umwelt
Environmental & Social Consultants

Delta coal

CHAIN VALLEY COLLIERY MODIFICATION 4

Statement of Environmental Effects

FINAL

November 2020

CHAIN VALLEY COLLIERY MODIFICATION 4

Statement of Environmental Effects

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Great Southern Energy Pty Limited
(trading as Delta Coal)

Project Director:	Gabrielle Allan
Project Manager:	Kirsty Davies
Report No.	4760/R01
Date:	November 2020

Newcastle

75 York Street
Teralba NSW 2284

T| 1300 793 267
E| info@umwelt.com.au

www.umwelt.com.au

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Disclaimer

This document has been prepared for the sole use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by Umwelt (Australia) Pty Ltd (Umwelt). No other party should rely on this document without the prior written consent of Umwelt.

Umwelt undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. Umwelt assumes no liability to a third party for any inaccuracies in or omissions to that information. Where this document indicates that information has been provided by third parties, Umwelt has made no independent verification of this information except as expressly stated.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
FINAL	Kirsty Davies	16 November 2020	Gabrielle Allan	17 November 2020

Executive Summary

Chain Valley Colliery (CVC) is an underground coal mine located on the southern shore of Lake Macquarie, approximately 60 km south of Newcastle, NSW. Great Southern Energy Pty Ltd (trading as Delta Coal), owns and operates CVC. Mining has been undertaken at CVC since 1962 using a combination of bord and pillar and miniwall mining methods. Coal extraction has occurred from three seams, with current mining activities occurring within the Fassifern Seam. CVC operates under State significant development (SSD) consent SSD 5465 (CVC Consent), as modified.

In April 2019, Delta Coal acquired Lake Coal's CVC assets which included the adjacent Mannering Colliery Pit Top, as well as coal lease areas to the north of the CVC Consent boundary that were previously held by Centennial Myuna Pty Ltd. These coal leases form part of the Myuna Colliery, which is subject to project approval (PA) 10_0080 (Myuna Consent).

Delta Coal is proposing to extend CVC's mining operations in the Fassifern Seam into an area of the recently purchased Myuna lease holding. The proposed extension area, referred to as the Northern Mining Area, is located immediately to the north of the existing CVC consent boundary and forms part of the Myuna Colliery.

Mining generating less than 20 mm surface subsidence is approved within the Northern Mining Area in the Fassifern, Great Northern and Wallarah Seams under the Myuna Consent.

The proposed CVC Modification 4 (the Proposed Modification) seeks to extend the CVC consent boundary to incorporate the Northern Mining Area and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations. There are no other changes proposed, including no change to the mining method, approved subsidence impacts, production rate or surface facilities. Consistent with other overlapping mining areas under the CVC and Myuna Consents, no modification to the Myuna Consent in relation to the Northern Mining Area is proposed.

The Proposed Modification will allow for a reliable and cost-effective supply of coal for the Vales Point Power Station through the Delta Coal assets, with no increase in adverse environmental or social impacts beyond those approved through the CVC and Myuna Consents.

In addition to the proposed extension of the CVC Consent boundary, the Proposed Modification seeks to increase the number of employees under the CVC Consent. As the CVC and Mannering Colliery operations are adjacent to each other and increasingly being managed in an integrated manner, Delta Coal proposes a more centralised management of employees at CVC. To reflect this more integrated approach, Delta Coal proposes to increase the number of employees able to report to the CVC pit top by 110 to 330 full time equivalent employees.

This Statement of Environmental Effects (SEE) has been prepared to assess the environmental and social impacts of the Proposed Modification to the CVC Consent. This SEE will support a modification application under section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The SEE demonstrates that the Proposed Modification can be effectively managed to meet current approved environmental performance measures and without any change to existing approved impacts on the local environment or community.

Table of Contents

Executive Summary i

1.0 Introduction 1

1.1 Site Context 3

1.2 The Applicant 3

2.0 Overview of Existing Operations 5

2.1 Chain Valley Colliery 5

2.1.1 Current Approved Operations 5

2.1.2 Mining Methods 7

2.1.3 Mine Design 7

2.1.4 Coal Handling, Processing and Transportation 8

2.1.5 Site Infrastructure 8

2.1.6 Environmental Management of Existing Operations 9

2.2 Myuna Colliery 9

2.2.1 Mining Method 9

2.2.2 Site Infrastructure, Coal Handling, Processing and Transport 10

2.3 Mannering Colliery 10

3.0 Proposed Modification 12

3.1 Northern Mining Area 13

3.2 Employee Numbers 14

3.3 Need for the Modification 14

3.4 Alternatives 15

4.0 Stakeholder Engagement 17

4.1 Community Consultation 17

4.1.1 Aboriginal Community Consultation 18

4.2 Government Consultation 19

5.0 Planning Considerations 22

5.1 Commonwealth Legislation 22

5.1.1 Environment Protection and Biodiversity Conservation Act 1999 22

5.1.2 Native Title Act 1993 22

5.2 New South Wales Legislation 23

5.2.1 Environmental Planning and Assessment Act 1979 23

5.2.2 Environmental Planning Instruments 26

5.2.3 Approvals required under other State legislation 31

5.2.4 Relevant Strategic Policies 32

6.0 Environmental Assessment 33

6.1 Preliminary Environmental Risk Analysis 33

6.2 Subsidence 36

6.2.1 Existing Environment 36

6.2.2 Existing Subsidence Criteria 38

6.2.3 Proposed Subsidence Criteria – Northern Mining Area 40

6.2.4 Pillar Design Considerations 40

6.2.5 Subsidence Performance and Management 40

6.3 Groundwater 41

6.3.1 Existing hydrogeology and groundwater environment 42

6.3.2 Groundwater modelling 43

6.3.3 Modelling Results 44

6.3.4 Impact assessment 44

6.3.5 Mitigation, monitoring and management 45

6.4 Traffic and Transport 46

6.4.1 Assessment Methodology 47

6.4.2 Predicted Traffic Impacts 49

6.5 Greenhouse Gas Emissions 49

6.5.1 Impact Assessment 49

6.6 Social 50

6.6.1 Existing Social Impacts 51

6.6.2 Existing Social Management and Mitigation Measures 53

6.6.3 Proposed Modification Community Engagement 54

6.6.4 Proposed Modification Social Impacts 54

6.6.5 Proposed Modification Mitigation and Management Measures 54

7.0 Environmental and Social Mitigation and Management Measures 55

8.0 Justification and Conclusion 56

8.1 Environmental Impacts 56

8.2 Ecologically Sustainable Development 56

8.2.1 The Precautionary Principle 57

8.2.2 Intergenerational Equity 57

8.2.3 Conservation and Biological Diversity 58

8.2.4 Valuation of Pricing Resources 58

8.3 Conclusion 59

9.0 References 60

Figures

Figure 1.1	Locality and Site Context	2
Figure 1.2	Existing Operations	4
Figure 2.1	CVC Mining Leases	6
Figure 2.2	Myuna Colliery Subsidence Zones	11
Figure 3.1	Existing and Future Mine Workings	16
Figure 5.1	Zoning Map	25
Figure 6.1	Northern Mining Area	37

Tables

Table 2.1	CVC Consent Modifications	5
Table 3.1	Comparison of the CVC Consent with the Proposed Modification	12
Table 4.1	Community Consultation	17
Table 4.2	Community Consultation Matters Raised	18
Table 4.3	Aboriginal Community Consultation	18
Table 4.4	Aboriginal Community Consultation Matters Raised	19
Table 4.5	Government Consultation	19
Table 5.1	Section 4.15 Matters for Consideration	26
Table 5.2	Non-discretionary development standards for mining under the Mining SEPP	27
Table 5.3	Development applications – matters for consideration	28
Table 5.4	Environmental Approvals Required for the Proposed Modification	31
Table 6.1	Preliminary Environmental Risk Analysis	33
Table 6.2	Myuna Subsidence Impact Performance Measures	38
Table 6.3	CVC Subsidence Impact Performance Measures	39
Table 6.4	Current Shift Data	46
Table 6.5	Intersection Level of Service Criteria	48
Table 6.6	Summary of the Proposed Modification's greenhouse gas emissions	50
Table 6.7	Matters Raised by Community and Interest Groups	52

Appendices

Appendix 1	Schedule of Lands
Appendix 2	Agency Correspondence
Appendix 3	Subsidence Report
Appendix 4	Groundwater Assessment
Appendix 5	Traffic Assessment
Appendix 6	Greenhouse Gas and Energy Assessment

1.0 Introduction

Chain Valley Colliery (CVC) is an underground coal mine located on the southern shore of Lake Macquarie, approximately 60 kilometres (km) south of Newcastle, NSW (refer to **Figure 1.1**). Great Southern Energy Pty Ltd (trading as Delta Coal) owns and operates CVC. Mining has been undertaken at CVC since 1962 using a combination of bord and pillar and miniwall mining methods. Coal extraction has occurred from three seams, the Wallarah, Great Northern and Fassifern seams, with current mining activities occurring within the Fassifern Seam.

CVC operates under State significant development (SSD) consent SSD 5465 (CVC Consent), originally granted in 2013. The CVC Consent has been modified on three occasions, most recently in June 2020.

In early 2019, Delta Coal acquired Lake Coal's CVC assets which included the adjacent Mannering Colliery Pit Top, as well as coal lease areas to the north of the CVC Consent boundary that were previously held by Centennial Myuna Pty Ltd (CMPL). These coal leases form part of the Myuna Colliery, which is subject to project approval (PA) 10_0080 (Myuna Consent).

Sunset Power International Pty Ltd, trading as Delta Electricity, owns and operates the Vales Point Power Station (VPPS) located adjacent to CVC at Mannering Park. VPPS is a coal-fired power station which has historically been supplied with coal from CVC and Mannering Colliery as well as from mines in the local area and other NSW coalfields (refer to **Figure 1.1**).

Great Southern Energy Pty Ltd is seeking to maximise the use of the Delta Coal assets to provide a reliable and cost-effective supply of coal to the VPPS. To facilitate this, Delta Coal is proposing a modification to the CVC Consent to extend CVC's mining operations in the Fassifern Seam into additional lease holding areas acquired from Myuna Colliery. The proposed extension area, referred to as the Northern Mining Area (refer to **Figure 1.1**), is located immediately to the north of the existing CVC consent boundary and overlaps the Myuna Consent boundary.

Mining generating less than 20 millimetres (mm) surface subsidence is approved within the Northern Mining Area in the Fassifern, Great Northern and Wallarah seams under the Myuna Consent. While the Myuna Consent permits mining within the Northern Mining Area, neither the CVC Consent or Myuna Consent authorise the transfer of coal from the Northern Mining Area to the surface via the CVC underground workings.

The proposed CVC Modification 4 (the Proposed Modification) seeks to extend the CVC consent boundary to incorporate the Northern Mining Area and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations. The Proposed Modification also seeks to increase the number of employees reporting to the CVC pit top by 110 full time equivalent (FTE) employees to 330 FTE employees, to reflect the increasingly integrated management of Delta Coal employees between CVC and Mannering Colliery. There are no other changes proposed, including no change to the mining method, approved subsidence impacts, production rate or surface facilities. Consistent with other overlapping mining areas under the CVC and Myuna Consents, no modification to the Myuna Consent in relation to the Northern Mining Area is proposed.

