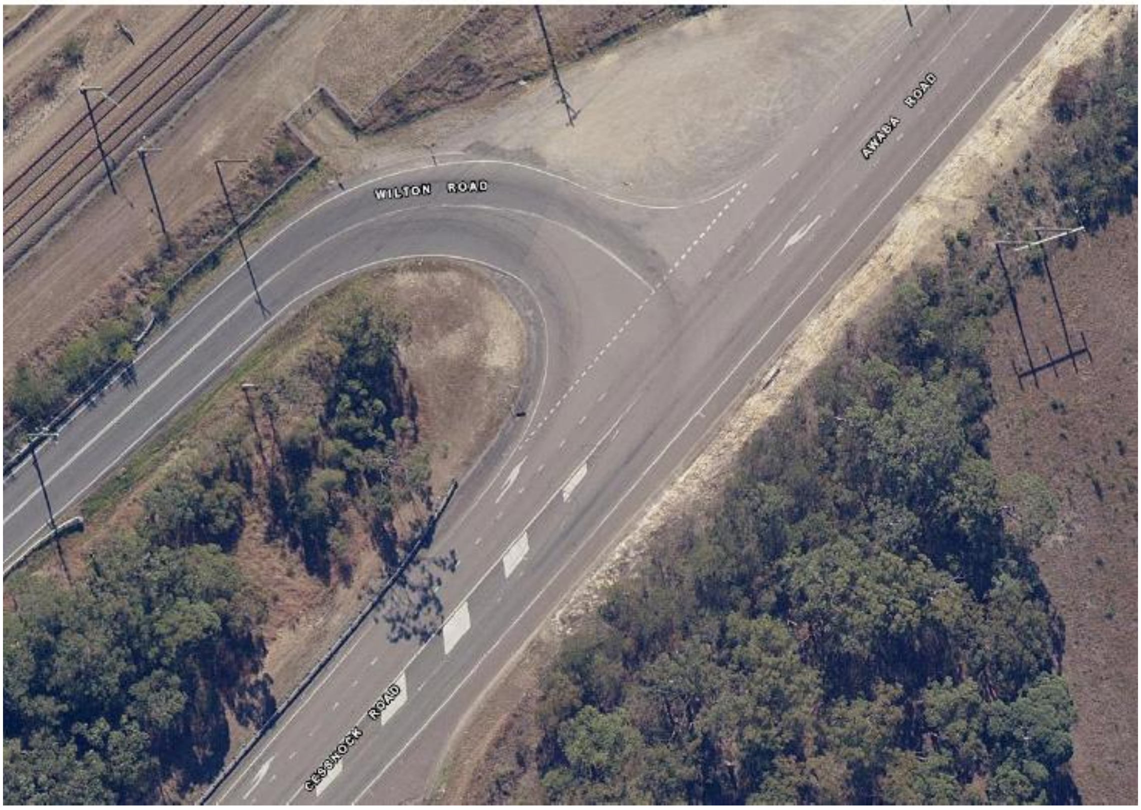

Figure 6-15 Intersection of Awaba Road, Cessnock Road and Wilton Road

The intersection of Awaba Road, Cessnock Road and Wilton Road operates at a LOS A in the early morning peak hour (6:00 am to 7:00 am) and a LOS B in the morning peak hour (7:00 am to 8:00 am. Traffic patterns in the afternoon occur in a similar manner, operating at a LOS A in the early peak hour (2:00 pm to 3: 00 pm) and LOS B in the afternoon peak hour (3:00 pm to 4:00 pm). Road saturation is approximately 25 percent in the morning peak hours and 26 percent in the afternoon peak hours. The 95th percentile back of queue length is 1.4 in the morning peak hour and 1.3 in the afternoon peak hour. A summary of intersection traffic for Awaba Road, Cessnock Road and Wilton Road are included in Table 6-53.

Table 6-53 Average traffic volumes for Awaba Road, Cessnock Road and Wilton Road

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Awaba Road (north of Wilton Road)	Northbound	237	2,370
	Southbound	325	3,250
Cessnock Road (south of Wilton Road	Northbound	334	3,340
	Southbound	412.5	4,125
Wilton Road (west of Awaba Road/Cessnock Road)	Westbound	110.5	1,105
	Eastbound	131	1,310

Wangi Road/ Wilton Road

The Wangi Road/Wilton Road is a seagull type T-junction where right turning outbound vehicles from the minor road (i.e.ie Wilton Road) only need to give way to vehicles coming from the right, therefore, speeding up the waiting time for outbound turning vehicles. Traffic turning right from the minor road (i.e.ie Wilton Road) has adequate gaps in traffic on the nearer carriageway (i.e.ie nearer lane) and is able to merge safely with the traffic on the other carriageway (i.e.ie throughput traffic lane on Wangi Road). This design also allows through traffic on the major road (i.e.ie Wangi Road) to pass a turning vehicle without queueing behind the turning vehicle. Additional road width is provided at Wilton Road approaching the intersection for better visibility and to ensure smoother turns for heavy vehicles. An aerial view of the intersection is shown in Figure 6-16.

Figure 6-16 Intersection of Wangi Road and Wilton Road

The intersection of Wangi Road and Wilton Road operates at a LOS A in the early morning peak hour and a LOS C in the morning peak hour. Saturation in the early morning peak hour is approximately 25 percent rising to 43 percent in the morning peak hour. The intersection operates at a LOS A in the early afternoon peak hour and a LOS B in the afternoon peak hour. Degree of saturation in the early afternoon peak hour is typically 33 percent, rising to 47 percent in the afternoon peak hour. The 95th percentile back of queue length is 1.6 in the morning peak hour and 2.2 in the afternoon peak hour A summary of intersection traffic is included in Table 6-54.

Table 6-54 Average traffic volumesTraffic Volumes for Wangi Road and Wilton Road

Road	Direction	Average Peak Hourly Traffic Volume	Daily Traffic Volume
Wangi Road (north of Wilton Road)	Northbound	748.5	7,485
	Southbound	632	6,320
Wangi Road (south of Wilton Road)	Northbound	883	8,830
	Southbound	708	7,080
Wilton Road (west of Wangi Road)	Westbound	140.5	1,405
	Eastbound	118.5	1,185

Traffic safety

Using data recorded within the TfNSW interactive accident history database (2013-2017) it was found that no fatal injuries were recorded along the assess road network during this period. There has been a general decline in the number of reported crashes occurring on the assessed road network. A number of the reported crashes were speeding-related, which could have potentially been avoided if the driver strictly adhered to the relevant road rules. Overall, the number of reported crashes in Lake Macquarie LGA have reduced from 396 in 2013 to 340 in 2017, and heavy vehicle related crashes have also reduced from 12 in 2013 to 4 in 2017.

Level crossings

An active private spur line (level crossing) intersects with Miller Road, approximately 400 m to the west of the Macquarie Road/Fassifern Road/Miller Road intersection. This level crossing is controlled by flashing lights and boom gates.

Public transport

Fassifern and Awaba train stations are the two closest train stations to the project application area. Fassifern train station is approximately 20 minutes' walk from the Newstan Colliery Surface Site via Miller Street, and Awaba train station is approximately 10 minutes' walk from the Awaba Colliery Surface Site via Wilton Road. However, it should be noted that both roads on approach to the relevant mine sites are not pedestrian friendly or safe as roadsides are not built with established pedestrian footpaths. Both train stations are on the Central Coast and Newcastle Line and operate seven days a week. Buses also operate in the area with walking distances from the nearest bus stop similar to the train stations.

Pedestrian and cycling activities

No pedestrian walking activity was recorded during the intersection traffic surveys. There are currently limited cycleway on the assessed road network. Cyclists would need to share use of the assessed roads with other vehicles most of the time. No cyclist activity was observed along the road network during the site inspection.

Road Improvements and major developments

There were no RMS road improvement projects or major projects to a similar scale identified in the area.

6.10.4 Impact assessment

Overview

Road traffic from the project will include light vehicles and heavy vehicles for deliveries of equipment and consumables and employee, contractor, service provider and visitor movements to and from the Newstan Colliery Surface Site and Awaba Colliery Surface Site. Only marginal changes to the operational traffic volumes at these two sites are expected as a result of the project.

Heavy vehicles will require access to the Awaba Colliery Surface Site during construction of the proposed ventilation fans and gas flaring facility. In addition, heavy vehicles may also be required to assist with upgrades to the existing electrical and communications equipment at the Awaba Colliery Surface Site. Heavy vehicles will access the Awaba Colliery Surface Site via Wilton Road and Wangi Road (ie the southern approach) to avoid Awaba township.

Heavy vehicle traffic will be temporary in nature and will be spread out over the 11-month construction period. During construction, maximum daily heavy vehicle movements will be an order of magnitude lower than the forecast additional light vehicle movements and therefore it is considered that no detailed intersection traffic capacity or impact assessments are required.

The existing workforce traffic distribution for the Northern Coal Logistics Project has been used to forecast the proposed workforce traffic distribution. This is based on the existing workforce's residential locations and includes:

- 28% accessing the Newstan Colliery Surface Site from the west (all of which are assumed to come from north of Wakefield Road.
- 72% accessing the Newstan Colliery Surface Site from the east, which includes:
  - 61% coming from the north of Miller Road (via Macquarie Road)
  - 39% coming from south of Miller Road (via Fassifern Street).

This distribution is reflective of the Newstan Colliery Surface Site only, as there are currently a limited number of vehicles accessing the Awaba Colliery Surface Site.

Construction Impacts

It is estimated that approximately 50 employees will be recruited during construction. Construction is expected to see arrivals between 6:00 am and 7:00 am and departures between 3:00 pm and 4:00 pm. To assess a worst-case scenario, it has been assumed that all 50 employees will travel to the construction sites at the Awaba Colliery Surface Site via Wilton Road using their own car, representing 100 daily light vehicle movements. For the purposes of assessment, the predicted traffic distribution for employee and visitor associated light vehicle movements during construction have been split evenly to the north and south from the Awaba Colliery Surface Site access road. The assessed traffic distribution includes:

- 20% via Wilton Road and Wangi Road (north).
- 30% via Wilton Road and Wangi Road (south).
- 30% via Wilton Road and Awaba Road.
- 20% via Wilton Road and Cessnock Road.

Increases of traffic are summarised in Table 6-55.

Table 6-55 Estimated Construction-generated Traffic Volumes

Road	Daily traffic Volume	Estimated construction generated traffic movements	Future daily traffic volume	Compliance with Ausroads design standards and threshold band
Wilton Road	2,415- 2,590	100	2,515- 2,690	Generally, yes
Awaba Road	5,920- 6,889	30	5,950- 6,929	Yes
Cessnock Road	7,465	20	7,485	Yes
Wangi Road	14,165-20,784	50	14,215- 20,834	Generally, yes

During construction, it is expected that project-related vehicle movements will have a negligible impact on the local road network and remain within the current Austroads threshold band and would remain generally compliant with Austroads design standards.

The two intersections associated with construction (Awaba Road/ Cessnock Road/ Wilton Road and Wangi Road/Wilton Road) are forecast to only experience minor changes as a result of construction. Average vehicle delays will increase by 0.2 seconds or less during the early morning peak hour and 1.1 seconds or less in the afternoon peak hour. These delays are unlikely to cause an impact on the regular road users and the impact is consider to be negligible. Impacts to 95th percentile back of queue lengths are expected to increase by 0.2 in the afternoon peak hour for the Awaba Road/Cessnock Road/Wilton Road intersection and 0.4 for the afternoon peak hour for Wangi Road/Wilton Road intersection. No impact to the morning peak hour is predicted. There is also no impact predicted to occur on either intersections LOS.

Operational Impacts

Operations would increase the number of light vehicles in the following ways:

- Completion of previous day afternoon shift (ie 72 outbound light vehicles).
- Commencement of morning shift (ie 99 inbound light vehicles).
- Completion of night shift (ie 72 outbound light vehicles).
- Commencement of afternoon shift (ie 72 inbound light vehicles).
- Completion of morning shift (ie 99 outbound light vehicles).
- Commencement of night shift (ie 72 inbound light vehicles).

This would lead to a maximum of 468 light vehicle movements a day in the operation of the project. Traffic is predicted to be distributed during operations as (based on the existing workforce residence locations for the Northern Coal Logistics Project):

- 28% via Miller Road and Wakefield Road (north).
- 28% via Miller Road and Fassifern Road.
- 44% via Miller and Macquarie Road, including:
  - 31% via Macquarie Road and Toronto Road (north).
  - 13% via Macquarie Road and Toronto Road (south).

It is anticipated that all vehicles associated with the project will be parked on-site.

The additional daily traffic volumes generated on each route during operations are summarised in Table 6-56.

Table 6-56 Estimated Operation-generated Traffic Volumes

Road	Daily traffic Volume	Estimated construction generated traffic movements	Future daily traffic volume	Compliance with Ausroads design standards and threshold band
Miller Road	775- 1,745	486	1,261 – 2,231	Generally, yes
Wakefield Road	2,550 – 3,000	136	2, 686- 3136	Generally, yes
Fassifern Road	4,515	136	4,561	Generally, yes
Macquarie Road	4,040 – 5,600	214	4,254- 5,814	Generally, yes

Wakefield Road is expected to experience a minor impact in the operational phase of the project, with daily traffic volumes increasing between 4.5 and 5.3 percent. However, the existing road design is expected to be adequate enough to manage this increase. All other assessed roads will remain compliant with Austroads design standards during operation of the project.

Vehicle movements are expected to utilise three unsignalised intersections (Wakefield Road/ Miller Road; Willer Road/ Newstan Colliery Surface; Macquarie Road/Fassifern Road/Miller Road) and one signalised intersection (Toronto Road/Macquarie Road/ Bay Road). The unsignalised intersections are expected to increase average vehicle delay times by:

- 0.2 seconds or less during the early morning peak hour.
- 0.1 seconds or less during the morning peak hour.
- 0.4 seconds or less during the early afternoon peak hour.
- 0.2 seconds or less during the afternoon peak hour.

The signalised intersection of Toronto Road/ Macquarie Road/ Bay Road will experience almost no change to existing performance as traffic increases at this intersection will be negligible when compared to baseline conditions. There is no impact predicted to occur on LOS for any intersection as a result of the project. Impacts to 95th percentile back of queue lengths is summarised in Table 6-57.

Table 6-57 Current and Future 95th Percentile Back of Queue Lengths

Intersection	Current AM	Predicted AM	Current PM	Predicted PM
Wakefield Road/Miller Road	0.3	0.4	0.4	0.5
Miller Road/Newstan Colliery surface Site access road	0.1	0.3	0.1	0.5
Macquarie Road/Fassifern Road/Miller Road	0.3	0.4	0.7	1.1
Toronto Road/Macquarie Road/ Bay Road	16.1	16.1	19.2	19.2

Overall, the project is expected to have a negligible impact on the assessed intersections.

The operation of the project is expected to have no impact on road safety, demand on public transport or pedestrian or cycling activities. No cumulative impacts in regards to traffic and transport are expected over the operation of the project.

6.10.5 Mitigation and management

The project-related construction and operational vehicle movements are not expected to have a significant impact on the assessed road network and key intersections. Therefore, no road improvements or upgrades are proposed as part of the project. The project-related workforce will be made aware of a number of traffic-related safety matters prior to commencement of their employment, including:

- Heavy vehicles will avoid the Awaba township by accessing the Awaba Colliery Surface Site via Wilton Road.
- Nearby schools and hours of school zone speed limit enforcement.
- The level crossing location on Miller Road.
- Varying speed limits along the assessed access routes.
- General road safety rules and fatigue management measures.

6.11 Soil and land resources

A Soil and Land Resource Assessment was prepared by SLR Consulting to assess of the likely impacts of the project on the soils and land capability of the site and surrounds. The scope of the Soil and Land Resource Assessment has been designed to address the SEARs (refer to Appendix A) with regard to the assessment of land resources. It is noted that an Agricultural Impact Assessment was not a requirement of the SEARs.

The information presented in this section is summarised from the Soil and Land Resources Assessment (SLR Consulting, 2020b), which is presented in full in Appendix H.

6.11.1 Background

The project has the potential to result in limited impacts to soil and land resources through potential subsidence related surface disturbance and limited vegetation clearing at the Awaba Colliery Surface Site. As such the study area adopted for the Soil and Land Resources Assessment included the Extension of Mining Area and the predicted maximum extent of subsidence (refer to Section 6.1).

The purpose of the Soil and Land Resource Assessment was to:

- Identify and describe the major soil types within the study area.
- Assess pre and post mining land and soil capability classes.
- Provide recommendations on disturbance management.

6.11.2 Methodology

Soil survey methodology

The Soil and Land Resource Assessment followed a process of desktop study and field survey, as described below.

Reference mapping

An initial soil map (reference map) was developed using the following resources and techniques:

- Aerial photographs and topographic maps.
- Reference information including cadastral data, prior and current geological maps, vegetation, and water resources studies.
- Previous reports, including:
  - Soil Landscapes of the Gosford – Lake Macquarie 1:100,000 Sheet (Murphy, 1993).
  - NSW Soil and Land Information System (SALIS) (accessed through eSpade).

Following production of a broad soil map, surface soil exposures, topography and vegetation throughout the potential disturbance areas were visually assessed to verify potential soil types, delineate soil type boundaries and determine preferred locations for targeted subsurface investigations.

Field survey

A field survey was undertaken in accordance with the 1:150,000 scale survey criteria prescribed in the *Guidelines for Surveying Soil and Land Resources* (NCST, 2008).

Across the study area, 11 exposed soil profiles were assessed for soil type and distribution in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST, 2009).

Soil samples from nine of the soil assessment sites were subject to laboratory analysis in order to:

- Classify soil taxonomic classes in accordance with the Australian Soil Classification (Isbell, 2002).
- Determine land and soil capability.
- Determine suitability of soil as topdressing material in future rehabilitation works.
- Key physical and chemical parameters assessed included:
- Coarse fragments (>2mm).
- Particle-size distribution (<2mm).
- Soil reaction (pH).
- Electrical conductivity.
- Cation Exchange Capacity (CEC) and exchangeable cations.
- Munsell Colour Chart.

Land and soil capability methodology

The land and soil capability (LSC) classification applied to the study area was in accordance with the *The Land and Soil Capability Assessment Scheme; Second approximation* (OEH, 2013) (referred to as the LSC Guideline).

6.11.3 Existing environment

Soil types

Within the study area three dominant Australia Soil Classification (ASC) soil map units were identified. Four soil types are present in the study area: Kurosols, Kandosols, Dermosols and Disturbed Terrain (Anthroposols). These are summarised in Table 6-58 and described below.

- Kurosols are the major soil type within the study area. Kurosols are soils with a strong texture contrast between the A horizon and a strongly acidic B horizon. Kurosols generally have moderately low inherent fertility.
- Kandosols are soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout. Kandosols generally have moderately low inherent fertility.
- Dermosols are soils with structured B horizons which lack strong texture contrast between the A and B horizons. Dermosols generally have moderately high inherent fertility.
- Disturbed Terrain includes areas of infrastructure, dams and Anthroposols. Anthroposols are soils that have resulted from human activities which have led to a profound modification, truncation or burial of the original soil horizons, or creation of new soil parent materials by a variety of mechanical means.

Table 6-58 Soil map units

Soil Map Unit	ASC	Study area	
		Hectares	%
1	Kurosol	874	61
2	Kandosol	149	10
3	Dermosol	44	3
4	Disturbed Terrain (Anthroposol)	379	26
Total		1,446	100

Land and soil capability

Based on the biophysical features of the land and soil identified during the assessment, the pre-disturbance study area has been classified into LSC Class 4, 5 and 6. The land area of each LSC Class is shown in Table 6-59 and the limitations associated with each LSC Class are discussed below.

Table 6-59 Land and soil capability classes

Land and Soil Capability	Study Area		Agricultural Capability Rating
Class	Hectares	%	
4	682	47	Moderate
5	85	6	Moderately low
6	300	21	Low
Disturbed Terrain	379	26	Nil
Total	1,446	100	

Class 4 land is characterised by soils on lower slopes and flats associated with Soil Map Unit 1 – Kurosol. This classification indicates that the land is moderately capable for a range of land uses, and specialised practices are necessary to overcome very severe limitations. The primary constraint to this land class is soil acidification.

Class 5 land is represented by areas of Soil Map Unit 1 and 3. This classification indicates a moderate to low land capability, with severe limitations to high impact land management uses such as cropping. This land is generally more suitable for grazing with some limitations, or very occasional cultivation for pasture establishment. The primary constraints to this land class are steep slopes (water erosion hazard) and wind erosion.

Class 6 land is represented by Soil Map Unit 2. This classification indicates low capability land with very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation, it is considered capable for a limited set of land uses such as grazing, forestry, nature conservation and some horticulture. The primary constraint to this land class is steep slopes, soil depth and soil acidification.

Disturbed Terrain has no agricultural capability rating.

6.11.4 Impact assessment

Subsidence and remnant ponding

The Flood Impact Assessment (EMM, 2020a) for the project found that, based on the predicted subsidence, an additional 2 hectares of remnant ponding will be experienced under subsidence conditions. Changes to remnant ponding were primarily around existing waterbodies with minor areas within native bushland areas. Furthermore, the extent of flood inundation is similar to existing conditions with new areas of flooding and areas that no longer experience flooding, generally evenly distributed. Depth changes of greater than 50 millimetres typically occur in isolated areas or in reaches where the predicted subsidence contours are adjacent to the watercourse.

As a result of predicted subsidence there will be approximately 2 hectares of additional remnant ponding.

Post-mining land use

Post-mining land use will be comparable with pre-mining land uses, with only approximately 2 hectares of additional remnant ponding across the study area. The majority of predicted remnant ponding will occur in native bushland areas and all within the maximum extent of subsidence. The 0.35 ha of vegetation clearing required for construction of additional infrastructure at Awaba Colliery Surface Site is located within native bushland.

There will be negligible change in post-mining land use to the study area and surrounds.

Post-disturbance land & soil capability assessment

The post-disturbance LSC classes determined for the study area are anticipated to be the same as the pre-disturbance classes. Due to the nature of the project, the only surface impacts likely to impact on the classification of land resources are associated with surface water ponding and increases in overbank flood events as a result of subsidence. Surface water ponding can limit agricultural capability of the land, whereas increased flooding can result in waterlogging of soils.

Land impacted by additional remnant ponding (2 hectares) within the study area is LSC class 4 and 5 or within areas of disturbed terrain. Areas previously classified as LSC 4 or 5 will now be classified as Class 8 land.

LSC Class 8 Land indicates that the land has serve limitation that make the land incapable of sustaining any land use apart from nature conservation. The primary limitation of LSC Class 8 is waterlogging.

The utilisation of the existing Awaba Colliery Surface Site infrastructure area will result in no changes to the existing LSC classes due to construction and operation of surface facilities associated with the project.

Impact to agricultural resources

As the project will have comparable post-mining land use and the minor changes to LSC do not occur on land used for agricultural production there will be negligible impact from the project on agricultural resources or enterprises.

6.11.5 Mitigation and management

Soils that are subject to surface disturbance for infrastructure or subsidence remediation will be managed in order to minimise impact and ensure appropriate rehabilitation of the disturbed areas can be undertaken.

A CEMP will be prepared for the project prior to the commencement of any construction activities. The CEMP will include protocols for topsoil stripping, soil stockpile management and erosion and sediment control.

6.12 Aboriginal heritage

An Aboriginal Cultural Heritage Assessment was completed by Umwelt to assess the likelihood and significance of any impacts to Aboriginal cultural heritage items as a result of the project. The information presented in this section is summarised from the Aboriginal Cultural Heritage Assessment (Umwelt, 2020), which is presented in full in Appendix T.

The Aboriginal Cultural Heritage Assessment has been prepared to address the requirements of the relevant project SEARs (Appendix A) which state that the EIS for the project must include an assessment of the potential impacts of the development on Aboriginal heritage (cultural and archaeological), including consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage.'

6.12.1 Background

The project has the potential to impact on Aboriginal cultural heritage through subsidence related disturbance of items of Aboriginal cultural heritage significance, surface disturbance related to clearing for infrastructure construction at the Awaba Colliery Surface Site, and decommissioning and rehabilitation activites at Newstan Colliery Surface Site, Forest Road Ballast Borehole and Services Site and Awaba Colliery Surface Site. As such, the study area adopted for the Aboriginal Cultural Heritage Assessment comprised four distinct areas:

- The Extension of Mining Area[6].
- The Awaba Colliery Surface Site.
- The Forest Road Ballast Borehole and Services Site.
- The Newstan Colliery Surface Site.

6.12.2 Methodology

Consultation

Consultation with Aboriginal parties regarding the project was undertaken in accordance with the relevant aspects of Part 8A, Clause 80C of the NPW Regulation (now Part 5, Division 2 Clause 60) and the *Aboriginal cultural heritage consultation requirements for proponents* (DECCW, 2010). A detailed log of all Aboriginal party consultation and correspondence is included in Appendix S.

- [6] While the study area included the portion of land that comprises the Eraring Power Station and Eraring Ash Dam, due to access restraints associated with land owned by Origin Energy, the southern portion of the Extension of Mining Area (approximately 470 hectares) was subject to desktop assessment only, with the archaeological potential considered based on the outcomes of previous archaeological investigations in the area in conjunction with the environmental context of the area.

As a result of the project notification and registration process, 15 Aboriginal parties registered an interest in ongoing consultation regarding the project. Correspondence was provided to all registered Aboriginal parties providing information about the project and requesting information about cultural significance. It included a proposed methodology for a cultural heritage survey and an invitation for input in relation to developing an understanding of the cultural values of the study area and the ways in which these values may be identified during the field assessment activities.

Six Aboriginal parties were invited to attend the archaeological and cultural heritage survey. During the survey, none of the Aboriginal party representatives present identified any areas of Aboriginal archaeological potential or Aboriginal cultural heritage significance within or in proximity to the study area. A copy of the draft Aboriginal Cultural Heritage Assessment was provided to all Aboriginal parties for review and comment.

Further details of the Aboriginal stakeholder consultation undertaken for the Aboriginal Cultural Heritage Assessment are presented in Chapter 5 and Appendix S.

Desktop study

A search of the Aboriginal Heritage Information Management System (AHIMS) was carried out on 26 July 2019.

To supplement the data available via AHIMS and to contribute to the understanding of the archaeological context of the study area more specifically, relevant local assessments were also reviewed.

Field survey

A survey of the study area was conducted over five days between 2 December 2019 and 6 December 2019 by Umwelt archaeologists and six representatives of the registered Aboriginal parties (RAPs).

The aim of the survey was, as far as practical, to record sufficient information to satisfy the Code of Practice and to provide the registered Aboriginal parties participating in the survey with an opportunity to discuss the archaeological and Aboriginal cultural significance of the study area, and any sites/objects observed or revisited. These discussions extended to the archaeological materials that may remain below the surface of the study area.

The calculation of effective survey coverage was undertaken in order to designate the proportion of the study area in which it is possible to accurately assess the presence or absence of archaeological material. The level of effective coverage within the study area was generally very low. The main factor contributing to low coverage was dense vegetation cover (leaf litter, grass), some rubbish and fill material that limited exposure. Areas with the highest levels of effective coverage were modified landforms with significant disturbance, such as access tracks, infilled banks and quarried/cleared areas.

6.12.3 Existing environment

Environmental context

The environmental context of the study area indicates that the area would have provided a range of flora and fauna resources. However, the availability of freshwater within the Project Area is relatively limited, comprising several first and second order tributaries, the limited catchments of which would have resulted in these watercourses being ephemeral in the area.

The study area comprises a variety of landforms including ridges, slopes and crests, and this undulating topography, coupled with a lack of permanent fresh water sources, would have made the area less attractive for prolonged occupation by Aboriginal people in the past. The lack of flat ground in close proximity to reliable water sources would have restricted camping options, and the presence of areas such as Kilaben and Myuna Bays, with wider valleys and creek terraces, would have likely drawn Aboriginal people away from the study area, with its comparatively more difficult landforms. While the topography and hydrology of the study area suggests that Aboriginal occupation in the area would not have been as prolonged or frequent, it is probable that the area was still utilised, including for activities where the availability of water was not as critical.

Cultural context

The project is located in the lower Hunter Valley/Lake Macquarie region, within the traditional boundaries of the Awabakal and the administrative boundaries of the Biraban Local Aboriginal Land Council LALC. Earliest European accounts identify the Lake Macquarie area as being a central location of importance for the Awabakal people. While there is some conjecture regarding the boundaries of 'Awabakal Country' it is generally understood to extend south from the Hunter River to Norah Head and Wyong and west to include the Sugarloaf and Watagan Ranges.

The search of the AHIMS database identified 60 registered Aboriginal sites within the search co-ordinates. Of the identified sites, seven are located within the study area for the Aboriginal Cultural Heritage Assessment[7]. These sites are all listed as valid sites and comprise low-density artefact scatters (one with shell material), isolated artefacts and three modified trees:

AHIMS #45-7-0324 is recorded as a scarred tree, although it was noted by RAPs during field survey that the scar is likely natural in origin and the site is not considered to be of cultural significance. The site is located on a mid-slope in proximity to a nearby quarry/reject dam wall, approximately 20 metres from an existing access track.

AHIMS #45-7-0300 comprises a single silcrete flake, located within an existing road easement on an upper slope/ridgeline.

AHIMS #45-7-0301 comprises a single chert hammerstone with a ground edge, located in proximity to the existing abandoned railway easement in a creek bank.

AHIMS #45-7-0302 comprises a low-density artefact scatter containing four chert artefacts: 2 flakes, a core, and a chert manuport. This site is located on the edge of an existing access track within an upper slope/ridgeline.

AHIMS #45-7-0318 is recorded as a scarred tree, although it was noted by RAPs during field survey that the scar is likely natural in origin and the site is not considered to be of cultural significance. It was recorded on the edge of an existing access track on a gentle slope and exhibits evidence of fire damage. The scarred tree was recorded as containing two scars and being of high cultural significance.

AHIMS #45-7-0319 is recorded as a scarred tree, although it was noted by RAPs during field survey that the scar is likely natural in origin and the site is not considered to be of cultural significance. It was identified on a lower slope in an area of regrowth vegetation in a small tributary of Kilaben Creek.

[7] The Subsidence Impact Assessment (MSEC, 2019b) assessed potential subsidence related impacts to nine AHIMS listed Aboriginal heritage sites, however two of those sites (AHIMS #45-7-0306 and #45-7-0312) were excluded from the Aboriginal Cultural Heritage Assessment due to their distance from the Extension of Mining Area (500 m and 460 m respectively).

AHIMS #45-7-0070 is located within the disturbance area of the Eraring Ash Dam. It comprised two tuff artefacts, one containing evidence of usewear, surrounded by a scatter of cockle and broken shell. This site was identified on the northern bank of Crooked Creek on a section of bare ground, in proximity to a small modern sportsground. The site card for this site notes that the two artefacts are no longer extant and are in the possession of the Australian Museum.

Based on the environmental context, it is likely that the study area would have been occupied by Aboriginal people and that archaeological evidence of this occupation may remain. However, based on the lack of permanently available fresh water, the lack of flat terrain surrounding waterways, and the shallow erosion prone soil profile of the area, the potential for intact deposits to occur is limited as it is unlikely that the area supported extensive prolonged habitation by Aboriginal people.

Based on the identified environmental and cultural context**,** the following predictive model has been prepared for the study area:

- Isolated artefacts and artefact scatters are possible across all landforms. It is expected that any artefact sites will be low density, based on:
  - The lack of reliable water sources within the study area, and the known presence of more reliable/attractive sources of water outside of the study area.
  - The relatively shallow nature of the soil profiles across the study area.
  - The known extant AHIMS sites present within the study area, consisting of isolated artefacts, low-density artefact scatters, shell material and scarred trees.
- Grinding grooves may be present within first and second order tributaries and possibly at distance from watercourses within the study area if sandstone outcrops of a suitable quality occur.
- In areas where suitable old growth vegetation remains, there is potential for modified trees (carved or scarred) to be present. While much of the study area has been disturbed and contains regrowth vegetation, some areas of undisturbed vegetation with trees suitable for scarring remain.
- Rockshelters may be present if suitable sandstone outcrops or boulders are present, however based on the landforms within the Project Area, it is unlikely that these features will exist within the Project Area.
- Middens are common along the shores of Lake Macquarie, however, decrease in density and frequency further inland. As middens are typically restricted to foreshore margins or estuarine reaches of Lake Macquarie tributaries, it is unlikely that concentrated middens will occur in the Project Area however it is possible that minor scatters of shell may be present.

Field survey results

Eight previously recorded archaeological sites were revisited during the survey for their potential to reveal information relevant to developing an understanding of the study area's archaeological potential, including the seven AHIMS sites identified above, as well as one additional site located within 300 m of the study area.

Of the previously recorded sites, only three (45-7-0324, 45-7-0318 and 45-7-0319), comprising scarred tree sites, were able to be relocated, and no additional Aboriginal objects were identified in association with the extant registered sites. AHIMS site #45-7-0070 could not be physically revisited as it is located within the unassessed southwestern portion of the study area and is located beneath an active ash dam.

Feedback from the registered Aboriginal parties during the field survey suggested that the three identified scarred trees were likely not culturally modified, but rather had been scarred by natural processes.

The Project Area has also been subject to a range of impacts as a result of modern land uses, largely relating to the establishment of infrastructure such as access tracks, powerline easements and railway lines, as well as vegetation clearance in some portions. These activities are likely to have exacerbated the rate and severity of erosion in these areas, which in turn may have resulted in disturbance to topsoil profiles. When considered with reference to the cultural and environmental context of the study area and discussions held with the registered Aboriginal parties, the study area is assessed as having an overall low archaeological potential. It is recognised, however, that additional isolated artefacts or low-density artefact scatters may be present, but these are not likely to be common and will typically have been subject to disturbance. Other site types may include scarred trees, noting that, given the level of vegetation clearance and the nature of the trees visible during the survey, these are unlikely to occur with any frequency. Based on the topography and geology of the area, it is considered highly unlikely that any additional sites such as grinding grooves, rock shelters, rock engravings or stone arrangements will be present.

Additionally, the unsurveyed section of the study area predominantly comprises landforms that have been wholly modified, including the Eraring Power Station itself and a significant amount of associated infrastructure, as well as highly disturbed rehabilitated land. As such, this portion of the study area is also assessed as having no to low archaeological potential.

No new Aboriginal archaeological sites or objects were identified during the visual inspection of the study area, nor were any areas of archaeological potential.

Significance assessment

Significance assessments were undertaken in accordance with the *Burra Charter* (Australian ICOMOS, 2013), which defines cultural significance as meaning ‘aesthetic, historic, scientific or social value for past, present or future generations’. Archaeological significance was also assessed against the criteria set out in the Code of Practice.

In relation to the sites containing stone artefacts, the types of artefacts and the raw materials that the existing sites consist of are standard for artefact expectations in the region. These sites are in areas with limited depth of topsoil and which have been subject to previous disturbance, likely impacting the archaeological integrity of the sites. As such, these sites have low archaeological significance.

The scarred trees within the Project Area were recorded between 2010 and 2012 during different field programs with Aboriginal representatives in attendance. Whilst the opinions and cultural assessment by those archaeologists and Aboriginal community members is respected, it is suggested that these trees are scarred as a result of natural processes and are not cultural in nature. However, for precautionary purposes, and pending any definitive decision made on the cultural status of these trees, the existing significance assessment has been retained.

The assessment of significance for areas of archaeological potential is inherently difficult as any such assessment can only be based on the nature of the evidence that the area may contain. As such the assessment of significance of areas of archaeological potential remains a provisional assessment. The study area is assessed as having a provisional assessment of low archaeological significance.

No specific areas or items of historical or aesthetic value with a direct association with Aboriginal people were identified in the study area during the survey.

6.12.4 Impact assessment

The key impacts associated with the project will primarily relate to underground mining activities, such as vertical subsidence, as well as some vegetation clearance for infrastructure. Impacts will vary across the study area dependent upon the specific activities or requirements relating to the expansion of mining. No Aboriginal sites were identified within the proposed surface disturbance areas for the project (e.g. vegetating clearing areas).

The Subsidence Impact Assessment for the project (MSEC, 2019b) predicted that the study area will see a maximum vertical subsidence of 3250 mm, with the greatest subsidence predicted to occur where the proposed panels mine directly beneath the existing workings in the Great Northern Seam.

Aboriginal sites can be impacted by subsidence in various ways. Generally, shell middens, stone assemblages (such as artefact scatters or isolated artefacts) and scarred trees can withstand the relatively minor ground surface impacts as a result of subsidence. Subsidence can however be harmful to these sites when the impacts may lower the integrity of a broader complex, such as from ground surface cracking, and changes to ponding/surface water runoff can disturb or destabilise these sites. In the case of a total plug failure, substantial ground disturbance may occur as a result of rehabilitation works to remediate the area where the plug failure has occurred.

In areas of substantial subsidence, where a vertical drop is observed, sites such as rock shelters, art sites and grinding grooves have the potential to be significantly impacted. Sandstone, comprising a brittle matrix, has a tendency to crack and sheer at points of weakness, and while natural weathering and erosion processes can also cause sandstone structures to collapse/exfoliate, subsidence can exacerbate these processes and subsequent damage to these sites.

There are seven previously recorded Aboriginal heritage sites located within the study area and a further site located within a 300m boundary of the study area. These sites comprise three scarred trees and five isolated artefact/artefact scatter sites, with one site also containing shell material**.** No rock shelters, grinding grooves or art sites have been previously identified across the study area and based on the outcomes of the survey, are highly unlikely to occur.

Predicted values of total vertical subsidence, tilt and curvature for the Aboriginal archaeological sites within the study area are provided in Section 6.1.4.

The recorded artefact scatters/isolated artefacts (with the exception of 45-7-0070) may be indirectly impacted as a result of surface cracking and subsequent remediation (if required). It is noted that these impacts are identifiable based on monitoring of subsidence outcomes. That is, monitoring of the sites will allow for the identification of the occurrence of cracking and potential mitigation of its impacts.

The sites recorded as scarred trees are unlikely to be impacted unless depths of cover are less than 50 m (noting that none of these sites were recorded on steep slopes). Again, if impacts are to occur to these sites, monitoring of the sites will allow for the identification of these impacts and potential mitigation, if required.

Based on the above considerations, the project is unlikely to result in direct impacts to the Aboriginal archaeological sites present within the study area and the risk of indirect impacts to these sites is also low and can be mitigated. In addition, based on the outcomes of the survey, the study area is generally assessed as having low archaeological potential. This indicates that any further archaeological sites that may be present are likely to be similar to those already identified (both in distribution and site content), with the same potential for direct or indirect impact. Furthermore, surface impacts are limited to areas of no to low archaeological potential that do not contain recorded sites and therefore are also unlikely to result in harm to Aboriginal objects.

6.12.5 Mitigation and management

The following mitigation and management measures will be implemented for the project:

- In the event that a previously unrecorded Aboriginal object is identified within the study area, it will be managed in accordance with the Centennial Coal Northern Region Aboriginal Cultural Heritage Management Plan protocols.
- Centennial Newstan will ensure that all parties involved in the project are aware that it is an offence under Section 86 of the NPW Act to harm or desecrate an Aboriginal object unless that harm or desecration has been appropriately authorised under the Act.
- The Centennial Coal Northern Region Aboriginal Cultural Heritage Management Plan will be updated where relevant to incorporate the findings and recommendations of the Aboriginal Cultural Heritage Assessment for the project.
- Monitoring of Aboriginal heritage sites will occur in accordance with the Centennial Coal Northern Region Aboriginal Cultural Heritage Management Plan.
- Based on discussions held in the field during the revisit of previously recorded AHIMS sites, a request will be made to the Heritage Branch (formerly OEH) to amend the site cards and change the status to ‘not a site’ for the three modified trees present over the study area (AHIMS 45-7-0324, 45-7-0318 and 45-7-0319).

6.13 Historic heritage

A Historic Heritage Assessment was conducted by Umwelt to assess the likelihood and significance of any impacts to historic heritage items as a result of the project. The information presented in this section is summarised from the Historic Heritage Assessment (Umwelt, 2020), which is presented in full in Appendix T.

The Historic Heritage Assessment was prepared to address and satisfy the relevant project SEARs (Appendix A), and with reference to the advice/responses received from relevant agencies, including Lake Macquarie City Council and Heritage Branch (formerly OEH).

6.13.1 Background

The project has the potential to result in impacts to Historic Heritage items through subsidence related impacts in areas overlying and in proximity to the Extension of Mining Area. Potential impacts could also occur through surface disturbance at the locally significant Awaba Colliery Surface Site during construction of new infrastructure and at the Newstan Colliery Surface Site and The Forest Road Ballast Borehole and Services Site during decommissioning and rehabilitation activities. As such the study area adopted for the Historic Heritage Assessment comprised these four distinct areas:

- The Newstan Colliery Surface Site.
- The Awaba Colliery Surface Site.
- The Extension of Mining Area (including allowance for potential subsidence impacts).
- The Forest Road Ballast Borehole and Services Site.

The purpose of the Historic Heritage Assessment was to:

- Identify listed heritage items located within or in proximity to the study area.
- Identify and assess items, buildings, structures or other elements of potential historic heritage significance (i.e. those which are not listed) located within or in proximity to the study area.
- Identify and assess any areas of historic archaeological potential within or in proximity to the study area.
- Identify and assess the likelihood, extent and nature of potential impacts to any listed or unlisted items of heritage significance located within or in proximity to the study area.
- Develop appropriate measures to avoid, manage, and/or mitigate any identified impacts.

6.13.2 Methodology

Desktop study

To inform this assessment, searches of all relevant heritage databases were undertaken. This includes searches of:

- The Commonwealth Heritage List.
- The National Heritage List.
- The State Heritage Register (SHR).
- s170 Heritage and Conservation Registers.
- Relevant Local Environmental Plans (LEPs).

A review of available background information and previous heritage assessments that have been conducted in the area was also undertaken. The relevant previous assessments are identified in Table 6-61.

Field survey

A field survey was undertaken to enable the identification and inspection of any listed heritage items and/or any unlisted items, elements or places of potential heritage significance and/or historical archaeological potential within and in immediate proximity to the study area.

The survey was undertaken over five days from 2 December to 6 December 2019.

The purpose of the five-day survey was to achieve sufficient visual coverage of the study area to enable the identification of previously unidentified items, elements, sites or areas of potential historical heritage significance. Attempts were made to inspect as much of the study area as was feasible, noting that accessibility and visibility were constrained in some areas by difficult terrain and dense vegetation.

An additional day of survey was undertaken on 10 January 2020 to undertake targeted inspections of listed and previously identified potential (unlisted) historical heritage items within the study area.

Significance assessment

The heritage significance of each identified heritage item with the potential to be impacted by the project was assessed in accordance with The NSW Heritage Manual, which sets out a detailed process for conducting assessments of heritage significance.

The Heritage Council of NSW recognises four levels of significance for heritage in NSW: local, State, National and world. An item has local heritage significance when it is important to the local area. An item has State heritage significance when it is important in NSW. Most heritage in NSW is of local significance.

The criteria used for assessing heritage significance are presented in Table 6-60.

Table 6-60 Historic heritage significance criteria

Criterion	Description
(a) Historical Significance	An item is important in the course, or pattern, of NSW's cultural or natural history.
(b) Associative Significance	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history.
(c) Aesthetic Significance	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW.
(d) Social Significance	An item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons.
(e) Research Potential	An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history.
(f) Rarity	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history.
(g) Representativeness	An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places or cultural or natural environments.

6.13.3 Existing environment

As a result of the desktop study and field investigations it was determined that:

- No Commonwealth or Nationally listed heritage items or places are located within the study area.
- No State listed heritage items are located within the study area.
- No items listed on any s170 Heritage and Conservation Registers (NSW State agency heritage registers) are located within the study area.

Three locally listed heritage items, and two potential (unlisted) heritage are located within or partially within the study area. A further potential (unlisted) heritage item is located outside of but in close proximity to the study area. The listed and potential (unlisted) heritage items located within the study area are summarised in Table 6-61 including a description of each item based on the results of the desktop study and field survey. Significance assessments were undertaken for each listed and potential (unlisted) heritage item with potential to be impacted by the project. The outcome of each significance assessment is identified in Table 6-61 with full details provided in Appendix T.

Table 6-61 Listed and potential (unlisted) heritage items located within or in close proximity to the study area

Item Name/ID	Listing and Reference	Description	Significance
Eraring Power Station	**Listed and Unlisted** Lake Macquarie LEP Item ID 93 **References** (Suters, Turner & Doring, 1993)	Coal fired electricity power station with four 720 MW Toshiba steam driven turbo-alternators for a combined capacity of 2,880 MW. The station is owned and operated by Origin Energy. It one NSW's largest power stations. Construction of the power station began in 1977, and the first turbo-alternator was brought online in 1982, the second and third in 1983, and the fourth in 1984. The Power Station is still in operation.	Locally significant
Great Northern Railway Line or Main Northern Railway	**Listed and Unlisted** Lake Macquarie LEP Item ID 189 **References** (Suters, Turner & Doring, 1993)	Railway line constructed from 1857 through to 1889, with the section that extends through Lake Macquarie having been opened in 1887. In total, approximately five kilometres of the railway extends through the study area in a north-south orientation.	Locally significant Note: the significance assessment relates only to that portion of the Great Northern Railway that extends through the Lake Macquarie LGA and is listed on the Lake Macquarie LEP 2014.
Newstan Colliery and Newstan Colliery including Tucker's House, Bat Alley Tunnel, Arsenic Smelting Works	**Listed and Unlisted** Lake Macquarie LEP Item ID 189 **References** (Suters, Turner & Doring, 1993) (Higginbotham, 1997)	One of a number of mines associated with the second and capital intensive stage of deeper mining in the Newcastle and Hunter Valley Region in the 1880s. Though the colliery has been in operation from the mid-1880s through to the present day, only three elements that pre-date the 1940s are known to be present; these are the remains of Tucker's House (1881-1914), the remains of the Arsenic Smelting Works (1920s) and the Bat Alley Tunnel (Northumberland No. 1) (1887-1930). Within the curtilage of the locally listed item, there remains potential for archaeological remains of earlier workings to be present.	Locally significant
Awaba State Coal Mine or Awaba Colliery	**Unlisted** **References** (Archaeology Australia, 2007) (Suters, Turner & Doring, 1993) (RPS, 2012)	Relatively complete complex of colliery buildings including portals, conveyor, offices, shed, screen and loader. The Colliery or State Coal Mine was planned in the 1940s to provide coal for the (then) proposed Lake Macquarie Power Station, now known as the Wangi Power Station. The Colliery buildings all date from the 1950s.	Locally significant. Further research required to determine State significance, although potential for State significance is considered low.

Item Name/ID	Listing and Reference	Description	Significance
Awaba to Wangi Power Station Branch Railway Line	**Unlisted** **References** (Suters, Turner & Doring, 1993)	Branch line in use between c.1950 to c.1972 to haul coal from the Awaba Colliery to the Wangi Power Station. Assessed by Suters, Turner & Doring (1993) to have very high local significance and high regional significance through its associations with Awaba Colliery and Wangi Power Station, both of which the line served for over 20 years. Suters, Turner & Doring (1993) assumed that the majority of the physical components of the line had been removed, and noted that the line lends itself to adaptive re-use as an interpretive cycleway, footpath or heritage trail.	Locally significant
Bridge Over Main Northern Railway Line	**Unlisted** **References** (Archaeology Australia, 2007)	Former bridge identified as part by Archaeology Australia (2007). It is described as having been 'in use until recent times'. The bridge, known locally as 'Woodcutter's Bridge', was demolished by the (then) NSW State Rail due to concerns regarding the safety of rail traffic. At the time the bridge was recorded (2007), only the concrete and brick abutments remained. Archaeology Australia (2007) noted that the condition of the item was very poor (bridge span demolished). Its archaeological potential was assessed as very low.	Not assessed

6.13.4 Impact assessment

Eraring Power Station

No direct physical impacts are proposed to occur to Eraring Power Station as a result of the project. However, the Power Station may be subject to indirect impacts as a result of subsidence (refer to Section 6.1). It is considered that potential subsidence impacts can be effectively managed through the implementation of the mitigation and management measures identified in Section 6.1.5.

Great Northern Railway

No direct physical impacts are proposed to occur to the Great Northern Railway as a result of the project. However, the Railway may be subject to indirect impacts as a result of subsidence (refer to Section 6.1). It is considered that potential subsidence impacts can be effectively managed through the implementation of the mitigation and management measures identified in Section 6.1.5.

Newstan Colliery

As Newstan Colliery is not located within any predicted subsidence areas, it will not be subject to any indirect impacts as a result of subsidence. The Colliery will be subject to direct physical impacts in association with the proposed removal of ventilation fans.

Proposed works within ‘Newstan Colliery’ are limited to the decommissioning of existing ventilation fans that are located within the Colliery complex. These fans post-date the 1940s, and have not been identified in any relevant background reports to be of heritage significance.

No other physical works will occur within the Newstan Colliery footprint in association with the current project. As such, none of the previously identified significant elements within the Colliery listing curtilage (being Tuckers House, Bat Alley Tunnel and the Arsenic Smelting Works) will be subject to any impacts as a result of the project.

The overall presentation and character of the Colliery will not be adversely impacted by the decommissioning of the ventilation fans, which represent a relatively minor element of the overall site.

There are therefore no identified impacts to this listed item as a result of the project.

Awaba State Coal Mine

As the Awaba State Coal Mine is not located within any predicted subsidence areas, it will not be subject to any indirect impacts as a result of subsidence. Awaba State Coal Mine will be subject to direct physical impacts in association with:

- The construction of a proposed new power enclosure in association with existing infrastructure.
- The use of the north-eastern portion of the Colliery as a bulk materials area.
- The removal of a concrete wall previously used to place bulk materials against.
- The removal of concrete material storage areas.
- The introduction of new elements including a vent stack and flares, pumps area, and switchyard, control panels and transformer.
- The construction of a new sediment dam.
- The removal of miscellaneous moveable equipment.

The potential impact of these works were assessed with regard to their proximity to the core 1940s area of the Colliery (Figure 6-17) and their potential to detract from any items or areas of heritage significance.

Figure 6-17 Awaba State Coal Mine – core 1940s area

It is considered that the proposed works will not impact on the heritage significance of the Awaba State Coal Mine. The full impact assessment is provided in Appendix T.

Awaba to Wangi Power Station Branch Railway Line

The Awaba to Wangi Power Station Branch Railway Line could experience the full range of predicted subsidence effects as identified in Table 6-2. The predicted subsidence effects are sufficient to result in rail or buckling of the rail. The susceptibility to impacts will depend on the existing condition of the track and whether the track is continuous.

As the Branch Line lacks physical integrity, with some sections missing and breaks in the line where rail is present, it may be less susceptible to subsidence impacts such as buckling or breaking. The Branch Line will, however, be subject to some degree of adverse physical impact as a result of the project.