This Statement of Environmental Effects (SEE) has been prepared by Umwelt (Australia) Pty Limited (Umwelt) to assess the environmental and social impacts of the Proposed Modification to the CVC Consent. This SEE will support a modification application under section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area
- Nature Reserve
- State Conservation Area

FIGURE 1.1

Locality and Site Context

Image Source: Nearmap (May 2019) Data source: Delta Coal

1.1 Site Context

The local area has a long history of coal mining which has been historically linked to the several power stations located in the Lake Macquarie/Central Coast area. The area within and surrounding the CVC Consent area has been subject to extensive historical underground mining (refer to **Figure 1.2**).

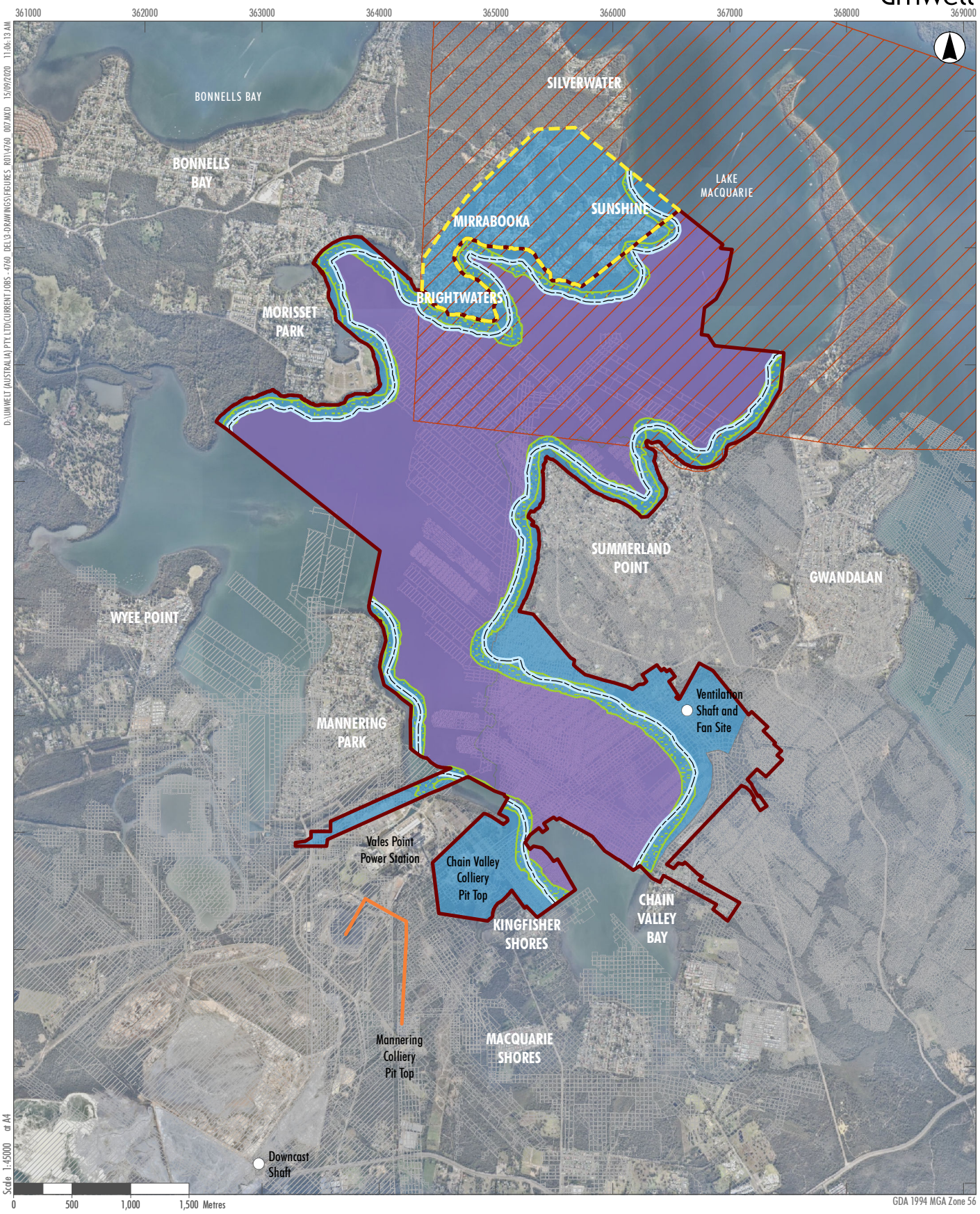
The CVC Pit Top is located on the southern shore of Lake Macquarie, west of Chain Valley Bay. Land surrounding the Pit Top primarily supports industrial uses and fragmented areas of vegetation (refer to **Figure 1.2**). Vales Point Power Station (VPPS) is located immediately to the north west of the CVC Pit Top, and Mannering Colliery Pit Top is located approximately 1.1 km to the south west.

The CVC Pit Top is accessed via Ruttleys Road and Construction Road, a private road which services CVC and VPPS. The current CVC Consent area is approximately 1,425 hectares (ha) which primarily covers the waters of southern Lake Macquarie, extending from Chain Valley Bay in the south to Sunshine in the north. The CVC Consent area straddles the boundary of Lake Macquarie and Central Coast local government areas (LGAs), with the CVC Pit Top located within the Central Coast LGA.

Surrounding residential areas include Kingfisher Shores, Macquarie Shores home village and Chain Valley Bay to the south-east, Mannering Park to the north-west and Summerland Point and Gwandalan to the north-east. CVC's ventilation fan site is located at Summerland Point, north-east of the CVC Pit Top area across Chain Valley Bay (refer to **Figure 1.2**).

1.2 The Applicant

The applicant for the Proposed Modification is Great Southern Energy Pty Limited, trading as Delta Coal, is an 100% Australian-owned company. Delta Coal owns and operates both the CVC and the adjacent Mannering Colliery.



Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area
- Seagrass Protection Barrier
- High Water Mark Subsidence Barrier
- Zone A - Long term stable mining systems generating up to 20 mm surface subsidence
- Zone B - Mining systems generating up to a maximum of 780 mm vertical susbsidence
- Myuna Colliery Consent Area
- Existing Workings (Excluding Myuna Workings)
- VPPS Overland Conveyor

Image Source: Nearmap (May 2019) Data source: Delta Coal

FIGURE 1.2

Existing Operations

2.0 Overview of Existing Operations

2.1 Chain Valley Colliery

Underground mining has occurred at CVC since 1962 using a combination of bord and pillar and miniwall mining methods (EMM, 2013). Up until 2011 secondary extraction was undertaken using pillar extraction methods, whereas since 2011 secondary extraction at CVC has employed the miniwall mining method.

Historic workings are located under the southern extent of Lake Macquarie and areas of Summerland Point, Chain Valley Bay, Mannering Park and Kingfisher Shores (refer to **Figure 1.2**). Areas of these historic workings are used for passive operational activities, such as: ventilation; water pumping and drainage; movement of personnel, materials and coal; conveyors; and services.

Mining at CVC currently takes place within consolidated coal lease (CCL) 707 and mining leases (MLs) 1051, 1052, 1370 and 1632, administered under the *Mining Act 1992* (Mining Act). A lease plan is provided as **Figure 2.1**.

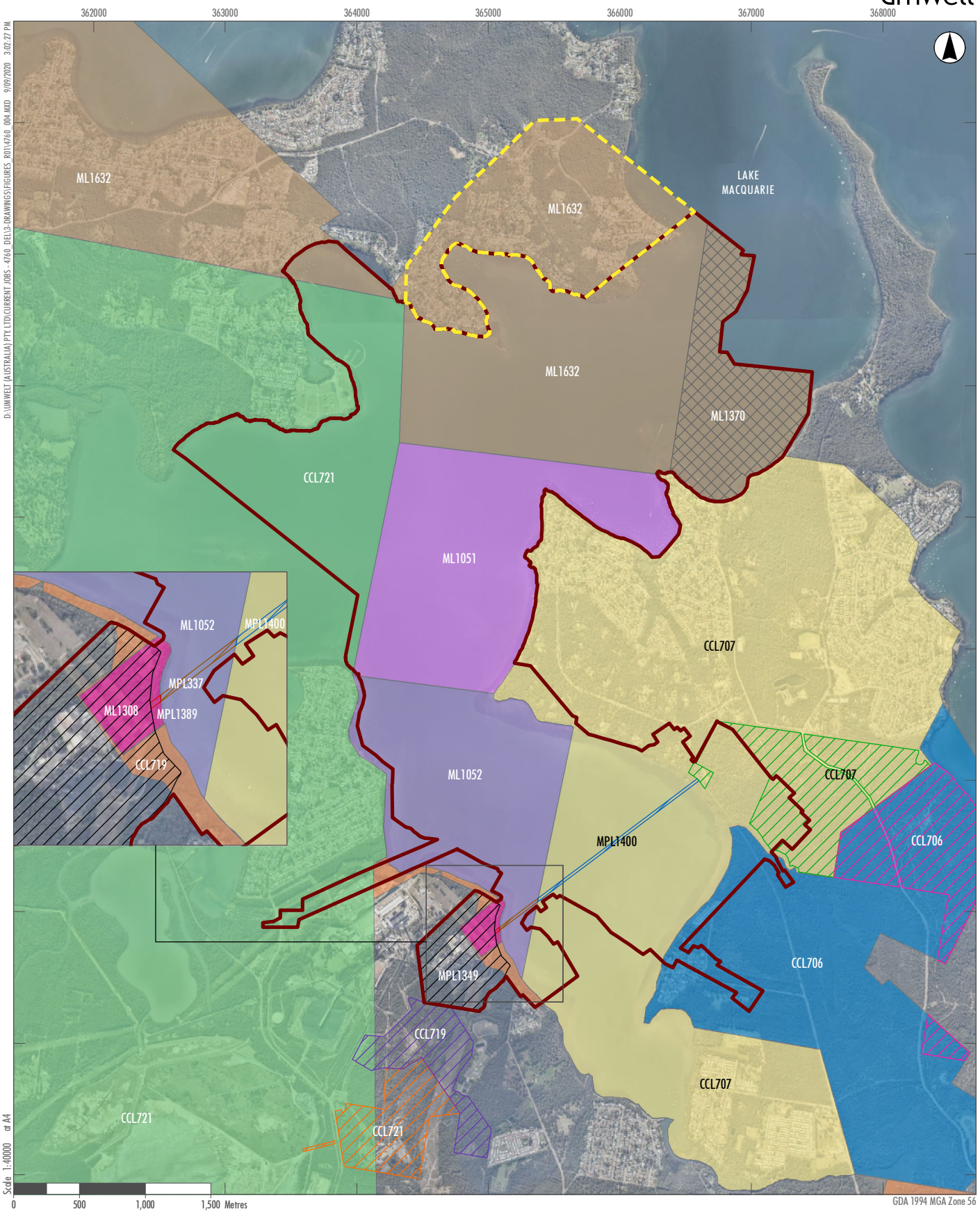
2.1.1 Current Approved Operations

The CVC Consent was granted on 23 December 2013 and has since been modified three times. The most recent modification (Modification 3) included the increased transport of CVC coal via the Mannering Colliery Pit Top (from 1.3 to 2.1 Million tonnes per annum (Mtpa)) and the ability to use alternative mining methods within approved levels of subsidence.