The identified heritage significance of the Branch Line is predominately derived from its historical value, rather than any identified aesthetic significance. The Branch Line has been recorded as part of several heritage assessments previously undertaken for the area, including the current assessment.

The Branch Line is in relatively poor condition and is, in some sections, entirely absent. The recent bushfires that extended through the area have further degraded the item's physical integrity. It is also noted that the area within which the Branch Line is located is not readily accessible to the public, particularly in comparison to other former railways/tramways in the area such as the Toronto Branch Railway, the West Wallsend Steam Tramline or the Fernleigh Track.

The recording of the Line undertaken as part of this assessment, coupled with the recordings of the Line undertaken as part of previous assessments, are a sufficient record of the Line. The physical extent of the Line has been fully mapped, and historical records pertaining the Line's construction and use are generally available.

For these reasons, the potential physical impacts that may occur to the Branch Line as a result of the current project are considered to be acceptable, and should not pose a constraint to the current project.

Bridge over Main Northern Railway Line

No direct physical impacts are proposed to occur to the Bridge remnants as a result of the project. The Bridge remnants are predicted to experience less than 20 millimetres vertical subsidence.

The Subsidence assessment (refer to Section 6.1) concluded that the Bridge remnants are not expected to be sensitive to far-field horizontal movements (as the bridge deck is missing). The Bridge remnants are therefore not expected to experience adverse impacts due to the proposed mining.

There are therefore no potential impacts to this potential (unlisted) item as a result of the project.

6.13.5 Mitigation and management

The following management and mitigation strategies will be implemented for the listed and potential (unlisted) heritage items located within the study area:

- All staff, contractors and sub-consultants will be made aware of the heritage significance of the heritage items relevant to Newstan Colliery and Awaba Colliery and their statutory obligations for heritage under the *Heritage Act 1977* when working near items of heritage significance as part of any site inductions.
- Measures will be developed and implemented to ensure that adjacent fabric (physical material) of significance is not inadvertently impacted during construction and operation of the project. This includes the entirety of the core 1940s area at Awaba Colliery Surface Site as shown in Figure 6-17.
- In the unlikely event that unexpected historical (non-Aboriginal) archaeological remains are discovered during works within the study area they will be managed with reference to the standard protocols and procedures of Section 146 of the *Heritage Act* 1977.

6.14 Visual amenity

A Visual Impact Assessment (VIA) (GHD, 2020f) was prepared by GHD to assess the potential visual impacts of the project. The information presented in this section is summarised from the VIA, which is presented in full in Appendix U.

The scope of the VIA has been designed to address the SEARs (refer to Appendix A) with regard to the assessment of visual impacts.

6.14.1 Background

Potential visual impacts from the project will only be with the above ground works which are localised to the Awaba Colliery Surface Site. The study area for visual impact assessment was therefore defined as publically accessible land within approximately three kilometres of the Awaba Colliery Surface Site.

6.14.2 Methodology

The following is an overview of the methodology adopted for the VIA.

Assessment of existing visual environment

- Desktop review of existing information, and collation of relevant background information including planning and statutory requirements, topography, land use and vegetation.
- Mapping of the mine extension including Zone of Theoretical Visibility (ZTV) mapping (a computer-generated analysis which identifies land from which it is theoretically possible to view the components of the project) for the ventilation fan 'fan house' building, and identification of sensitive visual receivers (road users, residents, etc.) within the viewsheds.
- Evaluation of the existing visual environment, and assessment of sensitivity of visual receivers, to assess public and private sensitive receiver locations within the project surrounds.
- A site inspection was undertaken on the 22 August 2019 to inspect publically accessible locations identified during the desktop study, take photographs and identify sensitive visual locations.

Assessment of visual impacts

- Description of the visible elements of the project (during both the operation stages), and identification of potential impact generators.
- Assessment of the magnitude of change resulting from the project that will be likely to affect the identified sensitive visual receivers.
- Subsequent determination of impact significance based on ratings of receiver sensitivity and impact magnitude. Impact significance was rated against a qualitative impact scale.
- Due to the project utilising existing infrastructure at the Newstan Colliery Surface Site, it was assumed that there will be minimal changes to the visual characteristics of the site and therefore was not included in the assessment of visual impacts.

6.14.3 Existing environment

The Awaba Colliery Surface Site is located in a valley, within an undulating landscape that has dense and mature tree cover. The land is predominantly characterised by areas of dense, native, eucalypt forest 20m in height extending beyond existing mining operations. Stony Creek runs through the base of the valley and dissects the Awaba Colliery Surface Site. Other smaller drainage lines are located perpendicular to the creek, in the hill inclines. In terms of geological features within proximity to the site, there is a dominant ridgeline one kilometre to the north parallel to the Main Northern Railway, with rural residential properties extending along the hillside. There are also a number of discontinuous ridgelines with spurs descending towards drainage lines.

The land use within the Project Application Area includes a range of large-scale industrial activities related to underground mining and power generation.

Other large-scale industrial developments are located nearby, notably Eraring Power Station, which is located four kilometres to the south, and has two tall chimney stacks that are often visible above the horizon.

The closest populated urban centres are the Awaba township, approximately one kilometre to the north. There are industrial areas three kilometres to the north-east, on the outskirts of Toronto and denser urban development six kilometres to the south-east, fringing Lake Macquarie.

The rural township of Awaba is comprised of primarily low-density residential areas, centred around a small train station, two schools, a sports oval and other community facilities. Awaba is surrounded by dense vegetation of typically 20m high native trees.

The nearest privately-owned residences are identified at over 500m to the north-east on Olney Street and 750m at the corner of Wilton Road and Sydney Street (note: distances are measured from the highest proposed vertical element to the nearest edge of the residential building).

Regional features of note include Lake Macquarie to the east, M1 Pacific Motorway to the north-west and the Watagans National Park to the west.

Key visual elements

Due to the undulating topography and forest vegetation, much of the existing mining infrastructure is screened. Long views are typically to forested ridgelines.

The Eraring Power station is a key visual element in the project area, containing grey concrete stacks taller than 100 m in height which are much higher than the surrounding forest canopy of approximately 20 m height. They are visible from elevated locations in the Awaba township.

ZTV mapping undertaken for the proposed fan house buildings revealed some visibility of the project from the surrounding area. However, this mapping does not take into consideration the presence of the dense and tall forest vegetation.

The entrance to the Awaba Colliery on Wilton Road may also offer a viewing opportunity; however the view would be from a vehicle, travelling at high speed around a corner and with vegetation screening the foreground. It would be a very short viewing duration and a glimpse through mature vegetation. Therefore this viewpoint was not considered as a sensitive visual receiver.

Sensitive visual receivers and viewpoints

This visual impact assessment has been undertaken to determine the likely visual significance of the project on people living and working in, or travelling through, the surrounding landscape.

Based on the existing environment analysis, sensitive visual receivers were identified and viewpoint locations selected for assessment. Sensitive visual receivers within the viewshed were identified as the following:

- Some (approx. 15) residential properties in the Nelinda Street / Dora Street / Adelaide Street area, Awaba.
- Commuters and pedestrians using Awaba Station footbridge.
- Road users on Wilton Road, travelling south near Sydney Street, Awaba.
- Road users on Wilton Road, travelling north from the Awaba Waste Transfer Station.

Viewpoint location used for assessment are included in Table 6-62. Viewpoints (VP) 1-4 represent viewpoints for assessment of views from most of the sensitive receiver’s. VP 5-8 are locations considered but not assessed in detail due to their distance from the project and/or limited viewing opportunities, which rendered potential visible impacts negligible.

Table 6-62 Viewpoint locations

Viewpoint	Location	Description
VP1	Awaba Station footbridge	This elevated view is representative of pedestrians using the Awaba train station footbridge, crossing over the train line.
VP2	Awaba Oval	This view is representative of Awaba Oval pedestrians and Olney Street residents.
VP3	Awaba Waste Transfer Depot and community recycle centre 367 Wilton Rd	This view is representative of drivers along Wilton Road, including those exiting the Awaba Waste Transfer and Community Recycling Centre.
VP4	Nellinda Street Residential area	This elevated view is representative of residents and pedestrians on Nellinda Street and the north end of Dora Street, with views towards the station, township and project
VP5	Corner of Sydney Street and Wilton Road	This view is representative of road users travelling south on Wilton Road.
VP6	Wilton Road at the Bridge over Newstan Eraring Private coal road	This view is representative of a road user’s views from the Wilton Road bridge
VP7	Watagans National Park Off Mt Faulks Rd	This view is representative of visitors to Watagans National Park
VP8	Dora Street looking south-east	This view is representative of residents to the northern end of Dora Street. It was considered to be a similar view to Viewpoint 4

6.14.4 Impact assessment

As stated in Section 6.14.3, only VP 1-4 were assessed in depth for visual impact. VP 5-8 were deemed negligibly affected by the project due to their distance from the project.

VP1: Awaba station footbridge

VP1 is located on the pedestrian bridge which connects the two platforms at the train station. It is approximately one kilometre from the project. This view looks north-west and is representative of pedestrians and commuters within the local area (Figure 6-18).

Figure 6-18 View from VP1 looking north-west

The existing view includes Wilton Road to the left of the view, rising to the treed ridgeline on the horizon. To the middle and the right of view, behind the trees is the Awaba Oval in a low flat area. Low density single story residential dwellings appear to the left, adjacent to Wilton Road. Vertical infrastructure features appearing in the view include light poles, power poles and footbridge railings. The anticipated change to VP1 would be negligible as it is anticipated that the proposed development would be not be visible and be screened behind the vegetated ridgeline.

VP2: Awaba oval ("Robert "Dutchy" Holland oval)

Awaba oval is located in the Awaba oval driveway, to the north of Olney Street. It is approximately one kilometre from the project, looking south-east (Figure 6-19). This view is representative of pedestrians and sports users as well as residents on Olney Street.

Figure 6-19 View from VP2 looking south-east

The existing view comprises of Awaba Oval reserve to the foreground of the view and Olney Street residences on elevated land to the left, with dense forest vegetation behind the residences and reserve. Existing vertical infrastructure elements in the view include overhead power poles, transmission lines and the fencing of the tennis courts to the right of the view. The impact of the project is expected to be negligible as the project would not be visible behind the vegetated ridgeline.

VP3: Awaba Landfill and Waste Transfer Depot

VP3 is located on the corner of 367 Wilton Road and the Awaba Landfill and Waste Transfer Depot entrance. VP3 is approximately one kilometre from the proposed project. This view is representative of users of the Landfill and Waste Transfer Depot and road users (Figure 6-20).

Figure 6-20 View from VP3 looking south

The existing view comprises of dense eucalypt forest on both sides enclosing the view around the road. It is anticipated that change as a result of the project is negligible as the project would not be visible behind existing vegetation.

VP4: Nellinda Street water tower

VP4 is located on Nellinda Street adjacent to the water tower. It is representative of the elevated views from residential areas located on the southern crest of the ridgeline, including the northern part of Dora and Adelaide Streets. It is approximately one kilometre from the proposed project. The view looks south from an elevated position (Figure 6-21).

Figure 6-21 View from SP4 looking south

The existing view is residential properties, mature trees and a vacant lot rolling down the hill to Awaba township in the centre of the view. The middleground to background shows a rolling, hilly landscape with large tracts of native bushland. The centre of the view shows the two chimney stacks of the Eraring Power Station rising high above the horizon.

Due to the elevation and angle of view, it is possible that a small section of the upper portion of the fan house buildings may be visible in the centre of the view during daylight hours, as it is approximately at the same height as the tree canopy. However it is also possible that the fan house buildings may sit below the tree-lined ridge and therefore will not be visible. Water vapour may occasionally protrude above the fan house buildings to a height of approximately 3m. It would be more visually prominent during cooler months. However, at such distance, it is not expected to be easily visible from this view. It is unlikely that the fan house buildings will be visible during night-time as the upper portions of the fan house buildings will be unlit.

The sensitivity to change for this location is anticipated to be low as the project would most likely be screened from residences by the dense vegetation of the area. Entrances and exits to these properties typically face the opposite direction, and thus the residences are expected to experience this view infrequently. Magnitude of change is expected to be low, as the anticipated change is expected to noticeable but relatively minor, appearing below the dominant escarpment backdrop. The vertical chimney stacks of the Eraring Power Station also features in the middle of the view in the same direction of the project, however is significantly more dominant as they rise above the horizon line.

Summary of impacts

The project is expected to have a low impact on the visual amenity at VP4 and a negligible impact from all other assessed locations. Overall, as the highest part of the project is 20m high located in a valley surrounded by vegetation (of approximately 20m height) and with a treed ridgeline potentially blocking the view; visibility is unlikely. In addition, whilst water vapour may occasionally protrude above the above the fan house buildings to an approximate height of 3 metres, it is not expected to be easily visible from such distances.

Based on the ZTV modelling, desktop analysis and the site visit, it is expected that project will not be visible from publically accessible areas within 900m of the project's tallest element, the fan house buildings, with the exception of at the Awaba Colliery entrance gates, off Wilton Road.

Given the extent and combination of existing undulating landform character and tree cover surrounding the proposed Awaba Colliery Surface Site, the capability of the landscape to screen views to the key components is considered to be high. The dense forested vegetation of the surrounding landscape is likely to reduce the potential magnitude of visual impact significance.

6.14.5 Mitigation and management

Where practicable, Centennial Newstan will position surface infrastructure in locations where visual screening can be provided by the topography or existing vegetation. Building heights will also be limited to minimise visual environmental impacts.

6.15 Social

A Social Impact Assessment (SIA) was prepared by Hansen Bailey (2020) to assess the potential social impacts of the project. The information presented in this section is summarised from the SIA, which is presented in full in Appendix V.

The scope of the SIA has been designed to address the SEARs (refer to Appendix A) with regard to the assessment of social impacts.

6.15.1 Background

The project has the potential to result in both positive and negative social impacts to the local and regional community. In order to assess these potential impacts, the study area adopted for the SIA comprises both a local and regional area of social influence, as described in detail in Section 6.15.3.

The objectives of the SIA were to:

- Identify the social area of influence of the project.
- Implement an inclusive stakeholder engagement process that informs the social baseline, the impact and opportunities assessment and the development of mitigation measures.
- Develop a comprehensive baseline of social conditions in the project's social area of influence based on research, analysis and stakeholder engagement.
- Undertake preliminary assessment (scoping) of the project's social impacts and opportunities for the social area of influence, in order to ensure the assessment is focused on material effects on the social environment.
- Identify potential direct, indirect and cumulative social impacts and opportunities of the project for the social area of influence.
- Provide a detailed assessment of the likely impacts and benefits, and their significance for each stage of the project (construction, operation and post-mining).
- Consider biophysical impacts and their interaction with social values.
- Develop strategies to avoid and/or mitigate social impacts, and actions which would enhance social benefits.

6.15.2 Methodology

A best practice approach was adopted for the SIA, integrating international and NSW social impact assessment guideline requirements ((Vanclay, Esteves, Aucamp, & Franks, 2015; DP&E, 2017). Table 6-63 provides a summary of the methodology for each of the key phases in the SIA process, and outlines the assessment and engagement mechanisms utilised during each phase.

Table 6-63 SIA approach and methodology

Activity	Summary
Phase 1 - Preparation	
Stakeholder engagement plan	Initial stakeholder identification and analysis. Development of a tailored SIA stakeholder engagement strategy.
Phase 2 - Scoping	
Scoping of stakeholder impacts and opportunities	Review of Centennial Coal's complaints registers for Awaba Colliery and Newstan Colliery. Review of Centennial Newstan Annual Reviews and CCC meeting minutes. Analysis of relevant media including coverage of the cessation of mining at Awaba and Newstan Collieries, the commencement of Northern Coal Logistics Project (SSD-5145), and information on the Eraring Ash Dam PA 07_0084 Modification 1. Review and analysis of the findings of Centennial Newstan's engagement activities for the EIS (refer to Chapter 5). Review and analysis of the submissions received in response to the public exhibition of the: • Northern Coal Logistics Project EIS (2014). • Newstan Colliery DA 73-11-98 Modification 8 (2019). • Eraring Ash Dam PA 07_0084 Modification 1 (2019). The following considerations formed part of the scoping process: • Identification of project components which may affect or change the social environment. • Key assumptions about the project, and the surrounding local environment. • Potential social impacts and opportunities. • Material effects of the social impacts and opportunities. • Preliminary assessment of the impacts and opportunities. • Recommendations regarding the need for further assessment in the SIA or EIS.
Identification of social area of influence	The social area of influence of the project consists of the people that will potentially be impacted (adversely or positively) by project activities. Identification of the social area of influence included analysis of the potential spatial and temporal dispersion of potential impacts and opportunities, including consideration of proximate communities, supply chains, and the movement of workers.
Identification of material impacts	The scoping process identified the potential material social impacts for further consideration.
Phase 3 – Community profiling and social area of influence	
Socio-demographic analysis	Assessment and analysis of Australian Bureau of Statistics (ABS) Census data and other relevant social and community statistical data sets. Identification of areas of community vulnerability through analysis of particular demographic indicators.
Historic and contemporary issues and opportunities	Literature review and analysis of historical accounts of the region and local media, to understand previous and emerging issues and opportunities within the community.
Guidelines analysis	Review of corporate standards, policies and programs relevant to the SIA.
Aboriginal profile	Review of literature and data relevant to the Aboriginal community.

Activity	Summary
Phase 4 – Assessment of impacts and opportunities	
Analysis of impacts/opportunities	Stakeholder engagement (refer to Chapter 5). Review and analysis of the findings of the broader Centennial Newstan engagement activities for the project. Prediction of potential project social impacts and opportunities.
Phase 5 – Identification of management and enhancement strategies	
Social impact management	Identification and development of strategies to address predicted project impacts and enhance opportunities.
Impact significance assessment	Analysis of social impact significance using a risk matrix.
Phase 6 – Monitoring and reporting	
Performance monitoring	Preparation of performance framework for management and monitoring.

Focus areas for further investigation

The scoping process (Phase 2) identified the material social impacts and opportunities for consideration in the SIA. Table 6-64 presents the potential material impacts and opportunities considered in the SIA, the scope of investigations and analysis conducted.

Table 6-64 Focus impact areas for investigation

Potential key impact areas	Summary scope of investigations and analysis
Impacts to livelihood	• Findings of consultation with proximate residents. • Review of relevant EIS technical studies and in particular the Subsidence Impact Assessment, Groundwater Impact Assessment and Surface Water Impact Assessment.
Impacts to residential amenity and in particular the use and enjoyment of private property	• Findings of consultation with proximate residents. • Attendance at Newstan-Awaba CCC. • SIA consultation survey findings. • Visit to Awaba, Wakefield and Fassifern communities. • Analysis of surrounding land use and topography. • Review of complaints data for Awaba and Newstan Collieries. • Review of community surveys from the Five Bays Sustainable Neighbourhood Group. • Review of relevant EIS technical studies and in particular the Air Quality and Greenhouse Gas Impact Assessment, Noise and Vibration Impact Assessment, and Visual Impact Assessment.
Impacts to valued environmental assets	• Findings of SIA consultation. • Review of media and Lake Macquarie City Council documents to inform understanding of valued assets. • Attendance at Newstan-Awaba CCC. • Review of relevant EIS impact assessment reports. • Review of community surveys from the Five Bays Sustainable Neighbourhood Group.

Potential key impact areas	Summary scope of investigations and analysis
Indigenous and non-Indigenous cultural assets and values	• Participation in the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee meeting and face-to-face interviews with Committee members. • Review of existing Northern Region Aboriginal Cultural Heritage Management Plan. • Literature review of historical information for the Lake Macquarie LGA, particularly settlement history for the Project Application Area. • Review of relevant EIS impact assessment reports, in particular the Aboriginal Cultural Heritage Assessment and Historic Heritage Assessment.
Employment and economic development	• Analysis of labour market and industry data for the Lake Macquarie LGA and Newcastle-Maitland Significant Urban Area (SUA). • Analysis of employment data and procurement data for other Centennial Coal operations in the Lake Macquare LGA i.e. Mandalong Mine and Myuna Colliery. • Review of supplier types
Future land development opportunities	• Consultation with Lake Macquarie City Council. • Literature review of Lake Macquarie City Council strategic planning documents. • Analysis of building and land development data.
Stress and anxiety in relation to Eraring Ash Dam stability, safety and security	• Findings of consultation with nearby residents, community groups and organisations. • Review of Response to Submissions for the Eraring Ash Dam PA 07_0084 Modification 1. • Review of project EIS technical reports relevant to Eraring Ash Dam e.g. Subsidence Impact Assessment, Surface Water Impact Assessment, Groundwater Impact Assessment. • Review of recent media. • Discussions with service and facility providers located on Fassifern and Miller Road. • Review of Traffic Impact Assessment.

6.15.3 Existing environment

Community context

The three local suburbs proximate to the project are Awaba (proximate to the Extension of Mining Area and Awaba Colliery Surface Site), Fassifern and Wakefield (proximate to the Newstan Colliery Site). These suburbs are shown on Figure 6-22.

Awaba

The rural village of Awaba is tucked away on the side of a hill approximately 1 km north of Awaba Colliery Surface Site. Awaba is a small and thriving rural community, with over 400 residents (ABS, 2017). The village comprises low-density residential development, centred around a small train station (Awaba Station). The location is a popular choice for families given a combination of factors including: housing affordability; the presence of Awaba Public School; and the ready access to Newcastle, Central Coast and Sydney provided by the Main Northern Railway line which passes through the centre of Awaba, dividing the community into two parts.

On the southern side of Awaba is a sizeable local sporting complex which includes Robert ‘Duchy’ Holland Oval and provides facilities for a number of organisations including junior and senior cricket clubs, a junior football club and the Toronto Pony Club. Awaba Public School and the Awaba Rural Fire Brigade are located on the northern side of the railway line. The nearest retail and commercial services are located in Toronto.

Awaba has a number of community organisations including the Awaba Public School Parents and Citizens Association, Awaba Rural Fire Brigade and the Robert Duchy Holland Oval Committee. Several members are also past or present members of the Newstan-Awaba CCC.

Fassifern

The suburb of Fassifern is located on the western side of Lake Macquarie proximate to the Newstan Colliery Surface Site. In 2016 the suburb had a population of 601 people (ABS, 2017). Fassifern contains a mix of low to medium density residential development and includes residential areas that were previously housing commission. The suburb is home to many long-term residents who have experience living proximate to Newstan Colliery when it was fully operational.

Fassifern Railway Station, located on the Main Northern Railway, is a major station along the Sydney – Newcastle rail service. The station has a large commuter car park and is serviced by a connecting local bus network. The suburb has two schools: Fassifern Public School, located on the western side of Miller Road to the south of the Newstan Colliery Surface Site and Charlton Christian College located on Fassifern Road. The nearest retail and commercial services are located in Toronto on the Lake Macquarie foreshore.

Wakefield

Wakefield is a predominantly rural residential suburb, with lifestyle blocks scattered along Miller Road and Wakefield Road to the north of the Newstan Colliery Surface Site. Miler Road provides access through to Fassifern and Wakefield Road provides direct access to the Pacific Motorway. The suburb supports a public behavioural school (Wakefield School) and Wakefield Rural Fire Brigade.

Residential development within Wakefield is confined to small pockets of land. The old Rhondda Colliery site is located to the immediate west of Wakefield and to the north of the Newstan Colliery Surface Site. A $77 million motorsport complex has recently been approved for development on the former Rhondda Colliery site.

Social area of influence

This section describes the local and regional social area of influence of the project.

Local social area of influence

The local social area of influence includes the three distinct areas that form the project site (Newstan Colliery Surface Site, Awaba Colliery Surface Site, and the Extension of Mining Area). It encompasses those neighbours who are at risk of experiencing adverse impacts as a result of the project. The project's local social area of influence was defined using the ABS geographic terminology - State Suburb (SSC). The project's local social area of influence is shown in Figure 6-22 and consists of the SSCs of Awaba, Fassifern and Wakefield. The SSC boundaries of these communities are relatively large but consist of both residential and densely forested areas and comprise small resident populations (<700).

The inclusion of Wakefield, Fassifern and Awaba SSCs in the project's local social area of influence reflects the potential for:

- Proximate neighbours to Newstan Colliery i.e. the communities of Awaba, Fassifern and Wakefield to experience a change in residential amenity due to the recommencement of mining at Newstan Colliery.
- Residents of Awaba to experience a change in residential amenity due to the construction and operation of surface infrastructure at Awaba Colliery Surface Site.

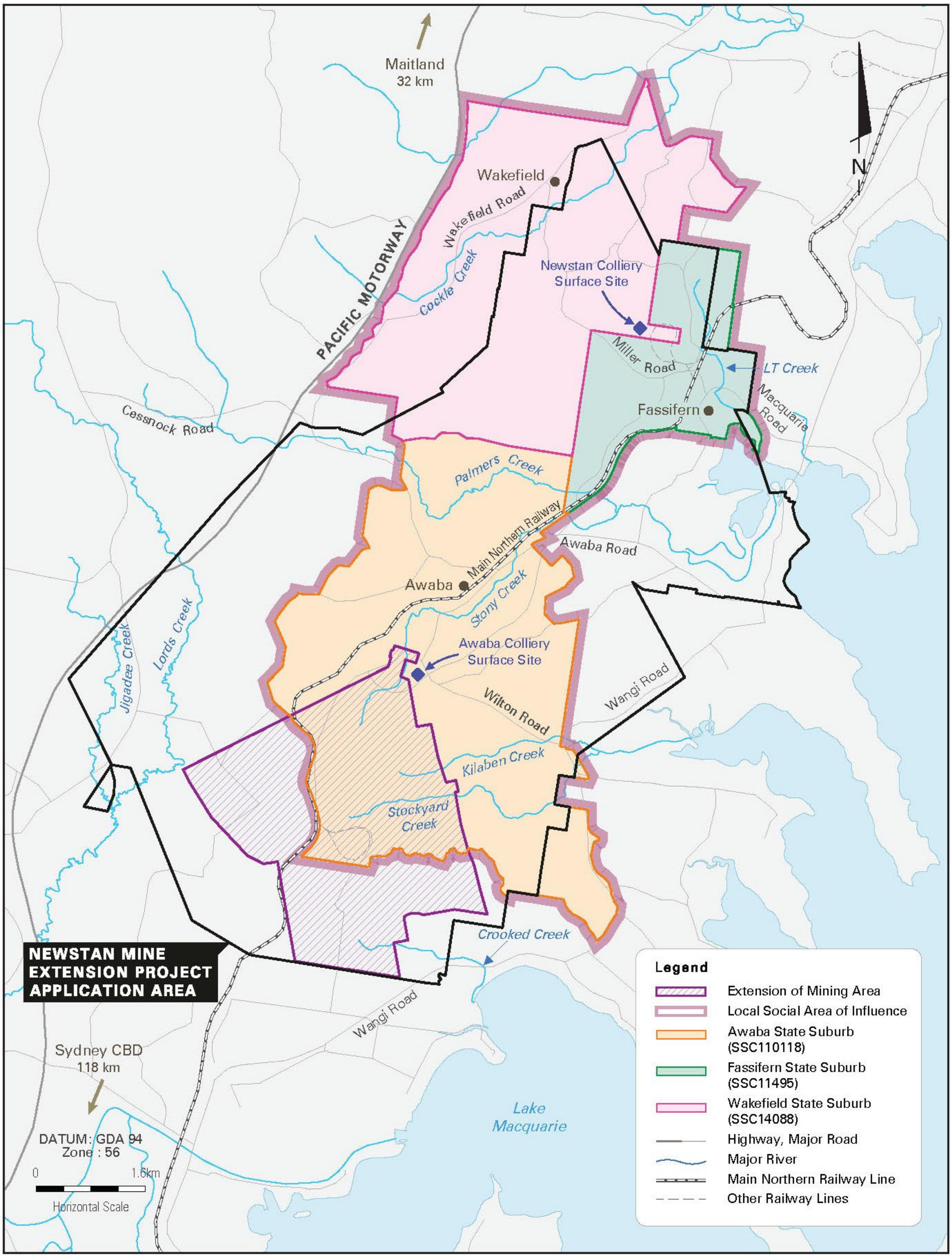

Figure 6-22 Local social area of influence (Hansen Bailey, 2020)

Regional area of influence

The Newstan Colliery is located within the Lake Macquarie LGA. A significant portion of the urban footprint of the Lake Macquarie LGA is located within the larger Newcastle-Maitland SUA. The regional area of social influence is therefore defined as the Newcastle-Maitland SUA with a focus on the Lake Macquarie LGA (refer to Figure 6-23).

The Newcastle-Maitland SUA comprises large urban centres i.e. Newcastle and Maitland, with a large labour pool and a strong and diverse economy. It is possible that a portion of the operations workforce will also be drawn from these skilled areas.

The social impacts and benefits of the project may extend across NSW. The SIA acknowledges the potential for economic opportunities and development, as well as community wellbeing benefits for NSW.

Statistical geography

Table 6-65 summarises the ABS statistical geography which corresponds to the local and regional communities in the project's social area of influence[8] .

Table 6-65 Study area statisification geographies

ABS statistical geography	Community
Local Government Area	Lake Macquarie (C) (LGA14650)
Significant Urban Area	Newcastle-Maitland Significant Urban Area (SUA1023)
State Suburbs	Awaba (SSC10118)
	Fassifern (SSC11495)
	Wakefield (SSC14088)

[8] ABS statistical geography data is also supplemented where necessary with available postcode data. Postcode data is provided for the postcode areas of Awaba (2283), Fassifern (2283), and Wakefield (2278). Toronto (2283) is occasionally coupled with available Awaba and/or Fassifern data.

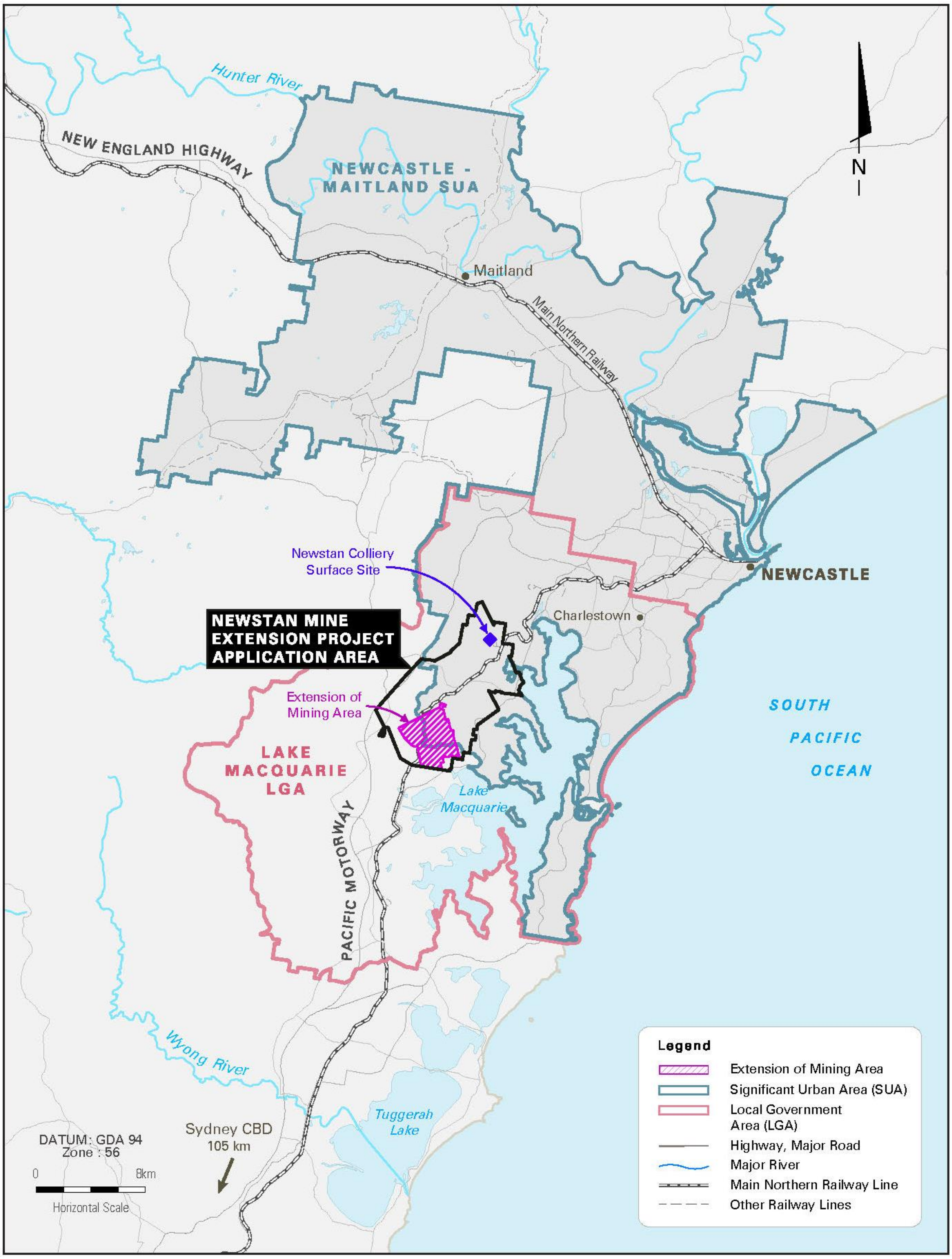

Figure 6-23 Regional social area of influence (Hansen Bailey, 2020)

Project setting

Local setting

This section describes the setting of the Project Application Area and Extension of Mining Area with reference to sensitive receptors and proximate communities.

There are a number of sensitive rural residential and recreational receptors located within and nearby the Project Application Area. The Air Quality and Greenhouse Gas Impact Assessment identified four sensitive receptors located within or in very close proximity to the Awaba Colliery Surface Site. These sensitivite receptors are representative of a large group of receptors in the area. The assessment does not consider any sensitive receptors for Newstan Colliery Surface Site as impacts relative to that surface site are already approved under SSD-5145 (Northern Coal Logistics Project) and DA 73-11-98 Mod 8 (Newstan Colliery).

A number of community facilities and services are located in close proximity to the Awaba Colliery Surface Site, Extension of Mining Area and Newstan Colliery Surface Site. These are shown on Figure 6-24 and include:

- Fassifern Public School.
- Charlton Christian College.
- Awaba Public School.
- Robert ‘Dutchy’ Holland Oval.
- Awabawac Park.
- Newcastle Lake Macquarie Clay Target Club.
- Fassifern Oval (utilised for Archery).
- Wakefield School.
- Awaba Waste Management Facility.

The closest communities to the Newstan Colliery Surface Site are Fassifern and Wakefield. The closest community to Awaba Colliery Surface Site and the Extension of Mining Area is Awaba.

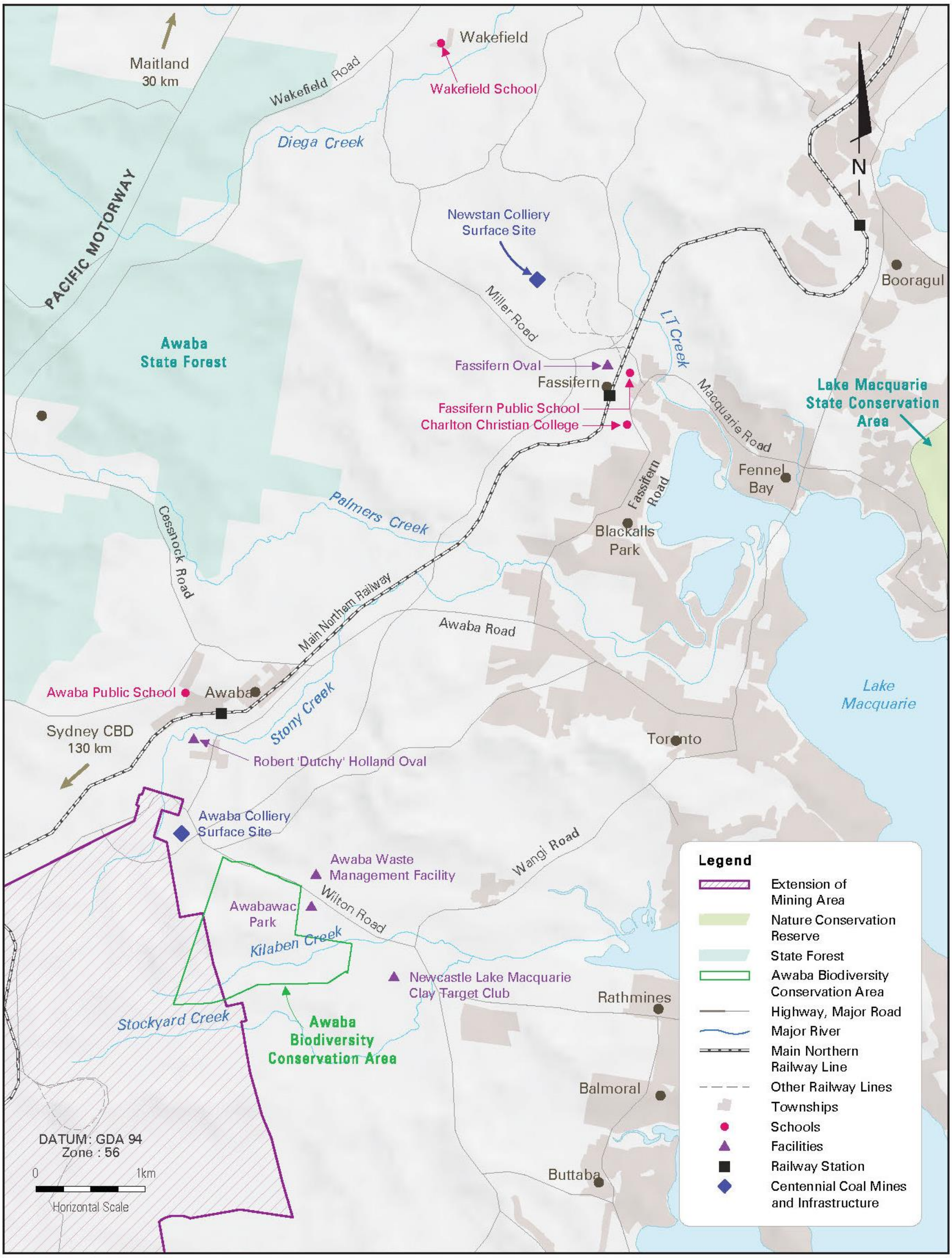

Figure 6-24 Local setting (Hansen Bailey, 2020)

Regional setting

Lake Macquarie LGA

The Lake Macquarie LGA is wholly located within the Newcastle-Maitland SUA and the broader Hunter Region. The Lake Macquarie LGA covers an area of approximately 649 km2. In 2018, the Lake Macquarie LGA had a population of 204,914 (Lake Macquarie City Council, 2019b). The Lake Macquarie LGA is one of the fastest growing areas in the Hunter Region. The economic stranegth of the Lake Macquarie LGA is decribed in REMPLAN (2019):

"*Lake Macquarie's economic strength is built upon its diverse landscape and natural resource base, with key industries developing out of timber, agriculture, water and minerals. The city has developed into a major hub for small to medium size business with knowledge and technology-based industries exhibiting strong growth.*"

A number of townships and centres within the Lake Macquarie LGA were established in response to high industry sector growth i.e. mining, power generation etc. Residential development across the Lake Macquarie LGA is concentrated around the lake; likely due to desirable lifestyle factors, as well as proximity to major regional centres i.e. Newcastle. Further inland, several small rural townships (e.g. Awaba) and residential clusters exist amongst densely vegetated areas.

Lake Macquarie is widely recognised as a popular location for retirement and/or older families. The Lake Macquarie LGA is also well known for its large industry base in mining and power generation. The link between the key regional industries of health care, aged care, mining and manufacturing is discussed in detail in the Central Coast and Lake Macquarie Regional Economic Development Strategy, 2018-2022 (NSW Government, 2018b) (Central Coast and Lake Macquarie REDS).

The area is also developing as an attractive area for younger families as it provides desirable residential values such as affordability, proximity to large centres with a range of employment opportunities and quality transport connections. The visitor economy is growing due to the Lake Macquarie LGA's strong environmental attributes (e.g. Lake Macquarie).

Newcastle-Maitland Significant Urban Area

The SUA structure represents significant towns and cities of 10,000 people or more. The Newcastle-Maitland SUA represents a cluster of related urban centres, including Newcastle which is located on the east coast and Maitland which is located to the north of the project. The Newcastle-Maitland SUA covers an area of approximately 1179.1 km2 and covers a portion of the Lake Macquarie LGA. The Newcastle-Maitland SUA is situated in the Hunter Region of NSW.

In 2016, the Newcastle-Maitland SUA had an estimated resident population (ERP) of 463,052 people (ABS, 2017). The City of Newcastle is forecast to grow from 166,984 people in 2019 to 202,049 people by 2041, representing a 21% increase (Forcast ID, 2019). In 2018, the City of Maitland had an ERP of 83,203 people (Maitland City Council, 2019). The population of Maitland is estimated to increase by 32.5% between 2016 and 2041 (NSW Government, 2018c). Maitland is anticipated to experience larger growth than Newcastle due to its desirable residential qualities i.e. less people, greater affordability, etc.

The Newcastle-Maitland SUA has a diverse economy based on manufacturing, mining and health care. Resource and mining exploration and operations are historical activities within the Newcastle-Maitland SUA. Newcastle is traditionally a manufacturing centre and is home to the Port of Newcastle, Australia's largest coal exporting port by tonnage. Despite a significant history and focus placed on manufacturing and mining, reliance on heavy industry in these centres has reduced in recent times.

6.15.4 Impact assessment

Social impacts have been identified and assessed for the project social area of influence (local and regional).

The impact assessment shows that the majority of potential social impacts accrue to landholders in proximity to the Awaba Colliery Surface Site and to people who value the environmental assets of the Lake Macquarie LGA. The potential opportunities of the project accrue to the nearby areas of interest and the broader Lake Macquarie LGA and relate principally to employment opportunities and economic stimulus.

The impact assessment considers the potential social impacts associated with the direct project related activities. During SIA consultation a number of stakeholders expressed concern in relation to potential changes in residential amenity and impacts to valued environmental attributes as a result of project induced changes at the Northern Coal Logistics Project (SSD-5145) e.g. increased coal production rate, potential increase in the number of train movements, increased traffic volumes on the local road network and increased discharge into LT Creek. The project will not result in any changes to the Northern Coal Logistics Project that have not already been modelled and approved under the existing development consent for Northern Coal Logistics Project (SSD-5145). Any impacts associated with changes to current operations approved under SSD-5145 are therefore not considered in the following discussion.

Residential amenity

The expansion of mining activity in close proximity to townships and residential properties across NSW has contributed to a range of social impacts, including a reduction in residential and rural amenity. The more common drivers of amenity change due to mining activities include noise and dust emissions and changing visual character. Despite the presence of some of these drivers in mining operations in the Lake Macquarie LGA and western Lake Macquarie, mining in the Lake Macquarie LGA remains a dominant industry. Further, the findings of SIA consultation suggest that mining continues to co-exist relatively successfully with nearby residential communities. This is most evident around Awaba and Fassifern where mining has existed since the 1840s (Section 7.3.2). This evidence of coexistence can be attributed to the integration of mining and mining related activity in the area, the presence of underground mining operations rather than open-cut operations, the economic contribution of mining (i.e. employment and procurement), and the geographical location of a number of the mines (i.e. largely concealed by densely vegetated areas in the case of Awaba Colliery and Newstan Colliery). During SIA consultation, a number of stakeholders acknowledged the history, prevalence and importance of mining in the area.

The project is located within the existing boundary of Newstan Colliery. The project has the potential to adversely impact the residential amenity of residents proximate to the Extension of Mining Area and Awaba Colliery Surface Site. Potential amenity impacts are associated with:

- Construction and operations phase activities at the Awaba Colliery Surface Site.
- Transport of materials, equipment and workers to the Awaba Colliery Surface Site during the construction phase.

The findings of SIA consultation indicate that residents of Awaba anticipate some level of tangible and adverse changes to their existing amenity; specifically, acoustic amenity, air quality and visual amenity as a result of the project.

Environmental values

This section describes the potential for changes to the local environment due to subsidence and related impacts e.g. sinkholes, loss of biodiversity, and groundwater and surface water changes which could affect community held environmental values.

Environmental attributes both within the local and regional area (i.e. Lake Macquarie LGA) are integral to community values. Lake Macquarie City Council describe the natural assets of the LGA as 'defining features' of the landscape (Lake Macquarie City Council, 2019c). These assets mostly relate to the rural setting of the LGA and Lake Macquarie. The lake underpins "the City's identity, and its health is critical to [the] lifestyle and the future of [Lake Macquarie LGA's] economy" (Lake Macquarie City Council, 2019c).

One of the key findings of the SIA consultation with local residents is the value placed on the environmental attributes of their surroundings i.e. bushland, wildlife, presence of creek systems. Stakeholders acknowledged these attributes as a reason why they chose to live where they live and how greatly these attributes contribute to the quality of both their surroundings and way of life i.e. bushwalking, swimming. Benefits derived from the natural environment include enrichment, recreation and aesthetic experience. These benefits primarily related to the presence and diversity of fauna which are in turn attributed to the presence of water and natural vegetation communities.

During SIA consultation, several Awaba residents said that they value their surroundings, primarily the bushland, as it is an integral part of the residential area. Residents and representatives of the broader local community expressed concerns that the project would adversely impact the surrounding bushland and creek systems, as well as Lake Macquarie. A few residents in Awaba anticipate that project induced changes i.e. impacts of land disturbance, loss of vegetation, and change in systems, to the natural environment within the Extension of Mining Area, will degrade the cultural services they derive from the surrounding ecosystem.

The findings of consultation show some stakeholder concern in relation to the environmental impacts of subsidence. Several Awaba residents spoke about the effects of subsidence from previous mining activities in the local area, on the creek systems and biodiversity of the local area. These stakeholders expressed concern that the project would result in further subsidence which may in turn lead to adverse changes in valued environment assets e.g. biodiversity along Stony Creek. These stakeholders spoke about the emergence of sinkholes from historic mining activities and expressed concern in relation to the impacts of sinkholes on the natural environment.

A number of stakeholders expressed concern regarding the potential impacts of subsidence on water quantity and quality in the creek systems overlying the Extension of Mining Area and in adjoining areas. These concerns relate primarily to the potential for subsidence to change creek system hydrology and over time biodiversity along the creek systems. A few Awaba residents cited concerns that any adverse changes in the biodiversity value of Stony Creek and the broader Extension of Mining Area may detract from their enjoyment of the local area and reduce the intrinsic value of the local area.

A few stakeholders commented on potential changes in surface water quality due to project related discharges.

The Lake Macquarie City Council and a number of other stakeholders expressed concern in relation to the potential impacts of subsidence on the biodiversity values of the Awaba Biodiversity Conservation Area. The Awaba Biodiversity Conservation Area is a biodiversity offset area established by the Lake Macquarie City Council. The Lake Macquarie City Council is keen to ensure that potential impacts to the biodiversity values of the Awaba Biodiversity Conservation Area are avoided and/or managed. During SIA consultation stakeholders indicated that the Awaba Biodiversity Conservation Area is not widely used or accessed for passive or active recreational purposes, which is consistent with its biodiversity status.

Stakeholders were also concerned about potential project impacts on groundwater quality and the potential for surface and groundwater connectivity. The findings of consultation indicate that several stakeholders are concerned about the potential for groundwater contamination due to seepage from the EAD and Awaba underground void to underlying water sources.

Changes in the natural environment (excluding changes in amenity) due to the project are associated primarily with the operations phase of the project, and specifically underground mining activities. A number of different EIS technical studies have assessed the potential environmental impacts of the project. The following section discusses the findings of these studies with reference to the issues raised by stakeholders during SIA consultation, and discussed above.

Livelihood impacts

This section considers the potential for downstream water users and groundwater users proximate to the Extension of Mining Area to experience livelihood impacts as a result of the project.

Two surface water users were identified downstream of the project, both of which were downstream of the Extension of Mining Area. There were no surface water users identified downstream of the existing LDPs proposed to be utilised by the project.

The Extension of Mining Area comprises less than 2% of the total catchment area of Jigadee Creek and therefore potential impacts on downstream water users on Jigadee Creek were considered negligible.

The project has the potential to reduce surface water flows and quality in Jigadee Creek, Kilaben Creek and Stockyard Creek, which may reduce the water available to downstream water users. However, with consideration of the proposed mining method, and the implementation of a range of proposed mitigation measures, neither additional surface water take nor a measurable decline in water quality is expected as a result of the project.

SIA consultation did not identify any concerns in relation to the potential impacts of the project on downstream groundwater users. The Groundwater Impact Assessment (refer to Section 6.3) identified 67 registered bores within approximately 2 km of the Project Application Area. Of these bores, the majority (45 bores) were registered as monitoring bores or test bores. One bore was registered for waste disposal and two bores were registered for dewatering or mining purposes. The remaining bores (19 bores) were registered for a combination of stock, domestic, irrigation and farming purposes.

Project-related groundwater impacts were found to be less than the level 1 minimum impact considerations set out in the NSW AIP.

Given the findings of the Surface Water Impact Assessment and Groundwater Impact Assessment there is a low risk of the project adversely impacting the livelihood of existing downstream water users or groundwater users.

Employment and business

The economic impact of the project, including consideration of employment opportunities are assessed in detail in Section 6.16.

Energy security

The project is aligned with the broader Centennial Coal business strategy in that it facilitates the development of a new semi-soft coking coal product stream and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets. Over time, the project can potentially replace the coal product currently supplied to the domestic market i.e. to Eraring Power Station, by other Centennial Coal operations as these other resources become depleted. This will ensure ongoing security of supply for domestic electricity generation for NSW, specifically the Lake Macquarie region. The proximity of the Newstan Colliery to Eraring Power Station permits delivery of coal to the power station by existing rail infrastructure. This is a significant advantage when compared to sourcing fuel from alternative suppliers, which would entail greater socio-economic and environmental costs in terms of alternative transport requirements.

Culture

Impacts on indigenous cultural landscape values

Representatives of the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee expressed concern in relation to the impact of mining on cultural landscape values within the Project Application Area and Extension of Mining Area. Indigenous representatives expressed similar concerns as the broader community in relation to environmental values. Indigenous representatives expressed concern in relation to the impact of subsidence on hydrological structures and resulting adverse changes to creek systems and their associated biodiversity values (e.g. presence of wildlife). Indigenous stakeholders also expressed some concern and anxiety in relation to the corresponding reduction in traditional resources for collection.

Consultation with relevant Aboriginal parties indicates some use of land within the Project Application Area (not specifically the Extension of Mining Area) for social or cultural purposes. During SIA Consultation, representatives of the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee perceived that mining activities in the Project Application Area have reduced access for their people to different areas of the Project Application Area, which has resulted in fewer on-country gatherings. SIA consultation with RAP representatives indicated that there was existing concern for the cumulative loss of land and artefacts resulting from local and regional changes in land use, including the continuation of mining.