A summary of the CVC Consent modifications is provided in **Table 2.1**.

Table 2.1 CVC Consent Modifications

Modification Number	Description	Approval Date
Modification 1	Construction of an underground linkage between CVC and Mannering Colliery within the Fassifern Seam workings.	27 November 2014
Modification 2	Increase coal production from 1.5 to 2.1 Mtpa and reorient miniwall panels in the northern mining area.	16 December 2015
Modification 3	Increase transport of coal from CVC to Mannering Colliery via the existing underground linkage from 1.3 to 2.1 Mtpa and allow flexibility to use either miniwall or bord and pillar mining methods throughout the approved mining area.	26 June 2020



Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area

Lease

- CCL706, Underground
- CCL707, Underground
- CCL719, Underground
- CCL721, Underground
- ML1051, Lease
- ML1052, Lease
- ML1308, Lease
- ML1632, Lease
- CCL706, Surface Lease
- CCL707, Surface Lease
- CCL719, Surface Lease
- CCL721, Surface Lease
- ML1370, Lease
- MPL1349, Surface Lease
- MPL1389, Surface Lease
- MPL1400, Surface Lease
- MPL337, Surface Lease

FIGURE 2.1

CVC Mining Leases

Image Source: Nearmap (May 2019) Data source: Delta Coal

The CVC Consent, as modified, currently allows for:

- extraction of up to 2.1 Mtpa run of mine (ROM) coal
- transportation of up to 660,000 tpa of coal for export and up to 180,000 tpa of coal for domestic customers via public roads
- transfer of up to 2.1 Mtpa ROM Coal to the Mannering Colliery Pit Top via the approved underground linkage between CVC and Mannering Colliery
- transport of coal to VPPS via private road
- first and second workings using continuous miner and miniwall mining methods
- mining operations up to 31 December 2027.

2.1.2 Mining Methods

Historically, mining methods at CVC have included both bord and pillar and miniwall mining. Miniwall mining has been the preferred method of extraction since it commenced at CVC in 2011 and the approved mining layout plans under the CVC Consent have previously focussed on a miniwall layout. The recently approved CVC Modification 3 provides for greater flexibility to use either miniwall or bord and pillar mining methods throughout the approved mining area within approved levels of subsidence.

Two 'subsidence management zones' (refer to **Figure 1.2**) have been identified within the approved mining area based on current approved subsidence levels and performance measures. The 'subsidence management zone' approach provides greater flexibility in mining methods at CVC, and in particular, provides for broader use of first workings bord and pillar mining methods.

The three subsidence zones are:

- Zone A: Long-term stable mining systems generating up to 20 mm surface subsidence
- Zone B: mining systems generating up to a maximum of 780 mm of vertical subsidence.

2.1.3 Mine Design

The approved mine design process at CVC uses an adaptive management approach where appropriate mining methods are identified for an area based on geological and surface features, as well as geotechnical conditions and environmental performance measures. This approach involves the monitoring, periodic evaluation and remediation of the consequences of mining, with possible adjustment of the mining layout and/or methods to achieve the required measures of performance.

The CVC mine design is based on a number of key subsidence and environmental performance measures specified in Conditions 1 and 2 of Schedule 4 of the CVC Consent, which have been specifically designed to ensure protection of:

- the Lake Macquarie foreshore – by the use of a high water mark subsidence barrier (HWMSB), consistent with the requirements of the relevant mining leases (refer to **Figure 1.2**)
- seagrass communities – by the use of a seagrass protection barrier (SPB) consistent with Figure 1 in Appendix 3 of the CVC Consent
- land based infrastructure – through the adoption of the HWSMB and SPBs and confining secondary extraction to areas underlying Lake Macquarie.

Vertical subsidence within the HWMSB and SPB is limited to a maximum of 20 mm. This magnitude of subsidence is considered negligible and imperceptible for all practical purposes. In order to achieve this, first workings only are approved within the HWMSB and SPB.

2.1.4 Coal Handling, Processing and Transportation

CVC produces a raw crushed thermal coal with relatively low sulphur which is suitable for both export and domestic markets. CVC has approval to transfer up to 1.5 Mtpa ROM to the surface at CVC Pit Top and 2.1 Mtpa to the Mannering Colliery Pit Top via an existing underground linkage in the Fassifern Seam between CVC and Mannering Colliery.

The underground linkage between CVC and Mannering Colliery is permitted under the CVC Consent and Mannering Colliery Consent and enables ROM coal from CVC's operations to be handled at the Mannering Colliery Pit Top and transferred to VPPS via overland conveyors. This linkage is currently used preferentially in place of transport via private haul road. The CVC Consent, as modified, allows for the transfer of all of its approved production at a rate of up to 2.1 Mtpa to the surface via the approved underground linkage to Mannering Colliery (refer to **Figure 1.2**). While transfer to the surface at CVC and road haulage from CVC is approved under the CVC Consent, the coal handling infrastructure at CVC is not presently operable and significant upgrade works are required to give effect to this aspect of approved operations.

Raw coal is crushed underground following extraction from the seam and then transported to the surface on conveyor. Once on the surface, it undergoes a screening and secondary sizing process. The extracted coal does not require washing or additional treatment. As a result, ROM coal production equates to product coal production from CVC.

As there is no beneficiation of coal product at CVC, there is no coal reject material which requires management or disposal.

CVC is currently approved to transport coal by road (subject to restrictions on both the hours and frequency of dispatch for coal laden trucks):

- a maximum of 660,000 tonnes per annum (tpa) of product coal on public roads to the Port of Newcastle for export
- a maximum of 180,000 tpa of product on public roads to domestic customers other than VPPS
- product coal to VPPS via trucks on private roads only.

2.1.5 Site Infrastructure

The surface infrastructure supporting CVC is located at the pit top area and at Summerland Point (refer to **Figure 1.2**). The infrastructure at the pit top includes:

- main administration offices
- a surface electrical sub-station, cable belt switch room and electrical haulage rooms
- bathhouses
- workshop
- storage sheds
- 80,000 and 132,000 litre water tanks

- settling and diffusing ponds
- coal bins
- coal stockpile area
- downcast ventilation shaft
- various other items such as compressors, a weighbridge, water storage and a diesel storage tank.

At Summerland Point, site infrastructure comprises an upcast ventilation shaft and fans within a fenced compound, an overhead and underground power supply, and an unsealed access road.

2.1.6 Environmental Management of Existing Operations

The environmental management of existing operations at CVC is undertaken within the framework of Delta Coal's Environmental Management System and supporting management plans, the CVC Consent and associated Statement of Commitments, Environment Protection Licence (EPL) 1770, the combined CVC and Mannering Colliery Mining Operations Plan (MOP), approved extraction plans and associated management plans.

2.2 Myuna Colliery

As discussed in **Section 1.0**, Delta Coal has acquired coal lease areas to the north of the CVC Consent boundary that were previously held by CMPL and form part of Myuna Colliery.

Lake Macquarie City Council (LMCC) granted Development Consent SH110_148 for the development and operation of the Myuna and Cooranbong Collieries in 1977. The Development Consent remains in force and authorises the extraction of coal within the Development Consent Mining Area as shown on **Figure 1.2**.

The development of Myuna Colliery commenced in 1979 and underground mining using bord and pillar mining methods commenced in 1982. In 2002, CMPL acquired Myuna Colliery and has operated it since this time.

On 18 January 2012, the Myuna Consent was granted. The Myuna Consent authorises the continued mining in areas outside Development Consent SH110_148 mining area and within the boundary of existing mining leases held by CMPL, with part now held by Delta Coal in respect to the Northern Mining Area. The Myuna Consent authorises the use of bord and pillar methods in the Wallarah, Great Northern and Fassifern coal seams and the continued use of ancillary infrastructure, for a further 21 years until 2033. The Myuna Consent boundary is shown on **Figure 1.2**.

Myuna Colliery has approval to extract up to 2 Mtpa of ROM coal and operates 24 hour per day, 7 days per week.

Myuna Colliery currently operates under ML 1370, CCL 762, and MPL 334 issued under the Mining Act.

2.2.1 Mining Method

The method of mining used at Myuna Colliery is underground bord and pillar mining. The mining system includes:

- multiple seam mining – first workings or non-caving partial pillar extraction systems where multiple seams are to be mined
- single seam mining – first workings, partial pillar extraction or wide panel full extraction.

Two subsidence zones have been established at the Myuna Colliery, being:

- Zone A – long term stable mining systems generating up to 20 mm surface subsidence (i.e. no noticeable surface impacts) on sensitive surface features including land and seagrass beds
- Zone B – mining systems generating up to a maximum of 650 mm surface subsidence (under Lake Macquarie).

The Myuna Colliery subsidence zones are shown on **Figure 2.2**. The Northern Mining Area is primarily within the Zone A subsidence zone.

2.2.2 Site Infrastructure, Coal Handling, Processing and Transport

The Myuna Colliery surface site is located on Wangi Point Road, near the township of Wangi Wangi. ROM coal produced at Myuna Colliery is transferred from the underground workings to the surface coal handling plant (CHP) via a number of underground conveyors. From the final product bin, coal is transferred to the Eraring Power Station.