Other issues of concern raised during SIA consultation with Indigenous stakeholders included:

- The presence of sinkholes and fracturing in the Project Application Area - attributable to subsidence.
- Cleared vegetation associated with mining infrastructure. There is a perception that mining activities limit the resources available for collection/gathering, which in turn has resulted in a reduction in traditional activities taking place on country affected by mining.

Land disturbances from 1889 and the 1950s occurred within or in proximity of the Awaba Colliery Surface Site and Newstan Colliery Surface Site, and include the construction and operation of the former Awaba Colliery and Newstan Colliery, vegetation clearance, the deposition of fill and the establishment and ongoing use of access tracks, powerline easements and other infrastructure such as the railway. The portion of the Extension of Mining Area owned by Origin Energy includes areas of substantial disturbance associated with the Eraring Power Station.

Aboriginal cultural heritage

Consultation with representatives of the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee identified concern that cultural heritage sites could be damaged as a result of subsidence within mining areas.

The findings of the Aboriginal Cultural Heritage Assessment indicate that the project is unlikely to result in direct impacts to the Aboriginal archaeological sites present within the study area and the risk of indirect impacts to these sites is also low and can be mitigated.

Historic heritage

Whilst SIA consultation did not identify any specific concerns in relation to the impact of the project on items of local or regional historic significance, a number of participants noted the presence of local items of historic interest in proximity to the Extension of Mining Area. Items noted during SIA consultation were the Awaba State Coal Mine and the Eraring Power Station.

The Historic Heritage Assessment (refer to Section 6.13) concluded that five of the six heritage items known to be located within or in close proximity to the Extension of Mining Area may be subject to direct or indirect impacts as a result of the project, many of which relate to subsidence. A number of suitable management and mitigation strategies were identified as part of the assessment. The implementation of these management measures would significantly reduce any potential impacts to heritage items. The potential social impacts associated with any loss or damage to local non-Indigenous heritage values is considered to be minimal due to a lack of concern cited during SIA consultation.

Safety, health and wellbeing

This section describes the potential for the project to impact or benefit the safety, health and wellbeing of the surrounding community.

Impacts on public safety

During SIA consultation with the Awaba Rural Fire Service, concerns were raised in relation to the creation of new sinkholes in bushland areas of the Project Application Area, and the implications for the safety of Rural Fire Service personnel. The Rural Fire Service representative interviewed indicated that they generally confined activities in bushland to established access trails in order to avoid interactions with potential sinkholes. Similar issues were also raised by a few residents of Awaba. These residents cited examples of past interactions with historic sinkholes.

Stress and anxiety

A number of stakeholders engaged in SIA consultation expressed strong fears and a sense of anxiety in relation to the potential risks arising due to the interactions between the Eraring Ash Dam and the project. This fear was associated with the risk of an adverse incident (i.e. ash dam wall failure), and the potential environmental, social and economic implications of the event.

During SIA consultation, a number of stakeholders expressed their existing concerns in relation to the stability of the Eraring Ash Dam (in the absence of the project). The strength of these concerns is also evidenced in social media of the issues in 2019 (e.g. the Toronto and Westlakes Community Notice Board Facebook Page) and local and regional media coverage (e.g. Newcastle Herald, ABC News). The frequency with which this issue was raised during SIA consultation and the strong concern expressed by stakeholders can be attributed in part to the closure of the Myuna Bay Sport and Recreation Centre by the NSW Office of Sport in early 2019. The Myuna Bay Sport and Recreation Centre is located south of the southern boundary of the Eraring Ash Dam. The closure is alleged to be a response to the outcomes of a risk assessment conducted for the Eraring Ash Dam. A review of media articles in September 2019 indicates that the issue was highly topical in isolation i.e. separate from the project. However, it was observed during SIA consultation that the following actions have further exacerbated the fear and anxiety that some people are experiencing regarding public safety and environmental harm:

- The Origin Energy Eraring Ash Dam augmentation project (PA 07_0084 MOD 1).
- Centennial Newstan's proposed mining under the Eraring Ash Dam (i.e. the project).

Centennial Newstan acknowledges the concerns and fears of the broader community in relation to the stability of the Eraring Ash Dam. In response to stakeholder concerns Centennial Newstan undertook a risk assessment specific to the Eraring Ash Dam. This risk assessment considered the risk of a crack and/or failure of the Eraring Ash Dam wall due to project related impacts i.e. subsidence. The risk assessment indicated that there is no change in the risk profile due to the project when compared with the current state of the Eraring Ash Dam, or the Eraring Ash Dam following completion of the ash dam augmentation project approved under PA 07_0084 MOD 1.

Aspirations

The findings of SIA consultation informed an understanding of the values and aspirations of residents in the communities of Awaba, Fassifern and Wakefield. No issues were raised during SIA consultation that would indicate concern in relation to the impacts of the project on resident aspirations. Some Wakefield residents (existing and new incoming residents) raised concern about the impact of the Northern Coal Logistics Project (SSD-5145) on the desirability of their private property as a long-term residence, however consideration of these issues was outside the scope of the SIA as they relate to the approved operations of the Northern Coal Logistics Project. The Lake Macquarie City Council expressed a number of viewpoints in relation to the project's potential to support the delivery of the Lake Macquarie City Council's future land use aspirations for the LGA.

The following section discusses the potential impacts and benefits of the project on land use aspirations of key stakeholders.

Fast train corridor

Lake Macquarie City Council, in their input to the project SEARs, commented that the indicative very fast train corridor between Sydney and Newcastle is intersected by the Project Application Area. Lake Macquarie City Council expressed concern that the project has the potential to require relocation of this corridor and future transport infrastructure, with significant economic and public interest consequences.

Centennial Newstan has reviewed NSW Government's fast rail network corridor (NSW Government, 2018d). The potential routes identified for investigation extend from Port Macquarie in the north to Canberra in the south. Due to the scale of the publically available mapping, the specific location of the corridor relative to the Extension of Mining Area is indiscernible. However, based on the existing land uses, including underground mining and fly ash emplacement, it is considered unlikely that the Extension of Mining Area would be appropriate for any future use as a fast rail network corridor, with the exception of the areas occupied by the existing rail corridor for the Main Northern Railway. Notwithstanding, conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to the existing rail corridor for the Main Northern Railway. As such, the project is not expected to impact on the ability of NSW Government to establish a fast rail corridor.

Future land development opportunities

The project presents an opportunity to support the realisation of the Lake Macquarie City Council's future planning directions for the Lake Macquarie LGA. During SIA consultation Lake Macquarie City Council representatives highlighted the opportunities presented by the project for future land use planning in the Lake Macquarie LGA. Large areas of the Lake Macquarie LGA are designated for environmental conservation which means a limited supply of suitable degraded land exists for future industrial and commercial development initiatives.

During SIA consultation Lake Macquarie City Council representatives acknowledged the suitability of the existing cleared areas within the Project Application Area i.e. Newstan Colliery Surface Site and Awaba Colliery Surface Site, for industry hubs i.e. manufacturing and construction, and co-working spaces.

Centennial Newstan has developed a Conceptual Rehabilitation and Closure Strategy for the project (refer to Section 6.19). As described in the Strategy the intended post mining land is the beneficial re-use of the project infrastructure areas, where possible, to generate employment in the area. Areas within the disturbance footprint of the infrastructure at the Awaba Colliery Surface Site and infrastructure associated with the underground workings of Newstan Colliery present an opportunity for a possible industrial/commercial land use due to its proximity to the existing internal haul roads (part of the Northern Coal Logistics Project), related infrastructure and transport access, and the M1 Pacific Motorway. An industrial/commercial post mining land use on site would also meet the long-term vision of the Lake Macquarie LGA.

Cumulative impacts

Cumulative impacts are those that result from the successive, incremental and/or combined effects of an action, project or activity when added to other existing, planned and or reasonably anticipated future ones" (International Finance Corporation; World Bank, 2013). There are existing mining and power generation activities within and in proximity to the Project Application Area, as described in Section 2.2.1.

This section therefore considers the potential for cumulative social impacts from major projects proposed in the Lake Macquarie LGA. There is potential for project activities at the Newstan Colliery Surface Site and Awaba Colliery Surface Site to overlap with the construction and operations activities of other projects. The following new projects and modifications within and adjacent to the Lake Macquarie LGA have the potential to interact with the project:

- The Origin Energy Eraring Ash Dam augmentation project (PA 07_0084 MOD 1).
- Black Rock Motor Park on the Rhondda Colliery mine site at Wakefield assessed by Lake Macquarie City Council (DA/1556/2017).
- Wallarah 2 Project (located in the Central Coast LGA to the immediate south of the Lake Macquarie LGA).

The potential for significant cumulative social impacts is assessed as low for the following reasons:

- The project would have negligible additional impacts on population, social infrastructure or housing given the anticipated workforce sourcing arrangements, and as such there is low potential for cumulative impacts on these factors.
- In a scenario in which one other project of similar size was constructed in the same timeframe as the project, cumulative demand for construction workers is unlikely to result. This is because of the small construction workforce associated with the project.
- Lake Macquarie LGA residents currently experience the cumulative impacts of mine and power generation related activity i.e. traffic, housing/services and facilities demand, amenity impacts. The project would make a negligible contribution to the existing cumulative environment.
- The Lake Macquarie LGA community is experienced in managing the cumulative impacts of mining operations, so a degree of resilience to impacts is likely.
- Any cumulative social impacts of the project are likely to relate to stress and anxiety as nearby residents remain uncertain about the potential impacts of the Eraring Ash Dam and interactions with the project.

Impacts of mine closure

The project has an estimated life of 15 years. The Lake Macquarie LGA has experience in managing and responding to mine closure. Mine closure will involve the withdrawal of sustained economic stimulus (i.e. jobs and supply arrangements). The withdrawal of these funds will have a flow-on effect to the capabilities of Lake Macquarie City Council i.e. funding towards council owned services/facilities.

The current prevalence of mining in the Lake Macquarie LGA, in combination with Lake Macquarie City Council's aspiration to expand into other industries, suggests that the local economy would not weaken in response to mine closure. Nonetheless there may be an impact to the local economy.

The broader potential socio-economic impacts and opportunities associated with project closure include:

- Job changes or job loss and subsequent impacts such as financial stress due to lack of income.
- Potential outmigration of labour to areas outside Lake Macquarie LGA as former employees seek roles in other mining operations in nearby LGAs. However, this is anticipated to be minor given the proximity of the Lake Macquarie LGA to nearby employment centres e.g. Newcastle.
- Potential de-skilling of the labour force if some employees withdraw from the labour force.
- Decreased economic activity in the Lake Macquarie LGA.
- Reduced local business diversity due to changes in local expenditure arising from a reduction in direct mine contributions and local spend from employees.
- A shift in available employment opportunities from mining to other industries such as tourism, services, government and agriculture.
- Divestment from mine-owned and leased land and resulting impact on rates payable to Lake Macquarie City Council.

Significance of identified impacts and opportunities

This section presents the outcomes of the significance evaluation of the social impacts and opportunities of the project identified and discussed above. The assessment of impact significance is based on the methodology described in the SIA Guideline (DP&E, 2017).

Social impacts

The Social Risk Matrix set out in the SIA Guideline (DP&E, 2017) was used to quantify the significance of each identified social impact.

An initial evaluation of social risk was undertaken prior to consideration of management and mitigation measures. The outcomes of the initial risk assessment informed the need, or otherwise for the development of the project specific strategies.

The outcomes of the impact significance assessment are presented in Table 6-66. The outcomes of the significance evaluation indicate no significant social impacts are associated with the project once mitigation measures are applied.

Table 6-66 Project significance assessment – social impacts

Social impact	Stakeholder	Temporal	Project phase	Concern	Unmitigated risk	Mitigated risk	Rationale for residual rating
The project exacerbates existing anxiety in relation to the potential for failure of the Eraring Ash Dam and resulting environmental, social and economic costs.	Lake Macquarie LGA Residents and Environmental organisations.	Long-term	Operations Phase	High	Significant	Moderate	Special interest groups may not accept EIS findings and specialist reports. Concerns are likely to persist.
Potential environmental impacts of the project affect community held environmental values e.g. biodiversity and habitat.	Environmental organisations, NGOs, downstream water users, and local residents and residents of the broader Lake Macquarie LGA.	Long-term	Operations Phase	Moderate	High	Moderate	Access to EIS assessment findings and ongoing community engagement and reporting processes e.g. CCC may reduce some concerns but are unlikely to fully alleviate or resolve all concerns. Mine planning allows for first workings for protective barriers of sensitive features.
Downstream landholders experience livelihood changes due to project impacts on groundwater quantity and quality.	Downstream landowners within proximity of the Extension of Mining Area, and within the Project Application Area.	Long-term	Operations Phase	Low	Low	Low	No livelihood concerns were raised by stakeholders.

Social impact	Stakeholder	Temporal	Project phase	Concern	Unmitigated risk	Mitigated risk	Rationale for residual rating
Loss or damage to valued cultural assets.	Registered Aboriginal Parties, Indigenous Groups	Intergenerational	Life of Mine	High	High	Low	There are limited sites in the area and subsidence is not anticipated to be significant over the Extension of Mining Area due to the use of partial and full extraction.
Further impacts to cultural landscape including connection and access to country.	Registered Aboriginal Parties, Indigenous Groups.	Intergenerational	Life of Mine	High	High	Low	Much of the land within the Extension of Mining Area is crown land and accessible to the public. The project is an underground mine and does not involve clearing of native vegetation or significant and widespread changes in the landscape.
Loss or damage to Non-Indigenous heritage items impacts cultural values.	Residents with historical connection to the local area, Local historians.	Long-term	Construction Phase	Low	Low	Low	This impact was not raised as a concern during consultation. Further, the findings of the Historic Heritage Assessment do not indicate any significant impacts to identified existing and potential items of historic interest.

Social impact	Stakeholder	Temporal	Project phase	Concern	Unmitigated risk	Mitigated risk	Rationale for residual rating
Adverse changes to residential amenity.	Awaba residents.	Long-term	Construction Phase and Operations Phase	High	High	Moderate	Access to EIS assessment findings and ongoing environmental monitoring data together with community engagement and reporting processes e.g. the Newstan-Awaba CCC will reduce concerns.
Increased traffic volumes accessing Awaba Colliery Surface Site impact local accessibility and public safety.	Awaba residents, Users of Wilton Road.	Short-term	Construction Phase	Low	Moderate	Low	Any impacts experienced will be temporary in nature, minor in consequence and overall of low significance.
Withdrawal of sustained economic stimulus (i.e. jobs, supply etc.) impacts the socio-economic baseline of Lake Macquarie LGA.	Residents of Lake Macquarie LGA, business operators, service and facility providers and Lake Macquarie City Council.	Long-term	Mine closure	Low	Significant	High	The future cessation of mining will almost certainly result in a withdrawal of economic stimulus. The significance of this impact can be reduced through forward economic planning by Lake Macquarie City Council as illustrated in the LM Strategic Plan and the LM Community Plan.

Social opportunities

The Social Risk Matrix set out in the SIA Guideline (DP&E, 2017) was also used to assess the significance of potential opportunities associated with the project. The same social risk rating was applied to opportunities, with the social risk rating related to the scale of improvement or benefit likely to be experienced.

The outcomes of the opportunities significance assessment are presented in Table 6-67. The assessment also shows positive social outcomes associated with the project proceeding. These positive outcomes or opportunities relate primarily to employment and economic contributions to the Lake Macquarie LGA.

Table 6-67 Project significance assessment – social opportunities

Social opportunity	Stakeholder	Temporal	Project phase	Opportunity	Enhanced opportunity	Rationale for rating
The creation of direct and indirect jobs in Lake Macquarie LGA.	Residents of Lake Macquarie LGA and business operators.	Long-term (Project Life)	Life of Mine	High	Significant	The project will create 50 FTE construction jobs and 320 FTE operations phase jobs in the Lake Macquarie LGA.
Continued benefit to local and regional businesses from continued (or new) supply arrangements.	Business owners and operators of Lake Macquarie LGA.	Long-term (Project Life)	Life of Mine	High	Significant	Construction and operation of the project will necessitate significant spend by Centennial Newstan. Existing procurement arrangements.
Economic benefit to the region i.e. increases in revenue.	Lake Macquarie City Council and Lake Macquarie LGA.	Long-term (Project Life)	Life of Mine.	Significant	Signficant	Mining industry sector output in the Lake Macquarie LGA will increase when project operations commences. The Lake Macquarie LGA mining sector is the fourth highest revenue producing industry sector in the Lake Macquarie LGA.
Securing energy security for NSW	NSW Government, NSW Residents, and Eraring Power Station.	Long-term (Project Life)	Life of Mine	High	High	The EPS is projected to closure in 2032 (12 years from now). EPS relies on black coal, principally sourced by a number of mines in the Lake Macquarie LGA. Newstan Colliery will produce black coal suitable for use at the EPS and export.
Future land use aspirations of Lake Macquarie City Council supported by mine closure planning and final land use.	Lake Macquarie City Council and Lake Macquarie LGA Residents.	Long-term	Life of Mine	Moderate	High	The current Closure Strategy for Newstan Colliery aligns with Lake Macquarie City Council's future planning intent for the area.

6.15.5 Mitigation and management

Ongoing engagement

Centennial Newstan is committed to maintaining meaningful relationships across the communities in which it operates. Centennial Newstan consultation and engagement reflects the diversity of each community's characteristics, including their values and aspirations. Centennial Newstan also recognises that their communities of interest are not just located proximate to operations, but now reflect a broader network of attitudes and opinions about the coal mining industry. Centennial Newstan acknowledges and understands that open communication and listening to stakeholders' concerns is of great value. The frequency and nature of this engagement is adapted to the needs of various stakeholder groups. For example, the Newstan-Awaba CCC operates with a genuine two-way open dialogue to provide information about Centennial Newstan activities and provide a forum for stakeholder feedback on Centennial Newstan operations. Centennial Newstan also regularly engages with industry groups, interest groups, local committees and regulators on matters of importance to the business and stakeholders.

Stakeholder engagement is an integral component of Centennial's Environmental Management System Framework. Stakeholder engagement will be undertaken in a systematic manner consistent with the Environmental Management System Framework, taking into consideration government and community expectations.

Centennial Newstan will continue to engage with key stakeholders in relation to mine closure planning. Centennial Newstan will also negotiate a VPA (or equivalent agreement) with Lake Macquarie City Council for the project. Financial contributions made through the VPA will be available for Lake Macquarie City Council to use for investing into future development.

Ongoing community engagement and community relations building activities will include:

- Continued operation of the Newstan-Awaba CCC as a forum to provide information to community stakeholders and receive feedback of Centennial Newstan activities.
- Community sponsorships (financial and in-kind contributions).
- Active participation and support of a broad range of community organisations, activities and events.
- Maintenance of a dedicated phone line and community contact email for the project.
- Continued operation of the Northern Holdings Aboriginal Cultural Heritage Management Plan Committee.
- Periodic community information days held at the Newstan Colliery Surface Site.
- Regular and informal discussions and correspondence between Centennial Newstan representatives and external stakeholders including suppliers, residents, interest groups and facility and service providers.

Performance monitoring

The monitoring and evaluation of social impact management activities is important in understanding how programs are performing against expected outcomes and how successful these programs are at mitigating or managing identified impacts. Centennial Newstan will implement the following social performance monitoring measures for the project:

- Conducting regular meetings for the Awaba-Newstan CCC.

- Engagement with residents of the Project Application Area and interest groups in relation to the interactions of the project with the Eraring Ash Dam and Centennial Newstan's actions to minimise potential risks.
- Community information and engagement with residents of the Project Application Area, Indigenous and non-Indigenous stakeholders and interest groups in relation to the findings of the EIS and proposed management measures.
- Community information and engagement with residents of the Project Application Area in relation to the interactions of the project with the Eraring Ash Dam.
- Undertaking pre-construction briefings with potential construction companies and ongoing regular communication with suppliers.
- Engagement with Awaba residents in relation to the timing of construction activities.
- Scheduling community open days for residents of nearby communities.
- Communication with Fassifern Public School and Charlton Christian College families in relation to project activities.
- Ongoing engagement with relevant Indigenous parties in relation to the management of cultural heritage, and access to traditional country.
- Promoting operations phase employment opportunities locally.
- Ensuring that the operations workforce is made aware of any traffic related safety matters prior to commencement of their employment.

Mine closure SIA

Centennial Newstan will undertake a mine closure SIA for the project approximately five years prior to the envisaged closure date. To assist in the mine closure process, Centennial Newstan will investigate, develop and incorporate social closure goals and impact management strategies within the mine closure plan/mine closure SIA. The mine closure SIA and associated strategies will involve engagement with Lake Macquarie City Council and other key partners to support future land use opportunities for the Lake Macquarie LGA. Once decommissioning and closure is underway, closure planning strategies and programs will be monitored to provide opportunities for adaptive management.

6.16 Economic

An Economic Assessment was prepared by Aigis Group to assess the predicted economic benefits and costs associated with the project. The information presented in this section is summarised from the Economic Assessment (Aigis Group, 2020), which is presented in full in Appendix W.

This section addresses all of the economic impacts relating to the project, in accordance with the relevant SEARs (refer Appendix A).

6.16.1 Background

The project will result in a number of economic benefits to the community including through royalties and employee benefits, as wells as a number of costs associated with environmental impacts and potential impacts to other industries. These potential economic impacts have been assessed in accordance with the *Guidelines for the economic assessment of mining and coal seam gas proposals* (DP&E, 2015) and the supplementary *Technical Notes supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals* (DP&E, 2018b) collectively referred to as the DPIE Guidelines.

6.16.2 Methodology

The Economic Assessment included a Cost Benefit Analysis (CBA) and Local Effects Analysis (LEA). The methodology is summarised below and presented in full in Appendix W.

Cost benefit analysis

Economic benefit of the project

The CBA is based on measures that are most relevant to the community of NSW and the region, as required by the DPIE Guidelines. As such, the CBA assessed total economic benefit of the project with respect to NSW Government royalties and economic benefit to workers.

Royalties for the project have been calculated based on a number of assumptions, including royalty rate, price of product coal produced and exchange rate.

Economic benefit to workers was assessed by calculating the residual or surplus economic contribution (labour surplus) of future employees of Newstan Colliery, taking into account alternative employment outcomes. The approach taken is to adopt a ‘reservation wage’, which represents the minimum wage that workers would accept for working elsewhere in the mining sector, and compare this to the assumed wage level for ongoing employment within the project, producing an estimate of ‘labour surplus’.

Economic cost of the project

From the perspective of NSW and the community in the locality, the quantitative or monetised assessment of costs from the project essentially relate to valuations of environmental and related effects and their associated social aspects that can be validly calculated.

An assessment of environmental impacts and their associated social implications was undertaken, to determine which of these impacts were suitable for quantitative (monetised) valuation in accordance with the benefit transfer method described in the DPIE Guidelines.

It is noted that these valuations may not fully reflect the values placed on these environmental assets and the predicted effects on them by some stakeholders. In recognition of this, the qualitative aspects of these impacts are also considered, which augment the monetised values estimated, where appropriate.

Local effects analysis

The LEA was undertaken in accordance with the DPIE Guidelines to provide an assessment of the consequences of the proposal in its locality. As such the LEA has considered costs and benefits of the project that are likely to be perceived as material at a local level.

6.16.3 Existing environment

The economic assessment compares outcomes estimated to result from the project, with the alternative ‘business-as-usual’ (BAU) case. Newstan Colliery is presently operated on a care and maintenance (non-productive) basis. The BAU case is essentially that project approval is not granted and mining is not resumed at Newstan Colliery.

The base case scenario, in which project approval is not granted, would effectively result in the cessation of all operations at the mine. Beneficial outcomes associated with royalties accruing to NSW, additional direct employment created, with the resultant employment benefit to workers at the mine, and income derived, and indirect employment supported by firms providing goods and services to Newstan Mine, would not be realised.

The positive effects of the base case would be the avoidance of environmental impacts assessed within this EIS, the economic effects of which are assessed and analysed in the Economic Impact Assessment (Aigis Group, 2020) and summarised in Section 6.16.4.

6.16.4 Impact assessment

Cost benefit analysis

Economic benefit of the project

The economic benefit of the project was assessed with regard to the collective public interest of households in NSW and the economic benefit of the project to the NSW community. Royalties are of primary interest to the community, as they represent the return to government for licensing Centennial Newstan to mine the resource. The application of royalty revenues to the provision of state-provided infrastructure, goods and services, is the practical return to the community. Economic benefit to workers is the difference between the wage paid in the project and the minimum wage that workers would be paid for working elsewhere in the mining sector.

The estimates of royalties, economic benefit to workers and total economic benefit of the project in terms of Present Value (PV) are presented in Table 6-68.

Table 6-68 Estimate of economic benefit

Economic benefit	Assessed benefit
NSW Government royalties	$80.4 million
Employee benefit	$27.6 million
Other Federal, State and Local government taxes, rates etc.	Not quantitatively estimated
Total economic benefit	**$108.0 million**

Estimation based on DPIE Guidelines central discount rate of 7% indicates an assessed economic benefit of $108.0 million. The randomised sensitivity test assessment across the full range of discount rate based assessments (low assessment at 10% discount rate to high assessment at 4% discount rate) indicates that the economic benefit may be in the range of approximately $110 million to $112 million.

Economic cost of the project

The valuations of environmental and related social impacts as a result of the project that can be validly calculated are presented in Table 6-69. In aggregate, these valuations amount to approximately $28 million over the life of the project.

Table 6-69 Quantitative assessment of environmental and social costs

Description of impact	Assessment assumptions	Assessment outcome
Aboriginal Cultural Heritage	7 items of Aboriginal cultural heritage identified (3 assessed as at risk of potential subsidence impact): $8.35 per capita p.a. for each 1,000 places protected); SA3 population (78,923) assumed (as the locality)	PV = $70,692 (estimated to 2050 [30 years post-closure])
Historic heritage	5 of 6 listed or potential heritage items may be subject to impacts. Assessment combined with Aboriginal Cultural Heritage Assessment. 8 items assessed in total.	

Description of impact	Assessment assumptions	Assessment outcome
Groundwater	Cost range \$44/ML to \$524/ML	PV = \$2,688,071
Biodiversity	0.35 ha of native vegetation to be cleared; valuation assessed at \$187 p.a. 6 threatened flora and 11 threatened fauna species identified under BC Act (Refer to Appendix W for detailed assumptions).	\$2,507 \$2,041,969 **(total) PV = \$2,044,477**
Surface water	1.6km of streams directly above directly above proposed mining area; mean of \$2.03 per household per year	PV = \$739,623
Air quality	$PM_{2.5}$ emissions (6.312 tonnes per year); unit damage cost \$110,000/tonne, operational stage.	PV = \$7,018,127
Greenhouse Gas	Refer to Appendix W for detailed assumptions.	PV =\$21,157,138
Noise & vibration	*Not quantitatively assessed on basis of impacts unlikely to be material*	-
Traffic	*Not quantitatively assessed on basis of impacts unlikely to be material*	-
Subsidence	Impacts accounted for in qualitative and/or quantitative assessments for Aboriginal cultural heritage, historic heritage groundwater and surface water	-
Soil and land resources	*Not quantitatively assessed on basis of impacts unlikely to be material*	-
TOTAL ASSESSMENT		**PV = \$33,718,127**

Net public infrastructure costs

No material costs are anticipated to be imposed with respect to public infrastructure, as the significant majority of mine infrastructure and services are already in place and any subsidence related impacts to public infrastructure can be effectively managed as described in Section 6.1.

Loss of surplus to other industries

The project location in the Lake Macquarie LGA, and Hunter Region more broadly, places it in a large regional economy. As such, any positive or negative effects on other industries are likely to be largely subsumed in an economy of this scale.

There is likely to be an increase in relation to commercial activity between Centennial Newstan and supporting operations, and the NSW and regionally based businesses with which they are likely to trade over the course of the Project. Relationships with some proportion of these suppliers are pre-existing in respect of goods and services procured for current Centennial Coal operations. As such, any loss of surplus is likely to be of comparatively lower order when compared to the potential for positive effects.

The BAU scenario (not proceeding with the project) would eliminate the prospect of additional commercial opportunities for relevant industry sectors and businesses. Correspondingly however, this would also mean that there would be no prospect of attributable loss of surplus to other industries in comparison with the current situation.

It is likely that an alternative fuel source may be required for Eraring Power Station for the remainder of its operating life and an alternative supplier would obtain the benefit of that commercial relationship. However, alternative suppliers are likely to be geographically further from Eraring than Newstan Colliery, and probably unlikely to access the existing transport infrastructure (conveyors and private haul roads). This may result in increases in the cost of alternative supply. In addition to the direct cost to Origin Energy/Eraring, there is the prospect that the additional cost may be passed on to electricity consumers.

Distributional impacts

Given the established network of firms with which Centennial Coal customarily trades, any distributional effect is likely to be positive. Additional firms may also be retained by Centennial Newstan over time. This would result in a redistribution of the benefits between firms, however, this would be an outcome of competition between such firms. There is further potential for some distributional effects resulting from recruitment of the workforce for the mine, however given the scale of the workforce in the regional and surrounding economies, any effects on individual firms are likely to be broadly distributed and relatively short term.

As the majority of significant infrastructure required to support the project is already in place, there is low potential for disruption to existing community activity and effects on social cohesion or groups within neighbouring communities are considered to be of relatively low probability.

Net economic cost/benefit of the project

Combining the predicted economic benefit and economic cost of the project, as presented in Table 6-70, the assessed net economic valuation of the project is a benefit of approximately $74.3 million (Net Present Value (NPV) over the project life).

Table 6-70 Estimate of net economic cost/benefit

Economic Benefit	Present Value
Assessed benefit	**$108.0 million**
Assessed cost	**$33.7 million**
Project CBA NPV	**$74.3 million**

The DPIE Guidelines indicate a series of additional sensitivity testing parameters, which essentially test the central assumptions of the CBA based on adjustment of operating outcomes of the project. The magnitude of the outcomes of the various sensitivity analyses (refer to Appendix W for full details) indicate that from the public interest perspective it is considered very unlikely that the project will result in negative Net Present Value.

Based on the quantitative analyses of the assumptions and alternative scenarios, the conclusion of the CBA is that the project represents a sound economic outcome. Returns to the NSW community, expressed as royalty revenues, remain positive in the various scenarios assessed and employee incomes and the associated benefits of additional employment, from both state and regional perspectives, are also positive. In addition, commercial transactions between Newstan Colliery and the suppliers of goods and services with which it will trade are an additional source of benefit in the state, regional and local economies.

Local effects analysis

Regional economic impact

A comparison of the predicted labour surplus (as calculated for the CBA) with median and mean wage and salary incomes for the LGA (Table 6-71) indicated that, as is the case with other comparatively highly remunerated occupations, in comparison with other employees resident in the LGA, mining employees have greater capacity for discretionary expenditure, and consequently the withdrawal of these incomes from the regional economy under the BAU scenario may result in relatively greater impacts than would eventuate for a comparable loss of full time equivalent (FTE) positions in other regional industries.

Table 6-71 Comparison of employment income data

Income measure	Estimate
Wage assumption	$135,000
Reservation wage	$126,329
Mean 'labour surplus'	$9,039
Median employee income (2017, nominal)	$49,997
Median employee income (2017 adjusted)[1]	$48,833

1 - Adjusted on the same basis as the reservation wage. Refer to Appendix W.

It is also expected that, as is the case with Centennial's nearby Mandalong Mine and Myuna Colliery, the Newstan workforce will be largely resident in the immediate area, and almost entirely in the broader region. This being the case, the proportion of incomes spent by workforce members and their households in the regional economy is likely to be relatively high.

The regional benefit relating to employee incomes was assessed as approximately $15 million over the life of the project, based on randomised sensitivity analysis over a range of possible outcomes.

An indicative approximation of the proportion and scale of expenditure with regionally and NSW based businesses for the most recently available financial year at Centennial's Mandalong Mine was adopted as a proxy for the project, given its regional proximity with Newstan Colliery.

The assessment indicated that a further $53 million a year in non-labour expenditure may be disbursed in the regional economy by Centennial Newstan. Approximately $15 million of the regional sum would be spent in the local (LGA) economy annually. Total annual expenditure in NSW was estimated at approximately $82 million. As is the case with other identified benefits, these would not be realised in the BAU alternative.

The regional industry that is likely to be most affected by either the project or the BAU alternative is Origin Energy's Eraring Power Station. As mentioned above, the shortfall in projected fuel supply that would result if the project did not proceed would likely result in direct cost to Origin Energy/Eraring, with this additional cost potentially passed on to electricity consumers, thereby affecting them also.

Environmental and social impacts on the community

Those environmental impacts which are suitable for quantitative analysis were assessed in the CBA. Table 6-72 presents a quantified assessment of the local or regional distribution of those environmental impacts quantified in the CBA. These are assessed as being proportionally distributed. Some impacts are likely to be experienced by those in close proximity to sites, or in the case of Aboriginal heritage, those who may have a cultural interest in the sites or artefacts identified. Other effects, such as GHG impacts, are more broadly distributed. These are apportioned to the regional population as a proportion of the NSW population.

Table 6-72 Regional distribution of quantified environmental effects

Environmental effect	Basis of attribution	Assessed effects[9]
Aboriginal cultural & historical heritage	100%	PV ≈ $70.7K, local/regional Aboriginal communities (potentially 3,868 residents [ABS Estimated Residential Population (ERP) 2018]).
Air quality	100%	PV ≈ $7 million, immediate area, including 4 sensitive receptors (residential, therefore potentially ≈11 residents)
GHG	Regional proportion of NSW population	Share of total PV ≈ $209,030, (based on ABS ERPs 2018).
Biodiversity	100%	PV ≈ $2.04 million (27,145 households)
Surface water	100%	PV ≈ $793.6K (27,145 households)
Groundwater	100%	PV ≈ $2.7 million (27,145 households)

Certain environmental impacts that were quantified in the CBA and others that were qualitatively valued will have particular effect at local level. These include air quality, noise, traffic and visual amenity impacts, which entail highly localised impacts. With respect to these localised impacts, four potentially impacted receptors (residences) were identified in assessing the scope of air quality and noise and vibration impacts (refer to Sections 6.8 and 6.9). The assessments of these environmental impacts indicated that these impacts are unlikely to be significant. That notwithstanding, each of these potential impacts will be subject of continuous monitoring, as such effects may still be perceived by some stakeholders as impacting them in some circumstances. The Social Impact Assessment (Refer to Section 6.15) for the project, recognises that notwithstanding actual impacts and the reduction in these associated with mitigation and management strategies, some stakeholders may continue to perceive or experience effects. Section 6.15 includes recommendations in respect of ongoing engagement and consultation mechanisms for stakeholders that offer the best means for managing such potential circumstances.

The conclusion of the LEA is that the project will have an overall positive effect on the local/regional economies and communities. In the alternative BAU case, none of the projected benefits or costs associated with the project would be realised.

6.16.5 Mitigation and management

Mitigation and management measures identified for the specific environmental impacts considered in the economic assessment are addressed within other sections throughout this EIS. Centennial Newstan will continue its programs of community consultation and engagement, with local and regional stakeholders.

[9] PVs at 7% discount rate.

6.17 Hazard and risk

6.17.1 Background

In relation to chemicals, a hazard is a set of intrinsic properties of the substance, mixture, article or process that may cause adverse effects to organisms or the environment. There are two broad types of hazards associated with hazardous chemicals which may present an immediate or long-term injury or illness to people. These are:

- Health hazards—these are properties of a chemical that cause adverse health effects. Exposure usually occurs through inhalation, skin contact or ingestion. Adverse health effects can be acute (short term) or chronic (long term). Typical acute health effects include headaches, nausea or vomiting and skin corrosion, while chronic health effects include asthma, dermatitis, nerve damage or cancer. Examples of chemicals with health hazards include toxic chemicals (poisons), carcinogens (cancer-causing chemicals) and reproductive toxins (chemicals which may cause infertility or birth defects).
- Physical hazards—these are properties of a chemical that can result in immediate injury to people or damage to property. They arise through inappropriate handling or use and can often result in injury to people and/or damage to property as a result of the intrinsic physical hazard. Examples of physical hazards include flammable, corrosive, explosive, chemically-reactive and oxidising chemicals.

Many chemicals have properties that make them both health and physical hazards (NSW Government, 2019c).

Hazardous chemicals are legislated under the *Work Health and Safety Act 2011* (WHS Act) and Work Health and Safety Regulation 2017 (WHS Regulation) and the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* (WHS (Mines) Act) and Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 (WHS (Mines and Petroleum Sites) Regulation).

Under the WHS Regulation, a hazardous chemical is any substance, mixture or article that satisfies the criteria of one or more hazard classes in the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), as modified by Schedule 6 of the WHS Regulation. However, some hazard classes and categories of the GHS are excluded by the WHS Regulation.

Most substances, mixtures, and articles that are dangerous goods under the Australian Code for the Transport of Dangerous Goods by Road and Rail are hazardous chemicals, except those that have only radioactive hazards (class 7 dangerous goods), infectious substances (division 6.2) and most class 9 (miscellaneous) dangerous goods.

6.17.2 Impact assessment

Centennial Newstan currently holds all necessary approvals under these Acts and maintains a system for managing hazardous chemicals that satisfies the requirements of the legislation and relevant SafeWork NSW codes of practice.

As the project is essentially a continuation of the existing Newstan and Awaba Collieries, there is no plan to introduce additional classes of hazardous chemicals. The hazardous chemicals currently used at Newstan Colliery Surface, which will continue to be used, are:

- Oils and greases, including engine coolants, hydraulic oil, transmission oil and gear oil.
- Diesel.
- Gases, including oxygen, acetelyne, nitrogen, helium, argon, methane and LPG.
- Mining chemicals (chemical inserts for roof support, mine grouts, shotcrete).
- Other general use chemicals, including calcium lime rust remover (CLR), rat poison, general paints, coagulator, cleaning substances and dust suppression polymer.

The majority of hazardous chemicals will continue to be stored at the Newstan Colliery Surface Site in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145), however some additional substances will be stored at the Awaba Colliery Surface Site., including:

- Oils and greases for the maintenance of the gas flaring facility.
- Quantities of diesel (approximately 500 litres) for use in back-up generators.

There is no intention to store any gasses at Awaba Colliery Surface Site. Portable gas bottles will be brought to site for cutting and welding, as required. All mine supplies will be dispatched from the Newstan Colliery Surface Site to the underground workings.

The Awaba Colliery Surface Site will have the same controls for dangerous goods as at the existing Newstan Colliery Surface Site and will operate under the same management system.

With the continued implementation of best management practices for these materials within the Project Application Area, along with the effective implementation of the approved EMS and workplace health and safety management systems, the project should not pose any significant risk in relation to its locality, to human health, life or property or the biophysical environment. Further, by employing the mitigation and management strategies identified in this EIS, the project should not result in the emission of a polluting discharge in a manner which would post a significant risk or impact to the local environment or surrounding populace.

On this basis, the project is not considered to comprise a "potentially hazardous industry" or a "potentially offensive industry" within the meaning of these expressions in SEPP 33, and therefore a preliminary hazard analysis was not prepared.

6.17.3 Mitigation and management

Centennial Newstan will continue to employ the mitigation measures and management strategies currently adopted at Newstan Colliery for the storage, handling and disposal of dangerous goods to minimise the risk to human safety, the local environment and mine assets. Specific mitigation and management measures are set out in the following subsections.

Emergency management system

Newstan Colliery's Emergency management system and Pollution Incident Response Management Plan (PIRMP) will be reviewed and updated for the project. The review will take into consideration relevant requirements under the WHS (Mines and Petroleum Sites) Act, commitments made in this EIS, and all relevant SSD consent conditions.

Training and awareness

The updated Emergency management system and PIRMP will be used to train and inform employees and contractors of the appropriate emergency procedures. The following excerpts from the Emergency management system will be applied to hazardous chemicals awareness:

- Employees will be provided with suitable training, education and/or information to gain or refresh the necessary skills and knowledge to competently perform their tasks and be aware of specific hazards to be managed. Refresher training will be provided to maintain an employee's skills and/or knowledge in a particular area, as appropriate.
- All new employees and contractors, on commencing at the mine will be trained in the basic awareness of the hazards identified in the Emergency Management System.
- Where appropriate the Coal Services Order 34 induction and training scheme will be used to guide development and implementation of the additional training requirements of the Emergency Management System.

General

- All hazardous chemicals will be transported to and from the Newstan Colliery Surface Site and Awaba Colliery Surface Site by a licensed contractor in accordance with the relevant Australian Standards and codes of practice.
- All hazardous chemicals will be clearly labelled when delivered from the supplier and stored in suitable designated storage facilities in accordance with relevant Australian Standards and codes of practice.
- All on-site hazardous chemical storage facilities will be regularly inspected and maintained to avoid leaks, spills and other faults.
- Safety data sheets (SDSs) will be maintained for all chemicals and dangerous goods in a number of locations in both hard copy and electronically for ease of access by the entire workforce. The SDSs will be checked against first aid supplies to ensure all first aid requirements are available on site.
- Spill kits will be provided and maintained on-site.

6.18 Bushfire

6.18.1 Background and methodology

The bushfire risk assessment undertaken for the project included:

- Desktop analysis of bushfire history, access infrastructure, local environment and assets.
- Review of existing Emergence management systems and bushfire management plans for Newstan and Awaba Collieries.
- Review of the broad vegetation types within the Project Application Area.
- Description of the landform the Project Application Area.
- Characterisation of potential bushfire behaviour.
- Assessment of the bushfire risk for significant assets (life, environmental and structural).
- An assessment of suitable bushfire protection actions toward the identified assets.
- Assessment of roads and access adequacy for emergency response.

The assessment focused on the project’s two surface infrastructure sites; Newstan Colliery Surface Site and Awaba Colliery Surface Site.

The assessment was carried out with reference to relevant legislation and guidelines, including the NSW *Rural Fires Act 1997* and Planning for Bushfire Protection (NSW Rural Fire Service, 2006), and to address the key issues raised within the SEARs (refer to Appendix A).

The bushfire risk assessment presented in the following subsections builds on the findings of the previous bushfire risk assessment completed by Klienfelder (2014) for the Northern Coal Logistics Project (SSD-5145).

6.18.2 Existing environment

Bushfire hazard

Bushfire hazard is assessed through the identification of vegetation, slope and potential ignition sources. Each of these site characteristics, as relevant to the project, are described in the following subsections.

Vegetation

The predominant vegetation surrounding the Project Application Area is “Open Dry Sclerophyll Shrubby Forest”, with an estimated fuel loading is up to 35 tonnes per hectare (Kleinfelder, 2014). The fire thresholds for Open Dry Sclerophyll Shrubby Forest, being the upper and lower time limits or range of fire intervals recommended to support ecologically sustainable fire management, are a minimum of seven years and a maximum of 30 years (NPWS 2004, cited in Kleinfelder 2014).

Rehabilitated areas to the west of the Newstan Colliery Surface Site have large non-vegetated patches and low to sparse revegetated patches.

Slopes and terrain

The topography within and around the Project Application Area generally consists of rolling low hills with short side slopes and numerous closely spaced drainage lines. Slope gradients are generally 10 to 25 percent and local relief is between 20 metres and 110 metres AHD.

Table 6-73 lists the standard separation distances for Open Dry Sclerophyll Shrubby Forest on various slope ranges to avoid the “flame zone” (AS 3959-2009 Construction of Buildings in Bushfire-Prone Areas, cited in Kleinfelder 2014).

Table 6-73 Standard separation distances to avoid flame zone

Vegetation type	Standard separation distances to avoid flame zone (metres)				
	Flat or upslope	0-5 degrees	5-10 degrees	10-15 degrees	>15 degrees
Open Dry Sclerophyll Shrubby Forest	19-25 metres	25-32 metres	32-39 metres	40-49 metres	>50 metres

Ignition sources

The following are considered to be the most likely sources of ignition:

- Construction/operation and associated activities - the most common risk of ignition will be sparks generated from hot works and plant/equipment used in construction activities, for example exhausts and sparks of vehicles, maintenance works such as welding and landscape management. Actions of site personnel and malfunctioning equipment and motors may also result in fire ignition.
- External sources - bushfire may enter the Project Application Area from adjoining properties and transport corridors. Any local or neighbouring hazard reduction operations are also a potential ignition source, particularly under conditions of hot, dry summer winds (legal burning off in rural areas is mainly undertaken in autumn through to spring). Arson is also a potential ignition source, however is likely to be limited to the main road areas.
- Electricity transmission lines - under hot and windy conditions, electricity transmission lines may sag, come in contact with each other and arc. This can generate sparks that have the potential to cause fire.
- Lightning - lightning strikes are a common cause of fire ignition. The potential for lighting strike is not predictable, however if the conditions are suitable (dry vegetation, hot and windy) the risk is significant.

6.18.3 Impact assessment

Public safety and human life

The bushfire risk to public safety is significant with regards to awareness and evacuation provisions. Early detection and emergency evacuation is a key mitigation strategy to protect life of employees and contractors.

Newstan Colliery Surface Site and Awaba Colliery Surface Site are not open to the public and ingress/egress is managed in accordance with the existing Emergency management system.

The Awaba Colliery Surface Site will have a contracted workforce for the eleven month construction phase. Following the completion of construction, only a small full time administrative and maintenance workforce (less than 10) will be based at the site.

The majority of the operational workforce will be located at Newstan Colliery Surface Site. The existing access provisions to the Newstan Colliery Surface Site, which consist of Miller Road and Newstan-Eraring Private Haul Road, are considered suitable for evacuation and access purposes (Kleinfelder, 2014). The site has five on-site water tanks, with a total maximum volume of 1.5 million litres that can be used in the event of a fire emergency (Kleinfelder, 2014). The water supply is reticulated around the site, with hydrants sign-posted and spaced at desirable intervals. Fit-for-purpose trailer-mounted diesel powered pumps are available on site in case of an emergency.

The Building Code of Australia (BCA) does not provide for any bushfire specific performance requirements for Class 5 to 8 and 10 buildings (offices, factories, warehouses, public car parks and other commercial or industrial facilities). Such buildings have general fire safety construction provisions, such as structural materials, that are deemed acceptable solutions. Specific to bushfire protection, Class 5 to 8 and 10 buildings need to provide suitable emergency access, water supplies and services, emergency planning and vegetation or bushfire fuels management. These mitigation provisions have been provided in the existing development.

The extensive bushfire setbacks to existing infrastructure at the Newstan Colliery Surface Site and Awaba Colliery Surface Site, along with the provision of other bushfire treatments (landscape management, suitable access and water supplies), will assist in the protection of life.

Exploration drilling will have potential to locate contractors in bushland areas where there is limited access provisions and APZ clearance for fire protection. This task requires specific risk assessment and control measures.

With implementation of appropriate bushfire risk management controls, the risk of a local bushfire adversely impacting persons on site is low.

Infrastructure and economic

Although industrial infrastructure is generally resilient, components could be damaged through exposure to direct flame, radiant heat, smoke or ember. This risk could delay or prevent coal handling/processing, along with mining operations if critical infrastructure, such as surface ventilation fans, is damaged or fails. Any asset that is damaged for a prolonged period may have significant impacts on economic output for Centennial Newstan.

The varying levels of priority for infrastructure requiring bushfire protection have been assessed and presented in Table 6-74. The priority levels have been determined on the basis of distance from the hazard (direct impact) and consequences if infrastructure is damaged and non-functional (lost production). This priority identification could assist emergency operations and bushfire mitigation efforts to minimise bushfire impact.

Table 6-74 Bushfire protection priorities

Asset	Human risk	Commercial risk	Environmental risk	Priority
Newstan Colliery Surface Site				
CPP	Low	High	Low	1
CHP	Low	High	Low	1
Product handling facilities	Low	High	Low	1
Rejects emplacement areas	Low	Moderate	Low	2
Workshops and services buildings	Low	High	Low	2
Administration buildings and bathhouse	Low	High	Low	2
Car park	Low	Moderate	Low	3
Other infrastructure items	Low	High	Low	2
Services	Low	High	Low	2
Access road	Moderate	Low	Low	3
Threatened species	Low	Moderate	Moderate	2
Private haul roads	Low	High	Low	1
Awaba Colliery Surface Site				
Gas flaring facility	Low	High	Low	1
Workshop and services buildings	Low	High	Low	2
Administration buildings and bathhouse	Low	High	Low	2
Car park	Low	Moderate	Low	3
Services	Low	High	Low	2
Access road	Moderate	Low	Low	3
Other infrastructure items	Low	High	Low	2
Threatened species	Low	Moderate	Moderate	2
Private haul roads	Low	High	Low	1

Priority 1 – Critical infrastructure or high financial impact if function is compromised.

Priority 2 – Lower impact, partially resilient or easy to replace.

Priority 3 – Resilient, lowest priority.

Environmental assets

Ecological and cultural heritage assets require protection from bushfire and/or from bushfire mitigation treatments. Endangered ecological communities and threatened flora and fauna have some resilience to bushfire impact, however a high intensity and widespread fire would have significant impact. While threatened flora and fauna and Aboriginal heritage sites have been identified within the Project Application Area, no threatened flora and fauna or identified Aboriginal heritage sites will be directly impacted by the recommended bushfire treatments (refer to Section 6.18.4).

6.18.4 Mitigation and management

Centennial Newstan will continue to employ the mitigation measures and management strategies currently adopted at the Newstan Colliery, as relevant to the project, to reduce the bushfire hazard and minimise the risk to human safety and assets.

Industrial infrastructure is generally fire resilient, however the potential for component failure can be minimised via implementation of appropriate bushfire treatment options, which also provide a higher level of safety to personnel. The following specific mitigation measures and management strategies will be adopted.

Emergency management system

Newstan Colliery's emergency management system, including the bushfire management plan, will be reviewed and updated for the project.

Life safety – emergency management

The emergency response arrangement for the project will be detailed in the Emergency management system, including continual awareness and training in preparation for response to an emergency. Emergency evacuation procedures will include clarification of the main access road and alternative egress route (emergency safe route) and ensure an understanding of the extent/spread of fire is known prior to evacuating the site.

Asset Protection Zones

The existing APZs at the Newstan Colliery Surface Site and Awaba Colliery Surface Site will be maintained. These are considered acceptable to achieve the desired setbacks for flame and radiant heat protection. A minimum APZ of 45 metres will be established around the new infrastructure at the Awaba Colliery Surface Site. It will be established via perimeter roads, excavated walls and/or bushland management areas.

Road access

The access provisions to the Newstan Colliery Surface Site and Awaba Colliery Surface Site are considered suitable for evacuation and access purposes. These routes will continue to be detailed on an emergency operation map and integrated into the Emergency management system.

Water supplies

The existing water supplies at the Newstan Colliery Surface Site and Awaba Colliery Surface Site will continue to provide a reticulated supply, with hydrants sign-posted and spaced at desirable intervals.

Communication

The updated Emergency management system will be used to inform all personnel of the appropriate emergency procedures.

Consultation

For the purpose of bushfire safety, consultation with the NSW Rural Fire Service will be undertaken prior to and during the typical bushfire season each year between August and May. This consultation may include discussion of emergency procedures and the suitability of access roads, APZ areas and water supplies.