2.3 Mannering Colliery

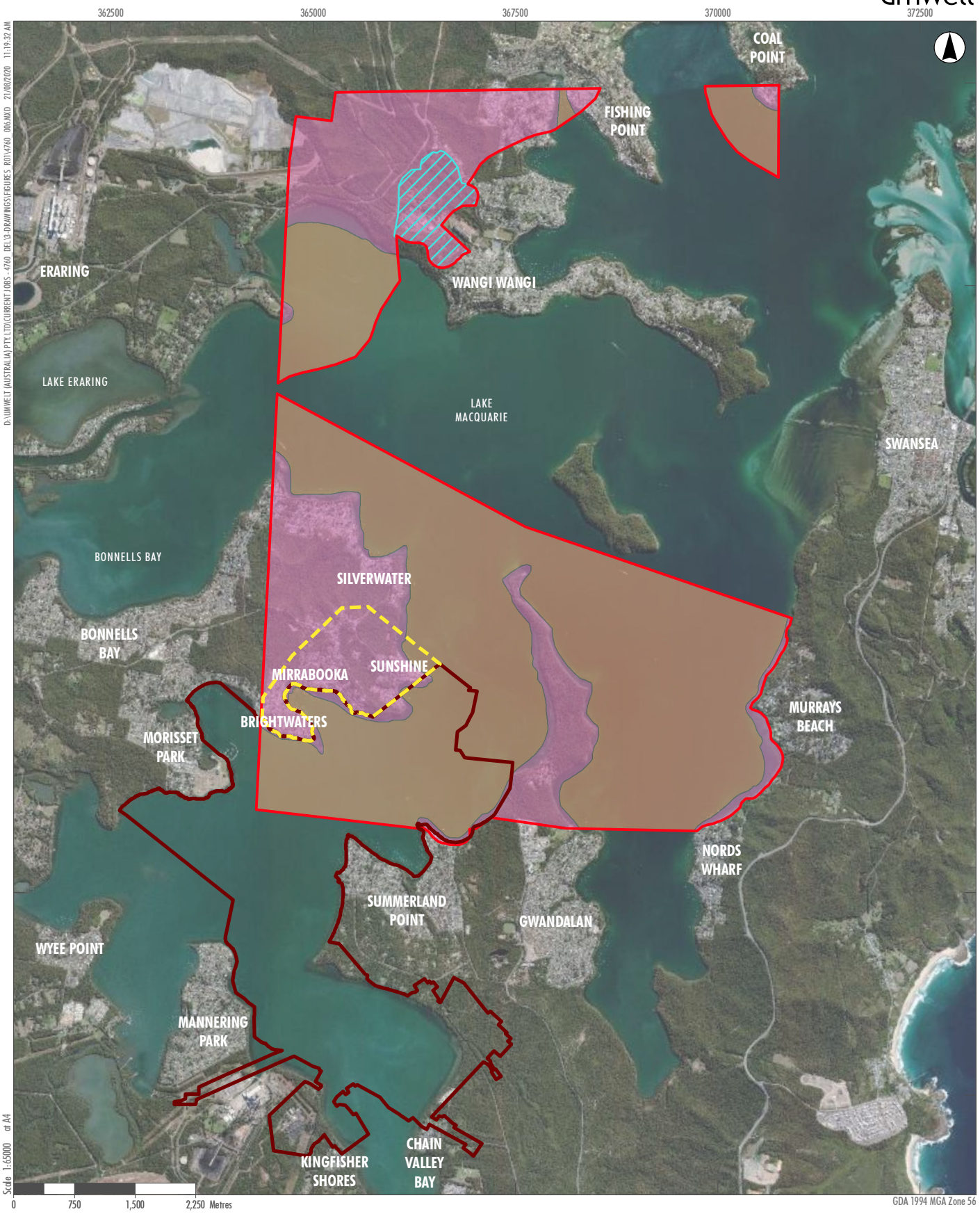
Delta Coal took over as the operator of Mannering Colliery on 1 April 2019. The Mannering Colliery Pit Top is located approximately 1.1 km south west of the CVC Pit Top and all coal handled at Mannering Colliery is transported via overland conveyor to VPPS.

Mannering Colliery operates pursuant to Project Approval 06_0311 (Mannering Consent). The Mannering Consent authorises the transport of coal from the CVC underground working via an underground linkage between the two operations from where it is transferred to VPPS via overland conveyor.

Total ROM coal extraction from Mannering Colliery's underground workings is limited to 1.1 Mtpa, but this does not apply to the ROM coal extraction tonnages from CVC.

Operations are currently approved at Mannering Colliery to 31 December 2027.

The Mannering Consent allows for the transfer of coal from CVC and pit top handling of no more than 2.1 Mtpa of ROM coal from the site.



Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area
- Myuna Colliery Consent Area
- Myuna Colliery Surface Facilities

Myuna Colliery Subsidence Zones

- Zone A
- Zone B

FIGURE 2.2

Myuna Colliery Subsidence Zones

Image Source: ESRI Basemap Data source: Delta Coal

3.0 Proposed Modification

As discussed in **Section 1.0**, the Proposed Modification seeks to extend the CVC Consent boundary to incorporate the Northern Mining Area and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations (refer to **Section 3.1**).

The Proposed Modification also seeks to increase the number of employees reporting to the CVC pit top by 110 FTE employees (from approximately 220 to approximately 330 FTE employees, to reflect the increasingly integrated management of Delta Coal employees between CVC and Mannering Colliery (refer to **Section 3.2**).

There are no other changes proposed, including no change to the mining method, approved subsidence impacts, production rate, coal handling rates, coal transport or surface facilities. Consistent with other overlapping mining areas under the CVC and Myuna Consents, no modification to the Myuna Consent in relation to the Northern Mining Area is proposed.

Table 3.1 provides a comparison between the approved CVC operations, as modified, and the Proposed Modification operations.

Table 3.1 Comparison of the CVC Consent with the Proposed Modification

Key Project Component	Approved Operations	Proposed Modification
Life of Mine	Approved operations to 31 December 2027	No change
ROM Coal Extraction	Up to 2.1 Mtpa of ROM coal	No change
Mining methods	Underground mining undertaken using continuous miner (bord and pillar and pillar extraction) and miniwall mining methods	No change
Development Area	As shown in CVC consent SSD 5465 Modification 3 Appendix 2 - Development Area	Development consent boundary and Schedule of Lands amended to incorporate the Northern Mining Area (refer to **Figure 3.1** and **Appendix 1**)
Underground Mining Areas	As shown in CVC Consent Appendix 3 – Development Layout Figure	To incorporate approved mining in the Northern Mining Area (refer to **Figure 3.1**)
Surface Infrastructure	Utilisation of existing surface infrastructure, including but not limited to: • personnel-and-material drifts, ROM coal conveyor drift • upcast and downcast ventilation shaft and fans • coal handling facilities for breaking, crushing, sizing and storing product coal • administration and workshop facilities • water management infrastructure • Asset Protection Zones (APZs) around some items of surface infrastructure	No change

Key Project Component	Approved Operations	Proposed Modification
Coal Processing	Screening and crushing of ROM coal at CVC	No change
Coal Transport	CVC is approved to transport: • a maximum of 660,000 tpa of product coal on public roads to PWCS for export • a maximum of 180,000 tpa of product coal on public roads to domestic customers (other than VPPS) • product coal to VPPS via truck on private roads only • up to 2.1 Mtpa to MC (MP06_0311) via the underground linkage for subsequent delivery to VPPS Note: restrictions on both the hours and frequency of dispatch for coal laden trucks also apply.	No change
Coal reject management	No coal rejects are generated	No change
Hours of operation	Mining operations are approved 24 hours per day, 7 days a week	No change
Mine access	Existing road access from Construction Road, off Ruttleys Road	No change
Performance Measures – Natural Environment and Built Features	Maximum of 20 mm subsidence within the HWMSB and within seagrass beds Performance measures as set out in Condition 2 and 4 of schedule 4 of SSD-5465	No change
Rehabilitation	Decommissioning of surface facilities and final rehabilitation following mine closure	No change
Employee Numbers	Employment of approximately 220 FTE personnel in total (including approximately 40 FTE contractors)	An increase to approximately 330 FTE personnel

3.1 Northern Mining Area

Delta Coal is seeking to modify the CVC Consent to extend CVC's mining operations into an area of the Fassifern Seam that currently forms part of Myuna Colliery. The proposed extension area is located immediately to the north of the CVC Consent boundary and is referred to as the Northern Mining Area (refer to **Figure 3.1**).

Delta Coal has recently acquired parts of the Myuna lease holdings which are currently approved to be mined under the Myuna Consent. This includes the Northern Mining Area, where mining generating less than 20 mm surface subsidence is approved in the Fassifern, Great Northern and Wallarah Seams under the Myuna Consent. Coal mined from the Northern Mining Area is currently transferred to the surface at the Myuna Surface Facilities under the Myuna Consent.

Delta Coal is seeking approval to access the Northern Mining Area from the CVC underground workings rather than from Myuna Colliery, and to transfer coal mined from the Northern Mining Area to the surface via the CVC underground workings. The Proposed Modification would allow for mains development from the existing CVC underground workings to progress into the Northern Mining Area to access the approved coal reserves.

Consistent with other overlapping mining areas under the CVC Consent and Myuna Consent, no modification to the Myuna Consent in relation to the Northern Mining Area is proposed.

Accessing the Northern Mining Area from the CVC underground workings would allow coal from the Northern Mining Area to be transferred via underground roadways to the surface at the existing approved Mannering Colliery or CVC surface facilities rather than at the Myuna Colliery surface facilities. There will not be any increase in the amount of coal received or processed at Mannering Colliery or CVC as a result of the Proposed Modification.

3.2 Employee Numbers

CVC currently has approval for approximately 220 FTE employees and Mannering Colliery (also managed by Delta Coal) has approval for approximately 170 FTE employees. As the CVC and Mannering Colliery operations are adjacent to each other and connected underground Delta Coal proposes a more centralised management of employees at the CVC Pit Top. To reflect this more integrated approach, Delta Coal propose to increase the number of employees able to report to the CVC Pit Top under the CVC Consent by 110 FTE employees to approximately 330 FTE employees. The change to employee numbers would not result in an overall increase from the two operations, rather the 110 FTE employees would report to CVC rather than Mannering Colliery. The increased employee numbers would be split over the existing shifts.

The Mannering Colliery and CVC Pit Top facilities are located approximately 1 km from each other and are both accessed off Ruttleys Road, Mannering Park. The relevant access points off Ruttleys Road are approximately 500 metres (m) apart. No residences are located on this 500 m section of Ruttleys Road. The change to traffic movements, including intersection performance has been assessed in **Section 6.4.** The minor change in employee location will not affect performance of the broader road network and would not result in any change to traffic and noise impacts at existing neighbours.

As outlined in **Section 2.1.5**, the CVC Pit Top facility has existing employee amenities including two bathhouses and adequate car parking facilities. Minor additions or amendments to these facilities are being undertaken to cater for the additional employees reporting to the CVC Pit Top which are not subject to the Proposed Modification. In addition, Delta Coal submitted a development application with Central Coast Council in August 2020 to progress the installation of a rising main which will transfer sewage from the CVC Pit Top facility to a new connection point with Central Coast Council's sewerage system on Tall Timbers Road, Kingfisher Shores, in accordance with their EPL. At the time of preparation of this SEE the development application had not been determined.

3.3 Need for the Modification

The primary objective for Delta Coal in undertaking the Proposed Modification is to obtain a reliable and cost-effective supply of coal for the VPPS through the Delta Coal assets. VPPS requires approximately 3 Mtpa supply of ROM coal for at least 10 years. Ideally, VPPS would obtain its total supply requirements from CVC and Mannering Colliery, however the ability to source coal from other additional sources is required to manage supply risks in the event that demands are not able to be fully met through CVC and Mannering Colliery.

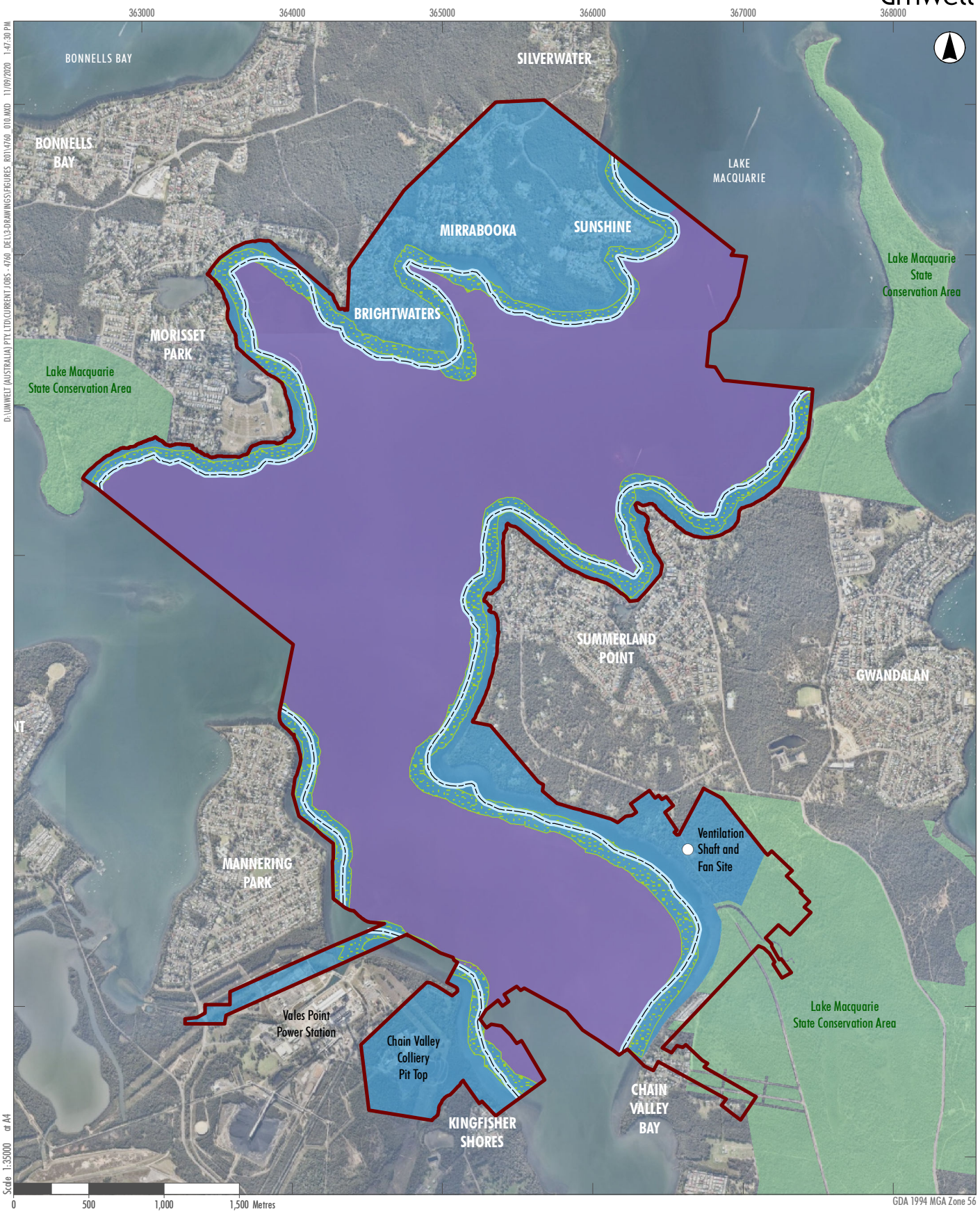
Continuity of supply is a key requirement for VPPS and measures that reduce supply risk are a key factor in achieving this objective. Minimising production costs (through both low operational and capital expenditure) is also a key objective for VPPS to maintain competitiveness.

3.4 Alternatives

The main alternative to the Proposed Modification would be to 'do nothing'. As discussed in **Section 3.0**, mining within the Northern Mining Area is currently approved under the Myuna Consent. Mining within the Northern Mining Area may progress, as approved, regardless of whether the Proposed Modification proceeds or not.

Due to considerable efficiencies that can be gained by transporting coal from the Northern Mining Area to VPPS via the CVC underground workings, and as these efficiencies can be achieved without any substantive changes to existing approved environmental and social impacts of existing operations, the Proposed Modification is preferred over the 'do nothing' option.

Alternative mine plans and alternative mining methods have not been considered for the Proposed Modification. Delta Coal is committed to undertaking mining within the Northern Mining Area in a manner that does not exceed the impacts approved as part of the Myuna Consent.



Legend

- Chain Valley Colliery Development Consent Boundary
- Seagrass Protection Barrier
- High Water Mark Subsidence Barrier
- Zone A - Long term stable mining systems generating up to 20 mm surface subsidence
- Zone B - Mining systems generating up to a maximum of 780 mm vertical susbsidence
- State Conservation Area

FIGURE 3.1

Chain Valley Colliery Modification 4

Image Source: Nearmap (May 2019) Data source: Delta Coal

4.0 Stakeholder Engagement

4.1 Community Consultation

Delta Coal is committed to supporting and making a difference in the local community which includes the localities of Doyalson, Wyee Point, Wyee, Chain Valley Bay, Mannering Park, Gwandalan, Summerland Point and surrounds. The Proposed Modification will expand CVC's underground operations into the communities of Brightwaters, Mirrabooka and Sunshine. Delta Coal has expanded its engagement programs to include these areas.

Delta Coal engages with the local community through the combined CVC and Mannering Colliery Community Consultative Committee (CCC). The CCC is made up of an independent chairperson and representatives from local communities, community groups, LMCC, CC Council and mine representatives. Delta Coal holds quarterly meetings with the CCC to provide the members with regular updates on operations and to gain an understanding of community views and concerns. Delta Coal extended an invitation for membership on the CCC to residents from the Brightwaters, Mirrabooka, Silverwater and Sunshine areas as a result of the Proposed Modification. A candidate was selected and endorsed by the Department of Planning, Industry and Environment (DPIE) in April 2020. This member has attended the subsequent three quarterly combined CCC meetings.

The stakeholder engagement program for the Proposed Modification utilised the existing consultation mechanisms in addition to specific activities focused on the Proposed Modification, as outlined in **Table 4.1**.

Table 4.1 Community Consultation

Activity	Date	Details
CCC briefing	May 2019	Initial briefing on the Proposed Modification
	August 2019	Update on the Proposed Modification
	November 2019	Update on the Proposed Modification
	February 2020	Update on the Proposed Modification
	May 2020	Update on the Proposed Modification, new member attended from Morisset Peninsula
	August 2020	Update on the Proposed Modification, new member attended from Morisset Peninsula
	October 2020	Provision of draft SEE to CCC Independent Chair and CCC Members
	November 2020	Update on the Proposed Modification, new member attended from Morisset Peninsula
Newsletter	February 2020	Information about the Proposed Modification and an invitation to the community information and feedback session was distributed in a newsletter to residents of Brightwaters, Mirrabooka, Sunshine and Silverwater
	September 2020	Information update about the Proposed Modification was distributed in a newsletter to residents of Brightwaters, Mirrabooka, Sunshine and Silverwater

Activity	Date	Details
Community information and feedback session	5 March 2020	A community information session was held at the Bonnells Bay Youth and Community Centre to inform the local community of the Proposed Modification and provide the community with an opportunity to ask questions of Delta Coal representatives. The community information session was advertised in the Delta Coal Newsletter which was posted to the surrounding suburbs of Brightwaters, Mirrabooka, Sunshine and Silverwater and in the local newspaper. Five community members attended the community information session.

The matters raised from the community consultation undertaken in relation to the Proposed Modification are detailed in **Table 4.2**.

Table 4.2 Community Consultation Matters Raised

Theme	Matter Raised
Proposed Modification	• Mine design and mining method • Project timeframe • Mining under existing residential areas
Subsidence	• Extent of subsidence and impact on built features • Property damage from subsidence • Methods of compensation and claims • History of adjacent mine locations
Community	• Addition of new CCC member from Northern Mining Area and invitation
Employment	• Interest in employment opportunities

4.1.1 Aboriginal Community Consultation

As there is no surface disturbance associated with the Proposed Modification, there is no potential to adversely impact on any item or feature of Aboriginal heritage or historically significant heritage that may be present. Notwithstanding, Delta Coal has consulted with the local Aboriginal community in relation to the Proposed Modification, as outlined in **Table 4.3**.

Table 4.3 Aboriginal Community Consultation

Activity	Date	Details
Briefing meeting with Darkinjung Local Aboriginal Land Council	August 2020	Briefing on the Proposed Modification, possible confidential sites, 20mm subsidence limits and combination of Delta Coal Heritage Management Plans. Briefing meeting extended to all registered aboriginal parties (RAPs) as identified in April 2020 Biodiversity Conservation Division (BCD) letter.
Briefing meeting with Biraban Local Aboriginal Land Council and Wonnarua representative	September 2020	Briefing on the Proposed Modification, possible confidential sites, 20 mm subsidence limits and combination of Delta Coal Heritage Management Plans
Consultation on draft SEE	November 2020	Provision of draft SEE to RAPs

The matters raised from the Aboriginal community consultation undertaken in relation to the Proposed Modification are detailed in **Table 4.4**.

Table 4.4 Aboriginal Community Consultation Matters Raised

Theme	Matter Raised
Proposed Modification	• Mining under archaeological sites • Locations of sites • Mine design and mining method
Subsidence	• Extent of subsidence and impact on archaeological sites • Impacts on groundwater aquifers • Impacts on lake biodiversity
Communications	• Further communications as the project progresses

4.2 Government Consultation

Delta Coal has consulted with a range of government agencies in relation to the Proposed Modification as detailed in **Table 4.5**.

Table 4.5 Government Consultation

Agency	Date	Activity	Details
DPIE	23 July 2019	Letter from Delta Coal to DPIE	Initial letter describing Proposed Modification and requesting confirmation of approval pathway and environmental assessment requirements
	31 July 2019	Letter from DPIE to Delta Coal	Confirmation of approval pathway under section 4.55(2) of the EP&A Act and environmental assessment requirements
	28 October 2019	Letter from Umwelt on behalf of Delta Coal to DPIE	Request for confirmation on approach to social impact assessment
	31 October 2019	Email from DPIE to Umwelt and Delta Coal	Confirmation of approach to social impact assessment
	14 October 2020	Meeting	Pre-scoping meeting
	14 October 2020	Email to DPIE	Submission of Draft SEE
	19 October 2020	Email from DPIE	Initial comments from DPIE
	9 November 2020	Letter from DPIE	Preparation of a Modification Application
Central Coast Council	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
	8 October 2020	Provision of draft SEE	Provision of draft SEE

Agency	Date	Activity	Details
Lake Macquarie City Council	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
	8 October 2020	Provision of draft SEE	Provision of draft SEE for review and comments
	14 October 2020	Email from LMCC	Confirmation of receipt and consultation
NSW Environment Protection Authority (EPA)	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
DPIE – Resources Regulator	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
	3 June 2020	Presentation	Presentation to the Resource Regulator on the Proposed Modification
	8 October 2020	Provision of draft SEE	Provision of draft SEE for review and comments
NSW National Park and Wildlife Service (NPWS)	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process.
	March 2020	Phone call	Consultation with the NPWS Team Leader on land owners consent for Lake Macquarie State Conservation Area in March 2020
	7 October 2020	Provision of draft SEE	Provision of draft SEE to support land owners consent considerations
Subsidence Advisory NSW	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
	27 February 2020	Site meeting	Site meeting with Subsidence Advisory NSW representatives
	8 October 2020	Provision of draft SEE	Provision of draft SEE for review and comments
	November 2020	Letter from SA NSW	No objection
DPIE – Biodiversity and Conservation Division	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
Department of Industry – Natural Resources Access Regulator	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process

Agency	Date	Activity	Details
DPIE – Mining, Exploration and Geoscience (MEG)	19 February 2020	Letter from Delta Coal	Letter from Delta Coal introducing the Proposed Modification and offering the opportunity for further consultation as part of the environmental assessment process
	3 June 2020	Teleconference	Teleconference with MEG representatives on the Proposed Modification
	7 October 2020	Provision of draft SEE	Provision of draft SEE for review and comments

No issues have been raised by Government Agencies as a result of the consultation undertaken to date.