Monitoring

All asset protection actions will be monitored on an opportunistic basis or a frequency not exceeding 3 years.

6.19 Rehabilitation and closure

A Conceptual Rehabilitation and Closure Strategy was prepared by Integrated Environmental Management Australia (IEMA) to establish preliminary objectives for the decommissioning and rehabilitation of disturbed land as part of the project. The strategy identifies options for final land use and defines success criteria to demonstrate that the desired final land use has been achieved.

The full Conceptual Rehabilitation and Closure Strategy (Integrated Environmental Mangement Australia, 2019), is provided in Appendix X, with significant findings and recommendations summarised below.

6.19.1 Rehabilitation objectives

The principal objectives of the Conceptual Rehabilitation and Closure Strategy for the project are to:

- Provide an overall framework for mine closure planning and rehabilitation that can be used to guide the project and ensure once completed, satisfactory rehabilitation and closure of the site can be achieved.
- Propose decommissioning and rehabilitation strategies that would:
  - Mitigate environmental impacts of the project
  - Ensure closure is completed in accordance with leading industry practice
  - Be prepared for sudden or unplanned closure events (although considered unlikely)
  - Ensure that the Project Application Area can be used for suitable beneficial uses post closure
  - Consider the biodiversity value of the surrounding area and integrate these values with the final land use options for the Project Application Area
  - Establish clear and agreed criteria that can be used to provide the standards against which the final mine rehabilitation and post disturbance land use can be assessed
  - Ensure the closed facility does not pose an unacceptable risk to public health and safety
  - Monitor rehabilitation success in terms of physical and biological parameters

Further, the following broader rehabilitation and closure principles have been adopted for the project. These include:

- To establish a final landform that is safe, stable, non-polluting and free draining.
- Not preclude other potential post mining land use options that may be considered feasible in the future as part of the detailed mine closure planning process.
- To remove all infrastructure that does not have any post mining beneficial use.
- If required, preserve surface infrastructure or features that are heritage listed or represent high heritage value.

6.19.2 Disturbance areas

The land within the Project Application Area for the Newstan and Awaba Colliery sites has already been highly disturbed and developed due to historical land use and mining related activities. Within the Extension of Mining Area, the main disturbance areas relate to infrastructure associated with the Northern Coal Logistics Project, Main Northern Railway, Eraring Power Station and Eraring Ash Dam. There is limited land disturbance proposed within the Extension of Mining Area as part of the project. Ground disturbance within the Extension of Mining Area includes exploration drilling, access tracks and impacts associated with mine induced subsidence. All proposed surface infrastructure for the project is within the previously disturbed areas at Awaba Colliery and Newstan Colliery Surface Sites.

6.19.3 Mine closure domains and post mining land use options

The project's operational areas have been divided into three closure domains (Domains). Domains have been used to divide the Project Application Area into smaller more manageable portions for planning and execution of mine closure. A mine closure domain is generally defined as a portion of land within the site that has similar geophysical characteristics as well as often having similar potential for post-mining land use.

It is intended that the domains and domain objectives defined in the Conceptual Rehabilitation and Closure Strategy will be adopted and included in a new Mining Operations Plan (MOP), following approval of the project.

Post mining land use options for each domain were selected based on site suitability and identified risks and opportunities. Consideration was also given to relevant policies and guidelines as well as the existing land zoning for the area.

The overall goal of closure of the Project Application Area is to maximise the retention of existing infrastructure at the Awaba Colliery Surface Site for reuse, rehabilitate remaining disturbed areas to be consistent with adjoining areas whilst not prohibiting potential future re-development of the site. Post mining land use options for each domain are presented in the subsections below.

Domain 1 – Infrastructure areas

Domain 1 includes the mining infrastructure at the Awaba Colliery Surface Site, the Forest Road Ballast Borehole and Services Site, and infrastructure from the underground workings that surface at the Newstan Colliery Surface Site.

The decommissioning and rehabilitation of the existing features of the Newstan Colliery Surface Site will be undertaken as part of closure activities for the approved Northern Coal Logistics Project in accordance with the requirements of SSD-5145 and therefore do not form part of the Conceptual Rehabilitation and Closure Strategy for the project.

It is intended that the post mining land use for Domain 1 would be the beneficial re-use of the project infrastructure areas to generate employment in the area.

The areas within the disturbance footprint of this domain present an opportunity for a possible industrial / commercial land use due to its proximity to the existing internal haul roads, related infrastructure and transport access and the M1 Pacific Motorway.

If during the detailed mine closure process, it is determined that an appropriate beneficial post mining industrial land use is not identified, the infrastructure at the Awaba Colliery Surface Site will be removed and the site will be rehabilitated to native vegetation.

Domains 2 and 3 – Proposed mining area and Project Application Area

Domain 2 includes land above the proposed underground mining areas and all other remaining lands within the Extension of Mining Area.

Domain 3 generally includes the areas outside of the Extension of Mining Area that have been subject to previous undermining and as a result includes some areas that have been shown to be affected by mine induced subsidence. These areas are to be actively managed for potential subsidence related impacts. There is also some mine related infrastructure such as de-watering bores, exploration holes, gas and ventilation infrastructure.

The preferred post mining land use for Domain 2 and Domain 3 is the retention and replanting of native vegetation (woodland). On this basis, all areas disturbed by the project will be returned to a native vegetation similar to what is existing in the surrounding area. Surface disturbance within these domains is generally related to:

- Areas impacted by mine subsidence (typically historical mine areas requiring remediation).
- Access tracks and minor roads.
- Exploration bores.
- Mine ventilation shafts and associated infrastructure associated with former Newstan and Awaba Colliery workings.
- Materials supply shafts.
- Gas drainage infrastructure.
- De-watering bores.

The majority of land within Domains 2 and 3 is either Crown Land or privately owned, therefore consultation would be required if any alternative land use option such as recreational facilities were proposed. Should any opportunities arise to re-purpose any access tracks or minor roads to support any other land use option for, this would be considered as part of detailed mine closure planning for the project in the future.

As the majority of the land is not owned by Centennial, the proposal to rehabilitate these disturbed areas within Domains 2 and 3 with native vegetation does not prohibit the landowners from considering some other alternate land use in the future.

6.19.4 Decommissioning

Domain 1- Infrastructure areas

It is proposed that the infrastructure area at the Awaba Colliery Surface Site be retained for future post-mining industrial land use where possible. It is acknowledged that there are some features at the Awaba pit top site that are specifically related to underground coal mining and coal handling/processing that are unlikely to have any potential for reuse following the cessation of mining. Regardless of the selected post mining reuse option, it is intended that these features will need to be decommissioned and removed from the site before it can be used for some other beneficial land use.

To address this, a detailed decommissioning and demolition strategy will form an integral part of the detailed closure planning process. This will include a detailed investigation of all structures to determine the appropriate safe methods, demolition techniques, equipment required, and the sequence for decommissioning and removal required to execute the demolition activities safely.

Prior to commencement of demolition works, Centennial will review the current land contamination studies and where required complete further investigations and develop a remediation action plan to manage land contamination. Additionally, a detailed asset register will be developed and distributed to all other Centennial sites to ascertain whether any of the key assets can be reused within the wider Centennial business.

Site services

All services that are not required for some other beneficial post mining land use will be safely isolated, disconnected and terminated. Generally, all underground services will be made safe and left buried in-situ, while overhead power lines will be removed and the materials recovered for potential re-sale or recycling where practicable.

The location of pipelines that are to remain in-situ and that are not required for some other land use will be recorded in an abandoned services register, and signs will be erected where appropriate.

Equipment and buildings

All demountable/transportable buildings not required for some other beneficial post mining land use will be removed from the site. If no beneficial reuse options are identified, all remaining permanent buildings will then be demolished, with the component materials recycled or re-sold where practicable.

Where buildings and infrastructure will be retained, there will be ongoing in situ management of Asbestos under an implemented Asbestos Management Plan (AMP). Where buildings and structures were identified to contain Asbestos previously, a Hazardous Materials Register and AMP will continue to be implemented until demolition is completed.

Prior to decommissioning/demolition, hazardous materials assessment and subsequent asbestos removal will be undertaken by an appropriately licensed contractor and any other hazardous materials will be identified and managed appropriately to facilitate disposal to landfills licenced to receive this material.

Opportunities for the sale and/or re-use of assets and recycling of scrap steel will be maximised where possible. Any materials not recycled or re-sold will be disposed of in a suitable location either on-site or off-site at a licensed waste management facility. Material assessed as “not hazardous or contaminated” by a suitably qualified person will be crushed and disposed of within associated portal entries or placed as fill into shafts (where appropriate). Prior to disposal, all wastes will be assessed and classified in accordance with the relevant regulatory requirements.

All water management sumps and ponds will be de-watered and de-silted prior to the commencement of demolition. Following the removal of all structure all areas will be rehabilitated and revegetated.

Roads, tracks and hardstand areas

Roads and/or tracks may remain, with agreement by the landowner, to provide access to some other post mining land use as well as being required for the on-going access for monitoring and maintenance activities post closure of the mine.

Any access roads, tracks, car parks and hard stand areas that are not required post mining will have the stabilised and compacted material removed. The inert waste will be disposed of in a suitable location on-site or off-site at an approved waste management facility. Minor reshaping work may be undertaken where required and the areas rehabilitated. Any creek crossings (such as road culverts) will be removed and the pre-existing drainage line re-instated.

Fuel farms and chemical storage areas

Prior to closure of the site any remaining fuel and/or chemicals will be identified so that they can be recycled or disposed of at an appropriately licensed facility. All items of plant and equipment not being relocated to another Centennial site will be de-oiled, degassed, depressurised and isolated, and all hazardous materials would be removed from the site.

All infrastructure associated with fuel farms and chemical storage areas will be recycled, re-used or demolished and disposed of in a suitable location on-site or off-site at a licensed waste management facility.

Mine entries, ventilation shafts, exploration boreholes and ballast shafts

Prior to sealing mine entries and existing shafts suitably qualified experts will be consulted to prepare sealing strategies in accordance with the appropriate guidelines and standards, including the High-Risk Notification process under Clause 33 of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*.

All service boreholes and exploration boreholes will be grouted and sealed as per *EDG01 – Borehole sealing requirements on land: Coal exploration* and the shafts and drifts sealed in accordance with *MDG6001 Guidelines for the permanent filling and capping of surface entries to coal seams*.

Domains 2 and 3: Proposed Mining Area and Project Application Area

The infrastructure within Domain 2 and 3 that would require decommissioning includes access tracks and minor roads, exploration bores, ventilation and gas drainage infrastructure, and de-watering bores. These types of infrastructure are also present within Domain 1 and would be decommissioned via the same methods.

6.19.5 Rehabilitation

Landform establishment

As the disturbed areas within Domain 1 are intended to be retained for post-mining industrial land use and disturbed areas within Domains 2 and 3 will be limited to a relatively small amount of surface infrastructure and any mine-induced subsidence impacts, there is expected to be limited need for significant landform establishment during rehabilitation.

Landform establishment within Domain 1 will be limited to areas where mine–related infrastructure is to be decommissioned. In these areas there will be a requirement to undertake some re-profiling including establishing final landform drainage features.

In Domain 2, reshaping works will be required following the removal of the limited infrastructure in this area. Earthworks may also be required to manage mine induced subsidence in accordance with the existing with the existing Awaba Colliery Sinkhole Management Plan.

In Domain 3, where roads and access tracks are not to be retained, reshaping of the area would be required to ensure the landform is commensurate with the surrounding area, as well as to establish appropriate drainage.

Growth medium development

Following landform establishment activities, topsoil will be spread, treated with fertiliser (if required) and seeded in one consecutive operation. Thorough seedbed preparation will be undertaken to ensure optimum establishment and growth of vegetation. All topsoiled areas will be lightly contour ripped and, where possible, ripped when the soil is moist and immediately prior to sowing. If required, the re-spread topsoil surface will be scarified prior to, or during seeding, to reduce run-off and increase infiltration.

Bio-solids or a suitable organic compost may be used as growth media where topsoil is not available as there is a topsoil deficit across the site due to the age of the operation. Any use of biosolids will be in accordance with the current EPA guidelines.

Ecosystem establishment

Revegetation activities will be scheduled to occur promptly following the completion of topsoil spreading and drainage works. Where possible, the timing of seeding will coincide with the preferred tree seasonal sowing periods in autumn or spring. Selected tree and shrub species will be sown using direct seeding or tube stock depending on the species, slope gradients and area to be revegetated. Tree and shrub species will be established at a density and richness consistent with unmined woodland areas.

Species selection for areas to be rehabilitated to native bushland will focus on those species that will successfully establish on the available growth medium, bind the soil and result in a variety of structure and food/habitat resources. A combination of native and introduced pasture species may be used in some circumstance in the disturbance areas to ensure the quick establishment of a continuous groundcover, thereby reducing the risk of erosion.

The presence of weed species within topsoil spread on the rehabilitated areas within the surrounding land also has the potential to significantly impact on the biodiversity value of the rehabilitated areas. Weeds, including priority weeds listed under the *Biosecurity Act 2015,* will be managed across the site through a series of control measures, including:

- Regular inspections of the rehabilitated areas to identify potential weed infestations.
- Identifying and spraying existing weed populations.

Where required, feral animal control programs will be undertaken in accordance with legislation and in consultation with the Livestock Health and Pest Authority.

Ecosystem development

The ecosystem development phase of rehabilitation involves demonstration that an ecosystem is on a sustainable trajectory towards the desired post disturbance land use. Key activities in this phase include rehabilitation monitoring, rehabilitation maintenance and adaptive management.

A dedicated monitoring system will be established for each closure domain in order to assess effectiveness of implementation of the rehabilitation measures as well as to identify the need for corrective action as soon as required.

6.19.6 Conceptual rehabilitation success criteria

Conceptual rehabilitation success criteria have been developed to provide a framework to guide the development of more specific success criteria which will be used to demonstrate the completion of each phase of rehabilitation for each domain. The project is currently within the planning phase and, therefore, the rehabilitation success criteria are considered conceptual. They will be further developed during the detailed mine closure planning process and following further stakeholder consultation regarding final land use.

The conceptual rehabilitation success criteria for the project are provided in Appendix X. The success criteria comprise indicators for vegetation, fauna, soil, stability, land use and safety on a landform-type basis that reflects the nominated post-mine land use of industrial and native bushland/mixed native grasses. Each criterion is designed as a performance objective or standard against which rehabilitation success can be demonstrated. Meeting the success criteria (as indicated by monitoring results) demonstrates that the rehabilitated landscape is in a sustainable condition, ready to be relinquished, and handed back to the appropriate stakeholders.

6.19.7 Indicative closure timing

An indicative closure timeline is shown in Table 6-75, including the key rehabilitation and closure activities throughout the life of the project. The phases of closure are:

- Closure planning
- Decommissioning and rehabilitation
- Maintenance and monitoring
- Relinquishment

Table 6-75 Indicative closure timeline

Years from Closure	Closure Planning					Decommissioning and Rehabilitation				Monitoring and Maintenance				Relinquishment	
	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10
Closure Planning															
Stakeholder consultation regarding closure															
Agreed final Mine Closure Plan															
Update, review and approve MOP															
Develop an infrastructure demolition plan															
Closure Activities															
Demolition of infrastructure															
Landform establishment															
Growth medium development															
Ecosystem establishment															
Ecosystem development															
Post Closure Activities															
Maintenance of rehabilitated areas															
Monitoring and inspections															
Post Relinquishment Activities															
Management of residual risk															+

7. Evaluation of merits

This chaper integrates the findings of preceding chapters of this EIS and evaluates the merits of the project, including consideration of the principles of ESD. In particular, it evaluates:

- The design of the project.
- The consistency of the project with the strategic context.
- Compliance with any relevant statutory requirements.
- Stakeholder perceptions and how they have been addressed in the design of the project and assessment of its impacts.
- The economic, social and environmental impacts of the project.
- Whether the project is, on balance, in the public interest.

Further details are presented in the following subsections.

7.1 Project design

The project has been developed and refined in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the 'avoid, minimise, offset' hierarchy. In this regard, Centennial Newstan has worked through numerous iterations of the mine design to develop a project that responds to three key considerations:

- The coal resource is a public asset owned by the State of NSW and it is therefore in the public interest to optimise resource recovery.
- The project is constrained by a range of sensitive built and natural environmental features and their protection throughout all project phases must be a priority.
- Feedback from stakeholders must be considered and incorporated into the development of the project.

The project makes use of the existing surface facilities at the Newstan and Awaba Collieries and the coal handling and transportation operations already approved for the Northern Coal Logistics Project under SSD-5145. This represents a beneficial use of existing infrastructure and offers a substantial synergy with approved operations that will minimise further impacts beyond those already approved.

The low-impact and flexible bord and pillar mine design, which includes areas of first workings, partial extraction and full extraction (see Figure 1-1), balances coal recovery with a need to limit mine subsidence. The utilisation of varying levels of extraction (first workings, partial and full extraction) will provide Centennial Newstan with the ability to limit the extent of subsidence in specific areas based on the need to protect certain important built assets or natural environmental features, which has been a key focus during development of the project.

Conservative protection barriers have been adopted in the mine design to minimise subsidence impact risks to overlying infrastructure such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam and sensitive surface water features such Stockyard Creek, Kilaben Creek, and Stony Creek.

The coal recovered from the project will produce both a semi-soft coking coal product for the export market and a thermal coal product for both the domestic and export markets. The project would ensure ongoing security of supply for domestic electricity generation to Eraring Power Station (provided through existing infrastructure). It will also provide for the continuation of mining at Newstan Colliery beyond 6 July 2021, the date at which Development Consent DA 73-11-98 lapses. This will enable the continued employment of 320 FTEs and generate approximately $80 million in royalties to the State and $28 million in employee benefits.

The project will prevent the sterilisation of a substantial coal resource within the mining lease area, that would be unlikely to be extracted independently or as part of any other mining proposal, whilst balancing impacts to stakeholders and the environment.

7.2 Strategic context

The project represents a proposed land use that is compatible with future land uses identified in relevant strategic planning documents. It is also well aligned with the objectives of the Strategic Statement on NSW Coal and the Integrated Mining Policy.

The existing land use is also appropriate for the development. The project seeks to extend underground mining operations at an existing coal mine and maximise the beneficial use of existing mining and coal handling and processing infrastructure.

The majority of the proposed Extension of Mining Area is located under unpopulated bushland, the Eraring Power Station, and associated infrastructure including the Eraring Ash Dam. It is also bordered by previous Newstan Colliery mine workings to the north and northwest and partially overlaid with mine workings from Awaba Colliery. Many of the impacts that would otherwise occur if the project were to be located in a less developed location have already occurred as a result of the existing mining and industrial land uses in the vicinity of the project.

The project’s strategic location adjacent to the Eraring Power Station, Australia’s largest power station, may also provide syngeries for future domestic coal supply arrangements between Centennial Newstan and Origin Energy to support the State’s energy needs. Coal from the existing Newstan Colliery Surface Site, including coal mined from the project, can be supplied directly to the Eraring Power Station via either the Newstan-Eraring Private Haul Road or the railway network. This existing coal supply infrastructure provides a highly efficient supply option for meeting the Eraring Power Station’s future thermal coal requirements.

The project has been designed to consider the benefits and consequences of the development for other land uses, including coexistence with urban and semi-urban areas on the western side of Lake Macquarie, existing biodiversity conservation areas (e.g. Awaba Biodiversity Conservation Area), nearby infrastructure such as the Main Northern Railway, and industrial development such as the Eraring Power Station and Eraring Ash Dam. It will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. It will also provide a number of positive flow-on effects to the local, regional and State economies through additional wages and royalties.

7.3 Regulatory compliance

The project has been designed to minimise potential environmental, social and economic impacts whilst optimising resource recovery. As detailed throughout this EIS, Centennial Newstan has worked through numerous iterations of the mine design to develop a project that meets regulatory requirements and stakeholder expectations. In particular the following is noted:

- The project is for underground mining purposes and is therefore permissible with development consent in accordance with Clause 7 of the Mining SEPP.

- The project is classified as SSD pursuant to Schedule 1 of the State and Regional Development SEPP, as it is development for the purposes of coal mining.
- Land owner consent has been formally obtained by Centennial Newstan as required to facilitate the project.
- All project activities are proposed within the Colliery Holding Boundary for the existing Newstan Colliery. The project will not require a new or extended mining lease. The project will optimise resource recovery that would not likely be efficiently extracted through an independent or new mining operation. The project therefore complies with the objectives of the Mining Act.
- A Development Application for SSD must be accompanied by an EIS, prepared in accordance with Clauses 6 and 7 of Schedule 2 of the EP&A Regulation and the SEARs. This EIS has been prepared in accordance with these relevant clauses and will accompany Centennial Newstan's application for the project.
- The project is consistent with the objectives of the EP&A Act and a detailed consideration of the project against the principles of ESD has been undertaken in this EIS.
- The project complies with Clauses 12 to 17 of the Mining SEPP which requires consideration to be given to the compatibility of projects with other surrounding land uses, including the existing and potential extraction of minerals, natural resource management and environmental management, resource recovery, transportation and rehabilitation.
- All other relevant EPIs have been considered and addressed in this EIS. The project complies with the relevant requirements of these instruments.
- The provisions of the Voluntary Land Acquisition and Mitigation Policy have been considered and addressed in this EIS. A detailed assessment of impacts to air quality and noise and vibration has been conducted in this EIS in accordance with the relevant policies and guidelines. The assessments found the project is predicted to generally comply with the relevant criteria.
- An assessment of the project's greenhouse gas emissions has been prepared in accordance with relevant State and national policies, programs and guidelines. The proposed flaring of fugitive CH_4 emissions significantly reduces the greenhouse gas emissions emitted by the project.
- The project has been assessed against the AIP. All groundwater impacts attributable to the project have been assessed to be less than the Level 1 impact considerations in the AIP.
- The project has been assessed against the requirements of the EPBC Act, in particular in regard to the project's impacts on threatened species and communities and water resources. It is unlikely to have a significant impact on threatened ecological communities and species listed under the EPBC Act or on Commonwealth water resources listed as MNES.

7.4 Stakeholder engagement

As detailed throughout this EIS, Newstan Colliery has well-established relationships with local community networks, landholders and other stakeholders. The Newstan Colliery CCC (now Newstan-Awaba CCC) has operated for almost 20 years.

Building on these existing relationships, Centennial Newstan has undertaken a significant stakeholder engagement program for the project. The engagement program has involved consulting with a number of community members, Aboriginal groups, infrastructure owners and government agencies to present the project and, where relevant, seek feedback on key project design considerations and areas for investigation during the EIS. Extensive consultation has been also undertaken regarding the management of direct and indirect subsidence-related impacts to key infrastructure assets such as the Main Northern Railway, Eraring Power Station and Eraring Ash Dam. These recommendations have formed an integral part of the mine design process and these consultations will continue during the construction, operation, and closure phases of the project.

During the stakeholder consultation program, a number of stakeholders acknowledged the history, prevalence and importance of mining in the area. Impacts to existing amenity; specifically, acoustic amenity, air quality and visual amenity as a result of the project were a key concern for stakeholders. Concern was also raised in regard to the impacts of subsidence of the natural environmental and local Aboriginal cultural heritage values and artefacts, in addition to additional project-related traffic on local roads.

Stakeholders also expressed concern in regard to the social, economic and environmental implications of any changes in the permeability and stability of the geology underlying the Eraring Ash Dam due to mining from the project. Residents of Lake Macquarie LGA have been vocal regarding the potential social, economic and environmental consequences of a failure in the Eraring Ash Dam wall. These considerations have been central to development of the project design and Centennial Newstan has also outlined a range of measures to mitigate these risks.

A variety of potential social benefits and opportunities presented by the project were also identified. These included:

- Creation of direct and indirect employment opportunities within the Lake Macquarie LGA.
- Creation of additional supply arrangements for local businesses and enhancement of existing supply arrangements.
- Ongoing and possibly increased voluntary contributions from Centennial Newstan to the surrounding community through event attendance, sponsorship and donations, and the VPA with Lake Macquarie City Council.
- In-migration of new residents to Lake Macquarie LGA as people seek to capitalise on employment opportunities associated with the project.
- Greater diversity in future land use opportunities for post mining land if:
  - Centennial Newstan’s rehabilitation and mine closure planning for the project is aligned with the strategic planning aspirations of Lake Macquarie City Council, and/or
  - The project results in complete subsidence of the historic Awaba Colliery underground workings and leads to surface stabilisation.

7.5 Economic, social and environmental impacts

Table 7-1 below presents a summary of the environmental, social and economic impacts due to the project, as detailed in Section 6.