5.0 Planning Considerations

This section discusses the application of the various Commonwealth and State environmental and planning legislation and policies that are relevant to the Proposed Modification.

5.1 Commonwealth Legislation

5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the primary environmental and planning regulatory instrument relevant to the Proposed Modification at a Commonwealth level. Under the EPBC Act, approval from the Commonwealth Minister for Environment is required for any action that may have a significant impact on Matters of National Environmental Significance (MNES).

MNES are identified in the following categories:

- World Heritage Properties
- National Heritage Places
- Wetlands of International Importance (listed under the Ramsar Convention)
- Threatened Species and Ecological Communities
- Migratory species protected under international agreements
- Nuclear Actions (including uranium mines)
- The Great Barrier Reef Marine Park
- Commonwealth land, marine areas and reserves
- A water resource, in relation to a coal seam gas development and large coal mining development.

If an 'activity' is likely to have a significant impact on a MNES then it may be a 'controlled action' and require approval from the Commonwealth Minister for the Environment. To obtain approval from the Minister, a proposed action must be referred to the Minister via the Commonwealth Department of Agriculture, Water and the Environment (DAWE). The purpose of a referral is to enable the Minister to decide whether the proposed action will need assessment and approval under the EPBC Act.

Mining operations within the Northern Mining Area have previously been referred under the EPBC Act as part of application EPBC 2011/5956 and were found to not be a controlled action. As the Proposed Modification is consistent with the previously referred action and approved Myuna Consent, the Proposed Modification has not been referred under the EPBC Act.

5.1.2 Native Title Act 1993

The *Native Title Act 1993* is not directly relevant to the approval process for the Proposed Modification. The *Native Title Act 1993* has potential implications for the granting of mining leases under *the Mining Act 1992* where native title has not been extinguished within the lease application area. No new mining leases are required for the Proposed Modification.

5.2 New South Wales Legislation

5.2.1 Environmental Planning and Assessment Act 1979

It is proposed to modify the CVC Consent pursuant to section 4.55(2) of the EP&A Act.

Modifications sought under section 4.55(2) must be substantially the same development for which the original consent was granted. The Proposed Modification is considered to be substantially the same development as that approved under the CVC Consent as:

- the overall nature of the development remains unchanged
- mining within the Northern Mining Area is approved under the Myuna Consent and the Proposed Modification will not result in any substantive change to approved impacts
- there is no change to approved mining methods or annual production rates
- the majority of the key project components remain unchanged from those currently approved, as outlined in **Table 3.1**
- there are no substantive changes to approved environmental impacts and the Proposed Modification can be undertaken in accordance with the approved environmental impact criteria contained in the CVC Consent and the Myuna Consent.

DPIE has confirmed that section 4.55(2) of the EP&A Act is the appropriate approval pathway for the Proposed Modification in correspondence dated 31 July 2019 (refer to **Appendix 2**).

5.2.1.1 Permissibility

Land zoning across the CVC Consent area and Northern Mining Area is shown in **Figure 5.1**. The CVC pit top area and the ventilation fan site are zoned SP2 Electricity Generating Works and E2 Environmental Conservation respectively under the *Wyong Local Environmental Plan 2013* (Wyong LEP). The majority of CVC's underground mining area is within the Lake Macquarie LGA and is zoned W1 Natural Waterways pursuant to the *Lake Macquarie Local Environmental Plan 2014* (Lake Macquarie LEP). Mining is not listed as being permissible, with or without consent, in these zones.

The Northern Mining Area lies primarily beneath the residential suburbs of Sunshine, Mirrabooka and Brightwaters, with zoning as shown in **Figure 5.1**.

The Northern Mining Area is located within the Lake Macquarie LGA and is covered by the following zonings under the Lake Macquarie LEP:

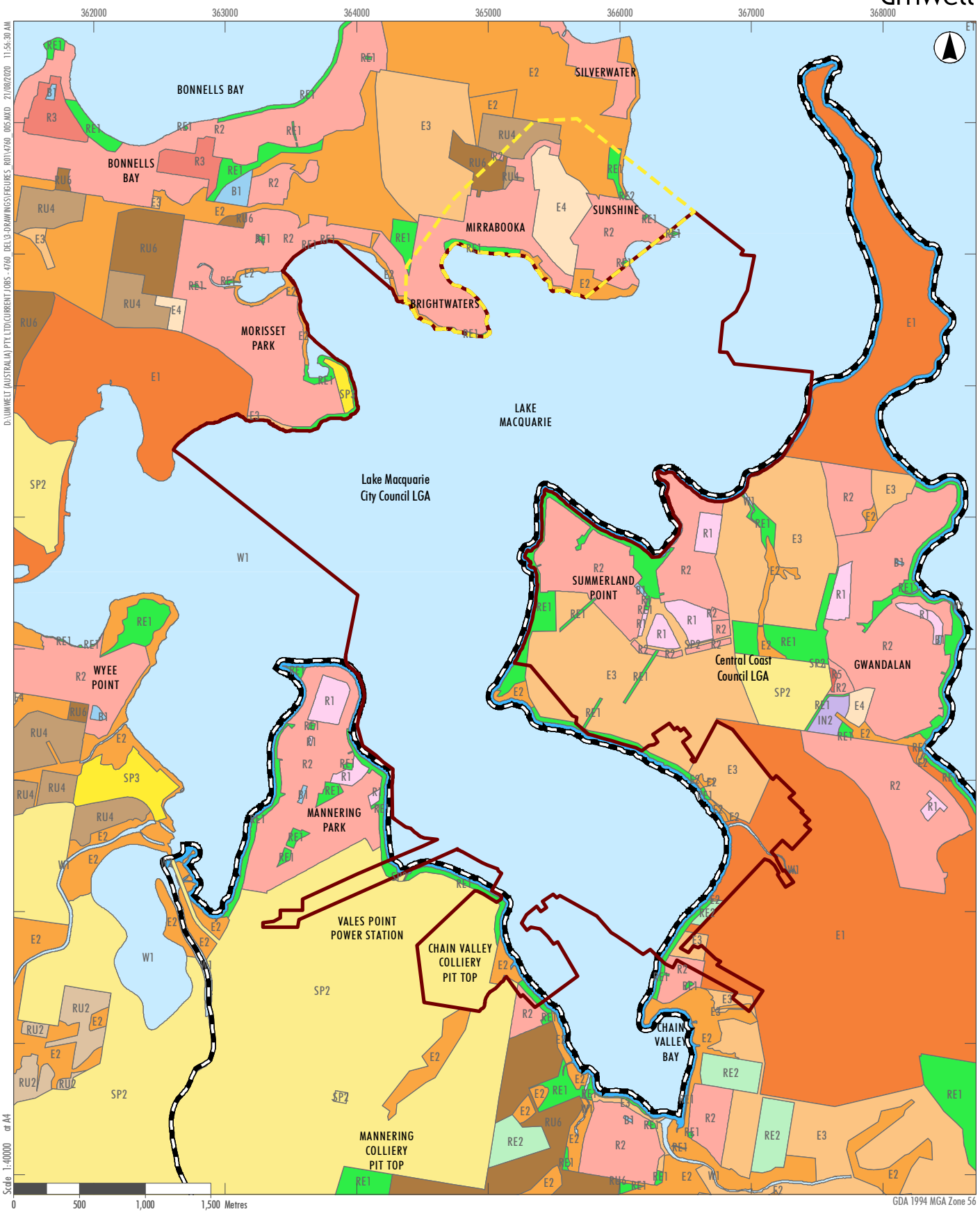
- R2 – Low Density Residential
- E2 – Environmental Conservation
- E3 – Environmental Management
- E4 – Environmental Living
- RE1 – Public Recreation
- RE2 – Private Recreation
- RU2 – Rural Landscape

- RU4 – Primary Production Small Lots
- RU6 – Transition
- W1 – Natural Waterways.

The Proposed Modification is considered to be generally consistent with the objectives of zonings within the Northern Mining Area as the long term stable mining systems generating up to 20 mm surface subsidence will have no noticeable surface impacts on sensitive surface features including land, built features and seagrass beds. The Proposed Modification will not prohibit the objectives of each of the zonings from being met.

Mining is not listed as being permissible, with or without consent, in any of the zones present within the Northern Mining Area.

The permissibility provisions of the State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007 (Mining SEPP) apply to the Proposed Modification. Clause 7 of the Mining SEPP permits underground mining to be carried out on any land with consent and prevails over a local environmental plan (section 3.28 of EP&A Act), therefore the Proposed Modification is permissible with development consent under the Mining SEPP. The provisions of the Mining SEPP are discussed further in **Section 5.2.2.1**.



Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area
- Local Government Area (LGA)

Zoning

- Neighbourhood Centre - B1
- Recreational Waterways - W2
- National Parks and Nature Reserves - E1
- Environmental Conservation - E2
- Environmental Management - E3
- Environmental Living - E4
- Light Industrial - IN2
- General Residential - R1
- Low Density Residential - R2
- Medium Density Residential - R3
- Large Lot Residential - R5
- Public Recreation - RE1
- Private Recreation - RE2
- Rural Landscape - RU2
- Primary Production Small Lots - RU4
- Transition - RU6
- Infrastructure - SP2
- Tourist - SP3
- Natural Waterways - W1

FIGURE 5.1

Zoning

Image Source: Nearmap (May 2019) Data source: Delta Coal, DPIE (2018)

5.2.1.2 Assessment Requirements

Under section 4.55(3) of the EP&A Act, when determining an application for the modification of development consent, the consent authority must take into consideration relevant matters referred to in section 4.15(1). These matters and the sections where they are addressed in this SEE are provided in **Table 5.1**.

Table 5.1 Section 4.15 Matters for Consideration

Matters for Consideration	Relevant SEE Section
(a) the provisions of: (i) any environmental planning instrument	Section 5.2.2
(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 Secretary has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and	Section 5.2.2
(iii) any development control plan,	Not applicable based on SSD provisions
(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	Section 6.0
(iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph), that apply to the land to which the development application relates,	Not applicable
(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	Section 6.0
(c) the suitability of the site for the development,	Sections 6.0 and 8.0
(d) any submissions made in accordance with this Act or the regulations	Not applicable
(e) the public interest	Sections 6.0 and 8.0

This SEE has also been prepared in consideration of the factors identified in section 4.55 of the EP&A Act and clause 115 of the *Environmental Planning & Assessment* (EP&A) *Regulation* to the extent that they are relevant.

5.2.2 Environmental Planning Instruments

5.2.2.1 State Environmental Planning Policies

The following State Environmental Planning Policies (SEPP) are relevant to the consideration of the Proposed Modification.

State Environmental Planning Policy (State and Regional Development) 2011

The *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP) identifies development to which the SSD assessment and determination process under Part 4 of the EP&A Act applies. The Proposed Modification is for the purpose of coal mining and is classed as SSD in accordance with clause 5(1) of the SRD SEPP. The Proposed Modification therefore requires development consent under Part 4 of the EP&A Act.

The NSW Independent Planning Commission (IPC) is the consent authority for SSD where certain objections and disclosures referred to in subclause 8A (1) of the SRD SEPP are made in respect to an application. For SSD where such objections and disclosures are not made the Minister for Planning is the consent authority (section 4.5(a) of the EP&A Act). Delta Coal has not made a reportable political donation under section 10.4 of the EP&A Act in the 2 years prior to lodgement of this application.

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

The Mining SEPP regulates the permissibility and assessment requirements for mining, petroleum production and extractive industries and related development.

Part 3 of the Mining SEPP requires specific matters to be considered in relation to development applications for mining development or applications that will affect existing or proposed mining operations. Clause 12AB of the Mining SEPP identifies non-discretionary development standards for mining and provides that the consent authority cannot impose more onerous standards in any approval in relation to the matters covered by the development standard. The prescribed criteria are summarised in **Table 5.2** with the relevant assessment outcomes noted for each criterion.

Table 5.2 Non-discretionary development standards for mining under the Mining SEPP

Matter	Non-discretionary Standard	Assessment Outcomes
Cumulative noise level	The development does not result in a cumulative amenity noise level greater than the acceptable noise levels, as determined in accordance with Table 2.2 of the Noise Policy for Industry, for residences that are private dwellings.	The Proposed Modification does not involve any activity that could increase existing noise emissions from the development. Therefore, the Proposed Modification will not result in additional noise emissions that could result in a cumulative amenity noise level in excess of the development standards.
Cumulative Air Quality Level	The development does not result in a cumulative annual average level greater than 25 µg/m^3 of PM_{10} for private dwellings.	The Proposed Modification does not involve any activity that could increase existing air emissions from the development. Therefore, the Proposed Modification will not result in a cumulative annual average PM_{10} concentration in excess of the development standards.
Airblast overpressure	Airblast overpressure caused by the development does not exceed: • 120 dB (Lin Peak) at any time, and • 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	The Proposed Modification does not involve activities that could cause airblast overpressure in excess of the development standards.
Ground vibration	Ground vibration caused by the development does not exceed: • 10 mm/sec (peak particle velocity) at any time, and • 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	The Proposed Modification does not involve activities that could cause ground vibration in excess of the development standards.

Matter	Non-discretionary Standard	Assessment Outcomes
Aquifer interference	Any interference with an aquifer caused by the development does not exceed the respective water table, water pressure and water quality requirements specified for item 1 in columns 1, 2, 3 and 4 of Table 1 of the Aquifer Interference Policy (AIP) for each relevant water source listed in column 1 of that Table.	All groundwater impacts attributable to the Proposed Modification have been assessed to be less than the Level 1 impact considerations under the NSW AIP.

The matters for consideration under the Mining SEPP are summarised in **Table 5.3** with relevant outcomes noted for each clause relating to the Proposed Modification.

Table 5.3 Development applications – matters for consideration

Clause	Matter for Consideration	Relevant Outcomes
Clause 12	Compatibility of proposed mine, petroleum production or extractive industry with other land uses	As the Proposed Modification involves the continuation of existing approved mining operations in a manner consistent with existing approvals, it is considered that there will be no change to the compatibility of the mine with existing land uses. Potential subsidence and associated impacts on both the natural and built environments have been addressed in **Section 6.2**, which confirms that with appropriate pillar design the current subsidence criteria can continue to be complied with.
Clause 12A	Consideration of voluntary land acquisition and mitigation policy	The Proposed Modification will not result in any change to existing approved air quality and noise impacts associated with the approved operations. It is noted that the relevant air quality criteria have changed since the CVC Consent was determined, however there will be no change to air emissions as a result of the Proposed Modification. The Proposed Modification does not trigger the *Voluntary Land Acquisition and Mitigation Policy* (2018) (VLAMP).
Clause 13	Compatibility of proposed development with mining, petroleum production or extractive industry	The interactions with other local mines, particularly Mannering Colliery and Myuna Colliery, are well documented and form the key purpose of this Proposed Modification. The geology in the area is well understood and the mine design aims to optimise resource recovery and to minimise the potential sterilisation of known coal resources in the area, without adversely impacting on the adjoining mining operations or the environment.

Clause	Matter for Consideration	Relevant Outcomes
Clause 14	Natural resource management and environmental	Clause 14 of the Mining SEPP requires the consent authority to consider the impact of a proposed mining project on the natural resources and whether specific environmental management conditions (relating to water resources, biodiversity and greenhouse gas emissions) should be imposed on the development if approved. The Proposed Modification's potential impact on natural resources is dealt with in detail in **Section 6.0** and specific commitments regarding the management of potential environmental impacts are contained in **Section 7.0**. Clause 14(3) of the Mining SEPP requires that the consent authority must consider any certification by BCD for measures to mitigate or offset the biodiversity impact of the proposal. The Proposed Modification involves the operation of an existing approved underground coal mine and no additional surface disturbance is proposed, therefore no impacts on biodiversity are predicted.
Clause 15	Resource recovery	Clause 15 of the Mining SEPP requires the consent authority to have regard to the efficiency of a proposed mining development in terms of its ability to optimise extraction of the target resources. A key outcome of the Proposed Modification is the optimisation of the recovery of coal resources using the existing infrastructure of the CVC.
Clause 16	Transport	Clause 16 of the Mining SEPP requires the consent authority to consider whether or not the mining development under consideration should be subject to conditions restricting the use of public roads for product transport or other mining related traffic. All product coal from the Proposed Modification will be transported within the existing approved transportation conditions. No additional traffic will be created as a result of the proposal.
Clause 17	Rehabilitation	Clause 17 of the Mining SEPP requires a consent authority determining a development application for a mining development to have regard to whether or not to impose specific conditions regarding the rehabilitation of land affected by the proposed mining development. The Proposed Modification involves the operation of an existing approved underground coal mine and no additional surface disturbance is proposed; therefore no additional land rehabilitation will be required.

Gateway Process

Part 4AA of the Mining SEPP, together with Clause 50A of the EP&A Regulation, provides for the implementation of the NSW Government's Strategic Regional Land Use Plan (SRLUP). The gateway process applies for projects located within Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Clusters (CIC) outside of existing mining lease areas.

The Proposed Modification area is covered by appropriate existing mining lease areas and new mining leases are not required. As a result, the gateway process does not apply to the Proposed Modification.

State Environmental Planning Policy (Koala Habitat Protection) 2019

State Environmental Planning Policy (Koala Habitat Protection) *2019* (Koala Habitat SEPP) aims to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas. The Koala Habitat SEPP applies to the extent that the Proposed Modification is located within LGAs listed in the SEPP, and a consent authority is restricted from granting development consent for proposals on land identified as core koala habitat without the preparation of a plan of management.

Lake Macquarie and the Central Coast LGA are listed in Schedule 1 of the Koala Habitat SEPP as being part of the Central Coast Koala Management Area. Parts of the Northern Mining Area are identified on the Koala Development Application Map and Site Investigation Area for Koala Plans of Management Map. The Koala Habitat SEPP therefore needs to be considered in regard to the Proposed Modification.

The Proposed Modification involves the operation of an existing approved underground coal mine and no additional surface disturbance is proposed. The Proposed Modification will not have any impact on koala habitat.

With reference to the DPIE Draft Koala Habitat Protection Guideline (DPIE 2020), the Proposed Modification meets the definition of a Tier 1 – Low or no direct impact development, in that the Proposed Modification:

- will not have a direct or indirect impact that results in clearing of native vegetation within koala habitat
- is below the Biodiversity Offset Scheme threshold under the *Biodiversity Conservation Act 2016* (BC Act)
- will not result in native vegetation removal
- relates to underground coal mining therefore mitigation measures listed in Table 1 of the draft guideline are not relevant.

State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP)

State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP) aims to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the *Coastal Management Act 2016*, including the management objectives for each coastal management area.

Clause 15 of the Coastal Management SEPP states:

> *Development in coastal zone generally—development not to increase risk of coastal hazards*
>
> *Development consent must not be granted to development on land within the coastal zone unless the consent authority is satisfied that the proposed development is not likely to cause increased risk of coastal hazards on that land or other land.*

The Proposed Modification relates to accessing approved mining within the Northern Mining Area, no additional mining or change to the nature or intensity of existing approved mining operations is proposed. The Proposed Modification will not cause an increased risk of coastal hazards on any land.

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

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) requires a consent authority to consider whether an industrial development is a potentially hazardous industry or a potentially offensive industry. A hazard assessment is completed for potentially hazardous developments to assist the consent authority to determine acceptability.

The Proposed Modification will not alter existing storage and/or use of dangerous goods or hazardous materials and will not increase emissions to the surrounding environment and therefore does not constitute a hazardous or offensive development. Accordingly, a preliminary hazard analysis is not required.

State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55)

State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) aims to provide a State-wide planning approach to the remediation of contaminated land and to reduce the risk of harm to human health and the environment by consideration of contaminated land as part of the planning process. Under SEPP 55, a consent authority must not consent to the carrying out of development on land unless it has considered any potential contamination issues.

SEPP 55 does not apply to the Proposed Modification as it involves the operation of an existing approved underground coal mine and no additional surface disturbance is proposed.

5.2.3 Approvals required under other State legislation

If the Proposed Modification is approved under Section 4.55(2) of the EP&A Act, the approvals under other state legislation outlined in **Table 5.4** will also be required.

Table 5.4 Environmental Approvals Required for the Proposed Modification

Act	Approval	Authority
Mining Act 1992	All of the land on which mining and associated activities will occur is covered by a current mining lease and therefore no additional mining leases are required. An amendment to the MOP will also be required to be approved under this Act.	MEG
Protection of the Environment Operations Act 1997	Each of CVC, Myuna Colliery and Mannering Colliery operate under separate EPLs issued pursuant to the Protection of the *Environment Operations Act 1997* (POEO Act). EPL1770 and associated plan must be approved or varied consistent with approved SSD consents.	NSW EPA

5.2.4 Relevant Strategic Policies

5.2.4.1 NSW Aquifer Interference Policy

The NSW AIP clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation and establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The AIP requires that, where mining will result in a loss of water from an overlying source covered by a water sharing plan (WSP), a water access licence is required under the *Water Management Act 2000* (WM Act) to account for this loss of water. In addition, the AIP requires proponents of mining projects seeking development consent under Part 4 of the EP&A Act to provide estimates of all quantities of water likely to be taken from any water source during and following cessation of the activity, and all predicted impacts associated with the activity.

The AIP also requires that potential impacts of the Proposed Modification on groundwater sources, including groundwater users and groundwater dependent ecosystems (GDEs), be assessed against the minimal impact considerations. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable.

Potential groundwater impacts associated with the Proposed Modification are discussed in **Section 6.2.5**.

6.0 Environmental Assessment

6.1 Preliminary Environmental Risk Analysis

A preliminary environmental risk analysis was undertaken for the Proposed Modification to identify, from a technical perspective, the key environmental and community issues of relevance and the level of assessment required as part of the assessment process.