Table 7-1 Summary of environmental, social and economic impacts

Environmental/ social/ economic aspect	Summary of key findings
Subsidence	• Less than 20 mm of vertical subsidence is predicted in areas of first workings only. This includes under second and third order streams, the Main Northern Railway, a 132 kV substation, the Eraring Power Station, and the Eraring Ash Dam wall. • A maximum vertical subsidence of 1,100 mm is predicted in areas of partial extraction (single-seam conditions). This includes under the Ulan Rail Loop and under sections of an existing 132 kV transmission line that are subject to multi-seam conditions. • The greatest subsidence effects (with a maximum vertical subsidence of 3,250 mm) are predicted to occur in areas of full extraction where the proposed panels mine directly beneath the existing Awaba Colliery workings in the Great Northern Seam. • Long term subsidence impacts on steep slopes and rock outcrops is considered unlikely. • Subsidence impacts to residential areas is considered unlikely. • Subsidence monitoring, management and remediation will continue to be undertaken, including rail line and watercourse impact monitoring.
Hydro geotechnical	• First workings within the West Borehole seam in areas underlying Origin Energy's proposed grouting areas within the Western Emplacement Area are considered unlikely to cause or increase any direct or indirect hydraulic connectivity between the workings. • First workings are also not expected to impact the integrity of Origin Energy's proposed void filling in the former Awaba Colliery workings or increase flow paths between the Eraring ash dam and former Awaba Colliery workings. • The mine design incorporates strategies developed in consultation with Origin Energy to mitigate any interactions and risks. • A comprehensive monitoring program will be undertaken with an appropriate trigger action response plan developed and implemented if required.
Groundwater	• The project is predicted to result in an increase in groundwater inflow into the mine workings. A Water Access Licence (WAL) will be required for the Sydney Basin – North Coast Groundwater Source for the interception and extraction of groundwater from the proposed and existing workings. • There is no predicted impact on baseflow or Lake Macquarie due to the proposed mine workings. • Groundwater impacts due to the proposed mine workings do not extend up to the alluvium. Therefore, there will be no impact to the alluvial water table or baseflow to creeklines attributable to the proposed workings. This specifically includes Stockyard and Kilaben Creek catchments. • Modelled drawdown of private bores due to proposed workings is less than 1 m at all bores at the end of mining. • There are no high priority vegetation GDEs within the radius of drawdown. • All groundwater impacts attributable to the project have been assessed to be less than the Level 1 impact considerations in the NSW AIP. • The existing groundwater and flow monitoring program will be continued.

Environmental/ social/ economic aspect	Summary of key findings
Surface water	• The existing water management systems at Newstan Colliery and Awaba Colliery will be sufficient to accommodate the project, given some minor upgrades. • All water will continue to be treated at the Clean Water Plant prior to discharge at Newstan LDP001. The quality and quantity of discharge water will remain in accordance with the existing approved limits of EPL 395. • No additional surface water take is required due to the project. Therefore no additional surface water entitlements are required. • Any changes in the catchment areas due to the predicted subsidence are expected to be minor. As a result, it is considered that no appreciable changes to stream flows are likely to occur as a result of the project. • The existing flow monitoring program at Newstan Colliery and Awaba Colliery will be continued, in particular the continued monitoring of the discharges via Newstan LDP001 and LDP017 and extractions from the Fassifern underground storage.
Flooding	• Remnant ponding areas are predicted to increase (by approximately 2 ha due to subsidence) around existing waterbodies with minor areas within native bushland areas. • No material impacts to infrastructure, with respect to flooding, are expected to occur downstream of the study area. • Downstream of the subsidence impact areas, flood hazard is expected to decrease due to minor attenuation of peak flows within the Extension of Mining Area. Emergency management arrangements are not expected to change as a result of the project. • The majority of watercourse reaches were assessed as having negligible or low risk of impact from subsidence. • Monitoring and management plans will be implemented, including regular visual monitoring and development of appropriate stabilisation techniques.
Terrestrial ecology	• Approximately 0.35 ha of native vegetation will be cleared for construction of new ancillary facilities that could not be sited on pre-disturbed areas. This impact will be offset in accordance with the NSW Biodiversity Offset Scheme. • The project is unlikely to have a significant impact on threatened ecological communities and species listed under the EPBC Act as Matters of National Environmental Significance. • The project has the potential to lead to impacts to threatened plants and ecological communities from subsidence, cracking, sinkholes, plug-failures and ponding. LIDAR will be utilised to detect potential impacts. If impacts are detected, the extent of those impacts will be quantified and an offset liability report will be prepared to both quantify the impacts and outline the offset strategy that will be adopted to address those impacts.
Aquatic ecology	• Impacts on macroinvertebrate communities in LT Creek and Stony Creek due to a change in water quality from the project are considered unlikely. • Subsurface flow diversion and loss of surface flows may have a marginal impact on habitat availability, water, and sediment quality for macroinvertebrate communities in Stony Creek and Kilaben Creek. • The existing aquatic ecology monitoring program will continue for the project.

Environmental/ social/ economic aspect	Summary of key findings
Air quality and greenhouse gas	• The project is predicted to comply with all relevant air quality criteria, with the exception of the 24-hour average PM_{10} criterion and annual average $PM_{2.5}$ concentrations (which are due to pre-existing high background concentrations and the incremental impacts from the project are low and unlikely to cause an exceedance). • The annual Scope 1 and Scope 2 GHG emissions from the project are estimated to be 0.03 tonnes of CO_{2-e} per tonne of ROM coal produced. The introduction of flaring of the fugitive CH_4 emissions, rather than venting it direct to atmosphere ad part of the project significant reduces annual emissions. • The project would represent approximately 0.012% of Australia's national emissions. On this basis, it is concluded that the project will have a minimal impact on Australia's ability to meet its emission reduction target.
Noise and vibration	• The project is predicted to comply with the relevant operational noise criteria during standard weather conditions. During noise-enhancing weather conditions, a negligible exceedance of the noise criteria (up to 2 dB) is predicted during the night-time period at one assessment location. • Sleep disturbance impacts are considered unlikely to occur. • Construction noise emissions are predicted to comply with the relevant noise criteria at all assessment locations under both standard and noise-enhancing meteorological conditions. • A minor increase in road traffic noise (0.1 bB) is predicted for night-time construction traffic (ie early morning arrivals between 6:00 am and 7:00 am). There was no predicted increase in daytime traffic noise levels.
Traffic and transport	• The project is expected to have a negligible impact on the assessed road network and key intersections. Therefore, no road improvements or upgrades are proposed as part of the project. • The operation of the project is expected to have no impact on road safety, demand on public transport or pedestrian or cycling activities. • No cumulative impacts in regards to traffic and transport are expected over the operation of the project.
Soil and land resources	• The post-mining land use will be comparable with pre-mining land uses. The majority of predicted remnant ponding will occur in native bushland areas. • There will be negligible impact from the project on agricultural resources or enterprises.
Aboriginal heritage	• Seven Aboriginal heritage sites were identified within the study area and a further site was located within a 300m boundary of the study area. • These sites comprise three scarred trees and five isolated artefact/artefact scatter sites, with one site also containing shell material. • The project is unlikely to result in direct impacts to the Aboriginal archaeological sites present within the study area and the risk of indirect impacts to these sites is also low and can be mitigated. • In the event that a previously unrecorded Aboriginal object is identified within the study area, it will be managed in accordance with the Centennial Coal Northern Region Aboriginal Cultural Heritage Management Plan protocols.
Historic heritage	• The assessment identified six listed and potential (unlisted) heritage items located within or in immediate proximity to the study area. • No significant impact to these heritage items was identified due to the project.

Environmental/ social/ economic aspect	Summary of key findings
Visual amenity	• The project is expected to have a low to negligible impact on the visual amenity. • The capability of the landscape to screen views to the key components is considered to be high. The dense forested vegetation of the surrounding landscape is likely to reduce the potential magnitude of visual impact significance.
Social	• The project will have a minimal social impact, with changes to acoustic, air quality and visual amenity the key concern. • The project will not change how residents or visitors utilise the area or local community. • The project would create additional employment and commercial opportunities within the local area.
Economic	• The assessed net economic valuation of the project is a benefit of approximately $74.3 million (Net Present Value (NPV) over the project life). • The regional benefit relating to employee incomes was assessed as approximately $15 million over the life of the project. • The assessment indicated that a further $53 million a year in non-labour expenditure may be disbursed in the regional economy by Centennial Newstan. • Approximately $15 million of the regional sum would be spent in the local (LGA) economy annually. Total annual expenditure in NSW was estimated at approximately $82 million.
Hazard and risk	• No additional classes of hazardous chemicals or materials will be required for the project. • The project is not considered to comprise a "potentially hazardous industry" or a "potentially offensive industry" as per SEPP 33.
Bushfire	• The risk of a local bushfire adversely impacting persons on site is low. • Bushfire risk will continue to be actively managed in accordance with existing strategies.
Rehabilitation and closure	• The overall goal of closure of the Project Application Area is to maximise the retention of existing infrastructure at the Awaba Colliery Surface Site for reuse, rehabilitate remaining disturbed areas to be consistent with adjoining areas whilst not prohibiting potential future re-development of the site • There will be limited need for significant landform establishment during rehabilitation.

7.6 Ecologically sustainable development

One of the key objectives of the EP&A Act is to encourage ESD. The key principles of ESD are defined by the EP&A Regulations to include:

- The precautionary principle.
- Intergenerational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation, pricing and incentive mechanisms.

The manner in which the project has addressed and considered these principles of ESD is detailed below.

7.6.1 The precautionary principle

The precautionary principle states *"that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:*

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and

(ii) an assessment of the risk-weighted consequences of various options…"

Adherence to the precautionary principle requires avoiding serious or irreversible environmental damage by properly assessing potential impacts and taking the necessary mitigation measures.

This EIS identifies, with certainty, all environmental and social impacts from the project, which has been designed to avoid serious or irreversible environmental damage. To ensure this, actions involving unquantifiable and unacceptable environmental consequences have been avoided. Environmental consequences have been assessed on a 'worst case scenario' basis, where if potential serious or irreversible damage was identified, a change to the design of the project was implemented to avoid these consequences.

The specialist assessments undertaken for the project have evaluated the potential for harm to the environment associated with the development of the project. A range of mitigation measures have been adopted as components of the project design to minimise the potential for serious and/or irreversible damage to the environment, including the development of environmental management and monitoring programs, mitigation measures and ecological management strategies (Appendix D).

In the Groundwater, Surface Water, Flooding and Economic Assessments (Appendix J, Appendix K, Appendix L and Appendix W respectively), risk and uncertainty have also been taken into account through sensitivity and/or uncertainty analysis. Other specialist studies have accounted for uncertainty by adopting conservative project assumptions and/or prediction methodologies, such as the Subsidence Impact Assessment, Air Quality and Greenhouse Gas Assessment and Noise Impact Assessment (Appendix H, Appendix O and Appendix P respectively).

Furthermore, the EIS has adopted a risk-based approach to assessment whereby key aspects of the project with a high risk profile (such as groundwater impacts) have been peer reviewed by leading technical experts to ensure certainty over the predicted impacts of the project.

7.6.2 Intergenerational equity

The principle of intergenerational equity requires "*that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations."*

Intergenerational equity refers to equality among generations, and is based on the concept that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The nature and design of the project, in that it is an extension of an existing underground mining operation using existing coal handling and processing infrastructure, exemplifies the principle of intergenerational equity as the majority of impacts to facilitate the project have been incurred (through the establishment of the mining precinct and surface facilities) and/or significantly minimised or avoided through mine plan design. Therefore, the future generation stands to predominately benefit from the project through domestic energy supply security and economic benefits.

The project design, determined through an examination of the alternatives, along with commitments to environmental mitigation and measures, will operate to ensure that there is no significant effect on the environment which would diminish the health, diversity and productivity of the environment for future generations.

This has been achieved through modifying the mine plan for the project to undertake first and second workings in selected ‘high risk’ areas, and developing environmental management and monitoring programs, mitigation measures and ecological management strategies.

The project would benefit current and future generations through the creation of employment opportunities. It would also provide significant stimulus to local and regional economies and provide NSW export earnings and royalties, thus contributing to current and future generations through social welfare, amenity and infrastructure.

The project incorporates a range of mitigation measures to minimise potential impacts on the environment and the costs of these measures would be met by Centennial Newstan and included in the Economic Assessment (Appendix W). The potential benefits to current and future generations have therefore been calculated in the context of the assessed project.

7.6.3 Conservation of biological diversity and ecological integrity

This principle identifies that the conservation of biological diversity and ecological integrity should be a fundamental consideration in the decision-making process.

The project will utilise bord and pillar mining which extracts coal from the ground whilst leaving pillars of coal behind to support the roof. This minimises the potential for subsidence when compared to longwall mining, which removes ‘walls’ of coal at a time, leaving the roof to collapse afterwards. By adopting the bord and pillar mining method, subsidence impacts to the surface, and therefore impacts to biodiversity, are likely to be less than from longwall mining.

Further, the proposed utilisation of the existing surface facilities at Newstan and Awaba Colliery Surface Sites will also minimise land disturbance impacts by reducing the need for land clearing to establish new facilities. Construction of new ancillary surface facilities will be limited to pre-disturbed areas where possible. Approximately 0.35 ha of native vegetation will be cleared for construction of new ancillary faciltiies that could not be sited on pre-disturbed areas. The 0.35 ha of native vegetation to be cleared for ancillary facilities at Awaba Colliery Surface Site will be offset in accordance with the NSW Biodiversity Offset Scheme.

Potential impacts to the Awaba Biodiversity Conservation Area have been considered by proposing first workings only within the 2nd and 3rd order watercourses within this area.

In order to determine the occurrence of mining related impacts on threatened species or ecological communities, it is proposed that LIDAR be utilised to detect the potential impacts of the project (i.e. sinkholes, cracking and plug-failures). If impacts are detected, the extent of those impacts will be quantified by comparison to the baseline dataset. Where insufficient baseline data is available, presence of threatened species will be assumed if they are considered likely to occur and potentially impacted.

Following potential impacts, an offset liability report will be prepared to both quantify the impacts and outline the offset strategy that will be adopted to address those impacts. The offset liability report will be prepared with reference to the BAM and provided within three months of any impacts being identified.

These actions will ensure that the project will not threaten the preservation of biological and ecological integrity of the area and that the biodiversity and ecological value of the area is maintained and potentially improved in the long term.

7.6.4 Improved valuation, pricing and incentive mechanisms

The principle of improved valuation, pricing and incentive mechanisms states: "*that environmental factors should be included in the valuation of assets and services, such as:*

(i) polluter pays – that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,

(ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanism, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems."

The Economic Assessment (Appendix W) has provided an analysis of the project and incorporates environmental values via direct valuation where practicable (e.g. greenhouse gas costs). Furthermore, wherever possible, direct environmental effects of the project are internalised through the adoption and funding of mitigation measures to mitigate and offset potential environmental impacts.

The 'polluter pays' principle applies to the project through the pricing of suface and groundwater resources in accordance with State regulatory mechanisms. The project design has further borne significant costs associated with mine plan design changes (i.e restricting some areas to first and second workings only) and the costs associated with management measures to mitigate social and economic impacts.

The project is the logical continuation of the Newstan Colliery to the south, utilising existing infrastructure and surrounding facilties (i.e. private haul road and conveyor to continue to provide a reliable supply to Erraring Power Station for domestic energy generation). In this regard, the project optimises the valuation and pricing of the coal resource with minimial impact by utilising available use of existing infrastrure and mining operations.

7.7 Public interest

The project seeks to extend the underground mining operations of Newstan Colliery to the south, maximising the beneficial use of existing mining and coal handling and processing infrastructure. The existing land use is therefore appropriate for the development.

The project will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. It will also provide a number of positive flow-on effects to the local, regional and State economies through additional wages and royalties.

The project has been developed and refined in consultation with the community, regulatory agencies, infrastructure owners, and other stakeholders to maximise environmental, social and economic outcomes by following the 'avoid, minimise, offset' hierarchy. The resulting mine design is one that balances impacts to the environment, incorporates and addresses stakeholder feedback and optimises resource recovery for the state of NSW.

As detailed throughout this EIS, the project has been designed in a manner to co-exist with stakeholders and provide for the continuation of mining at Newstan Colliery beyond 6 July 2021, the date at which Development Consent DA 73-11-98 lapses. The project would prevent the sterilisation of a substantial coal resource within the mining lease area, that would unlikely be extracted independently or as part of any other mining proposal, whilst balancing impacts to stakeholders and the environment.

A variety of potential social benefits and opportunities presented by the project were identified through the stakeholder engagement program (i.e. benefits perceived by the stakeholders) including:

- Creation of direct and indirect employment opportunities within the Lake Macquarie LGA.
- Creation of additional supply arrangements for local businesses and enhancement of existing supply arrangements.
- Ongoing and possibly increased voluntary contributions from Centennial Newstan to the surrounding community through event attendance, sponsorship and donations, and the VPA with Lake Macquarie City Council.
- In-migration of new residents to Lake Macquarie LGA as people seek to capitalise on employment opportunities associated with the project.
- Greater diversity in future land use opportunities for post mining land.

As outlined in Section 7.6, the project has been assessed against the principles of ESD in accordance with the EP&A Act and EP&A Regulations. This assessment has found that any environmental and social impacts associated with the project can be adequately avoided, mitigated and offset, whilst allowing the substantial economic and social benefits to the local region, State and Commonwealth to be realised. The assessment therefore concludes that the project is consistent with the principles of ESD.

Newstan Colliery has provided substantial economic benefits to the Commonwealth, State, regional and local levels since it began operating in 1887. The project as proposed is a logical continuation of Newstan Colliery that would continue to provide economic benefits for the community. The project would generate approximately $80 million in royalties to the State and $28 million in employee benefits. Furthermore, the project would provide the continued employment of 320 FTEs.

Not proceeding with the project would represent the loss of these economic and employment benefits and the loss of a secure coal supply to Eraring Power Station (provided through existing infrastructure of private haul roads and conveyors) to maintain reliable electricity for the State.

In weighing up the main environmental impacts (costs and benefits) associated with the project as assessed and described in this EIS, the project is, on balance, considered to be in the public interest.

8. Glossary and abbreviations

Acronym/ abbreviation	Definition
ABS	Australian Bureau of Statistics
ACARP	Australian Coal Association Research Program
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AIP	Aquifer Interference Policy
AIS	Agricultural Impact Statement
AMP	Asbestos Management Plan
APZ	Asset protection zone
AQMS	Air Quality Monitoring Station
AS	Australian Standard
ASC	Australian soil classification
AUL	Auxiliary left turn
AUSRIVAS	Australian River Assessment System
AQGGMP	Air Quality Greenhouse Gas Management Plan
AQMS	Air Quality Monitoring Station
BACI	Before-after-control-impact
BAM	Biodiversity Assessment Methodology
Banpu	Banpu Public Company Limited
BAU	Business-as-usual
BC Act	*Biodiversity Conservation Act 2016*
BCA	Building Code of Australia
BCD	DPIE - Biodiversity and Conservation Division
BDAR	Biodiversity Development Assessment Report
bgl	Below ground level
BIR	Biodiversity Inventory Report
BMP	Biodiversity Management Plan
BoM	Bureau of Meteorology
°C	Degrees Celsius
CBA	Cost benefit analysis
CCC	Community Consultative Committee
CEC	Cation Exchange Capacity
Centennial Coal	Centennial Coal Company Limited
Centennial Newstan	Centennial Newstan Pty Ltd
CEMP	Construction Environmental Management Plan
CHR	Channelised right turn
CL Act	*Crown Lands Act 1989*
CMSC Act	*Coal Mine Subsidence Compensation Act 2017*
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_{2-e}	Carbon dioxide equivalent
CH_4	Methane
CPDP	Conceptual Project Development Plan
CPP	Coal preparation plant
CWP	Clean water plant

Acronym/ abbreviation	Definition
DA	Development application
Dams Safety Act	*Dams Safety Act 2015*
DAWE	Commonwealth Department of Agriculture, Water and the Environment
dB	Decibels
DGVs	Default guideline values
DEM	Discrete Element Method or Digital Elevation Model
DMP	Discharge Management Plan
DLWC	Department of Land and Water Conservation
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DoI	Department of Industry
DoP	Department of Planning
DotEE	Department of Environment and Energy
DP	Deposited plan
DPI	Department of Primary Industries
DP&E	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
DPIE - Planning and Assessment	Department of Planning, Industry and Environment – Planning and Assessment Division
DRG	DPIE – Division of Resources and Geoscience
EAD	Eraring Ash Dam
EC	Electrical conductivity
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EMS	Environmental Mangement System
EPA	Environment Protection Authority
EPL	Environment Protection License
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPT	Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)
ESC	Erosion and sediment control
ESD	Ecologically Sustainable Development
ESCP	Erosion and Sediment Control Plan
ESP	Exchangeable sodium percentage
EY	Exceedances per year
FHWA	Federal Highway Traffic Noise Model
FM Act	*Fisheries Management Act 1994*
Forestry Act	*Forestry Act 1916*
FTE	Full time equivalent
GDEs	Groundwater dependent ecosystems
GHG	Greenhouse gas
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GSM	Global System for Mobile Communications
ha	Hectares
Heritage Act	*Heritage Act 1977*
Heritage Branch	Department of Premier and Cabinet – Heritage Branch
HVAS	High volume air sampler

Acronym/ abbreviation	Definition
IBRA	Interim Biodiversity Regionalisation for Australia
ICNG	Interim Construction Noise Guideline
IEMA	Integrated Environmental Management Australia
ILUA	Indigenous Land Use Agreement
IPC	Independent Planning Commission
IPCC	Intergovernmental Panel on Climate Change
IPM	Incremental profile method
IS	Intrinsically safe
KTPs	Key threatening processes
km	Kilometres
kV	Kilovolt
kW	Kilowatt
LALC	Local Aboriginal Land Council
LDP	Licensed discharge point
LEA	Local effect analysis
LEP	Local Environmental Plan
LGA	Local Government Area
LiDAR	Light Detection and Ranging
LMCC	Lake Macquarie City Council
LPG	Liquefied petroleum gas
LOS	Level of service
LSC	Land and soil capability
LULUCF	Land use, land-use change, and forestry
m	Metres
m^3/t	Cubic metres per tonne
mg	milligrams
Mining Act	*Mining Act 1992*
ML	Megalitres
MNES	Matters of National Environmental Significance
mm	Millimetres
MOP	Mining Operations Plan
MSEC	Mine Subsidence Engineering Consultants Pty Ltd
Mt	Million tonnes
Mtpa	Million tonnes per annum
NGER Act	*National Greenhouse and Energy Reporting Act 2007*
NGOs	Non-government organisations
NMLs	Noise management levels
NMP	Noise Management Plan
NO	Nitric oxide
NO_x	Total oxidised nitrogen
NO_2	Nitrogen dioxide
NPfI	Noise Policy for Industry
NPV	Net present value
NPW Act	*National Parks and Wildlife Act 1979*
NPW Regulation	*National Parks and Wildlife Regulation 2019*
NRAR	Natural Resources Access Regulator
NSW	New South Wales
NSWALC	New South Wales Aboriginal Land Council

Acronym/ abbreviation	Definition
NT Act	*Native Title Act 1993*
PA	Project approval
PCBs	Polychlorinated biphenols
PCD	Pollution Control Dam
PCTs	Plant community types
PED	Personal emergency device
PIRMP	Pollution Incident Response Management Plan
PHA	Preliminary Hazard Analysis
PM_{10}	Particulate matter less than 10 microns in diameter
$PM_{2.5}$	Particular matter less than 2.5 microns in diameter
PMF	Probable Maximum Flood
PMST	Protected Matters Search Tool
PNTLs	Project noise trigger levels
POEO Act	*Protection of the Environment Operations Act 1997*
PSE	Principal subsidence engineer
PV	Present value
RAPs	Registered Aboriginal Parties
RBL	Rating background noise level
REDS	Regional Economic Development Strategy
Resources Regulator	DPIE- Resources Regulator
RL	Reduced level
RMS	Roads and Maritime Services
RNP	Road Noise Policy
Roads Act	*Roads Act 1993*
ROM	Run of mine
SA	Statistical Area
SAII	Serious and irreversible impact
SAL	Strategic Agricultural Land
SALIS	Soil and Land Information System
SCADA	Supervisory Control and Data Acquisition
SDS	Safety data sheet
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SHR	State Heritage Register
SIA	Social Impact Assessment
SIGNAL-2	Stream Invertebrate Grade Number – Average Level
SMF	Synthetic mineral fibres
SSD	State Significant Development
SSGV	Site specific guideline values
SREA	Southern reject emplacement area
SUA	Significant Urban Area
TARP	Trigger Action Response Plan
TEOM	Tapered element oscillating microbalance
TfNSW	Transport for New South Wales`
The Proponent	Centennial Newstan
TIA	Traffic Impact Assessment
TOC	Total organic carbon

Acronym/ abbreviation	Definition
TSP	Total suspended particulates
UDEC	Universal Distinct Element Code
µg	Micrograms
µm	Microns
VIA	Visual Impact Assessment
VLAMP	Voluntary Land Acquisition and Mitigation Policy
VP	Viewpoint
VPA	Voluntary Planning Agreement
WAL	Water access licence
Water Act	*Water Act 1912*
Water Division	DPIE- Water Division
WHS	Work Health and Safety
WHS Act	*Work Health and Safety Act 2011*
WM Act	*Water Management Act 2000*
WMP	Water Management Plan
WONS	Weeds of National Significance
WRI	World Resources Institute
WSP	Water Sharing Plan
ZTV	Zone of theoretical visibility

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Appendices

Appendix A – SEARs compliance

Appendix B – Schedule of land

Appendix C – Detailed maps and plans

Appendix D – Management, mitigation and offsetting measures table

Appendix E – Statutory compliance table

Appendix F – Signed statement from EIS author

Appendix G – EIS project team

Appendix H – Subsidence impact assessment

Appendix I – Hydrogeotechnical impact assessment

Appendix J – Groundwater impact assessment

Appendix K – Surface water impact assessment

Appendix L – Flood impact assessment

Appendix M – Terrestrial ecology impact assessment

Appendix N – Aquatic ecology impact assessment

Appendix O – Air quality and greenhouse gas impact assessment

Appendix P – Noise and vibration impact assessment

Appendix Q – Traffic and transport impact assessment

Appendix R – Soil and land resources impact assessment

Appendix S – Aboriginal heritage impact assessment

Appendix T – Historic heritage impact assessment

Appendix U – Visual impact assessment

Appendix V – Social impact assessment

Appendix W – Economic impact assessment

Appendix X – Rehabilitation and closure strategy

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