The method used for the environmental risk analysis encompassed the following key steps:

- identify each element of the Proposed Modification
- identify the environmental and community aspects and potential impacts/risks associated with each element of the Proposed Modification in the context of the existing approved operations (that is, whether or not there is likely to be a change to the impacts approved as part of CVC Consent)
- assess the potential scope of the impact/risk to determine the key issues requiring further assessment and the level of assessment required.

The outcomes of the preliminary environmental risk analysis are detailed in **Table 6.1**.

Table 6.1 Preliminary Environmental Risk Analysis

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Action Required?
Subsidence	The Proposed Modification extends CVC operations into an area approved for mining by the Myuna Consent. While the Proposed Modification proposes similar mining techniques as approved under the Myuna Consent, an assessment of the pillar stability and potential subsidence impacts of the proposed mine design has been completed in order to confirm that the Proposed Modification can achieve the subsidence limits approved under the Myuna Consent.	Yes, refer to **Section 6.2**
Groundwater	The Proposed Modification will result in a change to the underground access point and direction of mining for the Northern Mining Area. These changes have the potential to alter groundwater regimes. Investigations to assess the impacts with the objective of determining whether they are 'substantially the same' as those of the existing operations has been undertaken.	Yes, refer to **Section 6.3**
Air Quality	There are no changes to surface infrastructure or intensification of CVC operations associated with the Proposed Modification. The Proposed Modification will not result in any changes to ventilation arrangements or any increase in particulate emissions from existing infrastructure used to ventilate the workings. Dust emissions will continue to be managed in accordance with site's Air Quality Management Plan, which will be updated to include mining within the Northern Mining Area. The air quality management and monitoring requirements of the CVC Consent are consistent with the Myuna Consent. Delta Coal is also of the view that increasing the proportion of fuel sourced from the Newcastle Coalfields may reduce sulphur emissions from the VPPS, and also improve the VPPS efficiency, due to the relatively low ash content of the Newcastle Coalfields.	No

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Action Required?
Noise and Vibration	There are no changes to surface infrastructure, operating hours, or intensification of CVC operations associated with the Proposed Modification. Noise emissions will continue to be managed in accordance with site's Noise Management Plan, which will be updated to include mining within the Northern Mining Area. The noise management and monitoring requirements of the CVC Consent are consistent with the Myuna Consent.	No
Traffic and Transport	No changes are proposed to the approved coal extraction limit at CVC. There would be no change to approved trucking rates, routes or hours on the public road network. While the Proposed Modification would result in an increase of approximately 110 FTE employees reporting to CVC, there would be no net increase to employee numbers between the CVC and Mannering Colliery operations.	Yes, refer to **Section 6.4**
Surface Water	There are no changes to extraction rates or surface infrastructure, or intensification of activities proposed by the modification and, therefore, water resources will not be impacted. There will be no secondary extraction outside areas currently approved for extraction meaning potential surface water impacts associated with subsidence remain unchanged by the Proposed Modification. Water management will continue to be undertaken in accordance with Delta Coal's Water Management Plan, which will be updated to include mining within the Northern Mining Area.	No
Greenhouse Gas and Energy	The Proposed Modification involves the mining of coal that is already approved to be mined by Myuna. The Proposed Modification does not extend the life of the currently approved CVC or Mannering Colliery operations or increase in approved production rates at either operation. The Proposed Modification will result in reduced transport related emissions associated with coal supplied to the VPPS. Greenhouse gas emissions reporting will continue to be undertaken in accordance with the requirements of the *National Greenhouse and Energy Reporting Act 2007*.	Yes, refer to **Section 6.5**
Visual Impact	The Proposed Modification will not result in change to existing surface infrastructure or intensification of activities at CVC. Therefore, no change to the existing visual impact of the operation will result.	No
Biodiversity	The Proposed Modification will not result in any surface disturbance or any change to approved subsidence limits or environmental performance measures relating to biodiversity. The Proposed Modification will therefore have no direct impact on native vegetation, fauna and fauna habitat including Commonwealth listed threated species, communities or migratory birds. There will also be no change to potential indirect impacts on biodiversity as a result of the Proposed Modification. Biodiversity will continue to be managed in accordance with site's Biodiversity Management Plan, which was prepared in accordance with the CVC Consent.	No

Environmental Aspect	Preliminary Environmental Risk Analysis	Further Action Required?
Heritage	There will be no surface disturbance associated with the Proposed Modification and, accordingly, no potential to adversely impact on any item or feature of Aboriginal heritage or historically significant heritage that may be present. The management of Aboriginal and historic heritage at CVC will continue to be undertaken in accordance with site's Heritage Management Plan, which was prepared in accordance with the CVC Consent.	No
Soils	There will be no surface disturbance associated with the Proposed Modification and no change to approved subsidence limits, accordingly, no change to existing impacts on soils.	No
Socio-economic	The *Mining Extension 1 Project EIS* (EMM 2013) assessed potential social and economic impacts from the continued operation of CVC. The increased flexibility in extraction would result in improved resource recovery and associated royalties to the NSW government which provide socio-economic benefits to NSW.	No, however a summary of the previous social impact assessment is provided in **Section 6.6**. A summary of community engagement activities undertaken for the Proposed Modification is also provided in **Section 4.1** .
Waste	CVC's waste streams and management procedures were described in the *Mining Extension 1 Project EIS* (EMM 2013). The Proposed Modification will not generate any additional waste streams nor result in any material increase in the volumes of wastes generated than approved under the CVC Consent or Myuna Consent. Waste will continue to be managed in accordance with BCD guidelines and the requirements of the CVC Consent.	No
Hazard and Risk	The Proposed Modification will not result in any changes to the existing operations which would alter the status of the operation in relation to its potential to be a hazardous or offensive industry, therefore no further assessment has been undertaken.	No
Rehabilitation	The mine closure and rehabilitation measures for CVC are described in the *Mining Extension 1 Project EIS* (EMM 2013), CVC's MOP and the site's Rehabilitation Management Plan. Mine closure and rehabilitation will be undertaken in accordance with the CVC Consent, with the surface facilities to be rehabilitated to the satisfaction of the Executive Director Mineral Resources. There will be no change to mine rehabilitation as a result of the Proposed Modification.	No

6.2 Subsidence

Mining with the Northern Mining Area is proposed to be first workings only which will generate up to 20 mm surface subsidence (i.e. no noticeable surface impacts) on sensitive surface features. Delta Coal engaged Strata^2 Ground Control Consulting (Strata^2) to assess the pillar design requirements to achieve a vertical subsidence of less than 20 mm across a depth range relevant to the Northern Mining Area. The report is contained in **Appendix 3** and a summary provided below.

6.2.1 Existing Environment

The Northern Mining Area includes a number of natural features and built features, including private residences, which will be undermined as a result of the Proposed Modification (refer to **Figure 6.1**).

Major natural features within the Northern Mining Area includes Lake Macquarie and the Lake Macquarie foreshore. The existing CVC operations undermine these features under the CVC consent. As discussed in **Section 2.1.4**, the existing CVC consent limits subsidence impacts through the adoption of the HWSMB and SPB. Vertical subsidence within the HWMSB and SPB is limited to a maximum of 20 mm. This magnitude of subsidence is considered negligible and imperceptible for all practical purposes. In order to achieve this, first workings only are approved within the HWMSB and SPB.

Built features within the Northern Mining Area includes:

- private residences within the suburbs of Brightwaters, Mirrabooka and Sunshine
- local roads
- utilities and other services, e.g. sewer, pipelines, electrical transmission lines, fibre optics
- jetties, navigational markers and boat moorings.

As outlined in **Section 2.2**, mining within the Northern Mining Area is currently approved under the Myuna Consent. Mining under the suburbs of Brightwaters, Mirrabooka and Sunshine is limited to a maximum of 20 mm of subsidence (i.e. no perceptible surface impacts) (refer to **Figure 2.2**).

Legend

- CVC Development Consent Boundary (SSD-5465)
- Northern Mining Area

FIGURE 6.1

Northern Mining Area

Image Source: Nearmap (Jan 2020) Data source: Delta Coal

6.2.2 Existing Subsidence Criteria

Myuna Consent

As discussed in **Section 2.0**, the Northern Mining Area is currently approved for mining under the Myuna Consent. Schedule 3 of the Myuna Consent prescribes the following subsidence limits:

1. *The Proponent shall ensure that the vertical subsidence within Zone A is limited to a maximum of 20 millimetres (mm) and that extraction methods are limited to first workings only.*

2. *The Proponent shall ensure that vertical subsidence within Zone B is limited to 650 mm and second workings are limited to partial pillar extraction within the Great Northern and Fassifern coal seams.*

   …

Schedule 3, Condition 4 of the Myuna Consent includes subsidence related environmental performance measure for biodiversity. Schedule 3, Condition 6 of the Myuna Consent includes built feature and public safety performance measures. **Table 6.2** re-produces the subsidence impact performance measures for the existing Myuna operations.

Table 6.2 Myuna Subsidence Impact Performance Measures

Biodiversity	
Threatened species, populations or their habitats and endangered ecological communities	Negligible impact or environmental consequences.
Seagrass beds	Negligible environmental consequences including: • negligible change in the size and distribution of seagrass beds; • negligible change in the functioning of seagrass beds; and • negligible change to the composition or distribution of seagrass species within seagrass beds.
Benthic communities	Minor environmental consequences, including minor changes to species composition and/or distribution
Built Features	
Key public infrastructure: Eraring Power Station Ash Dam	Negligible impact or consequence.
Other public infrastructure (including sewage pipes; power and telecommunications cables). Other built features (including jetties and boat moorings)	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repaired, replaced or fully compensated.
Public Safety	
Public Safety	Negligible additional risk.

As shown on **Figure 2.2**, the majority of the Proposed Modification Northern Mining Area is within Zone A. It is proposed to undertake mining within the Northern Mining Area as first workings only which will generate subsidence equivalent to Zone A under the Myuna Consent.

CVC Consent

As outlined in **Section 2.1.2**, the CVC Consent allows for a 'subsidence management zone' approach to operations at CVC, with zones based on current approved subsidence levels and performance measures. The subsidence management zones are shown on **Figure 3.1** and include:

- Zone A: long-term stable mining systems generating up to 20 mm surface subsidence (i.e. areas of imperceptible subsidence)
- Zone B: mining systems generating up to a maximum of 780 mm of vertical subsidence consistent with the subsidence levels currently approved for CVC (i.e. areas where either first or secondary workings would be undertaken).

The CVC mine design is based on a number of performance measures specified in Conditions 1, 2 and 4 of Schedule 4 of the CVC Consent. The key subsidence impact performance measures for the existing CVC operations are presented in **Table 6.3**.

Table 6.3 CVC Subsidence Impact Performance Measures

Biodiversity	
Threatened species or endangered populations	Negligible environmental consequences
Seagrass beds	Negligible environmental consequences including: • negligible change in the size and distribution of seagrass beds; • negligible change in the functioning of seagrass beds; and • negligible change to the composition or distribution of seagrass species within seagrass beds.
Benthic communities	Minor environmental consequences, including minor changes to species composition and/or distribution.
Mine workings	
First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible environmental consequences	To remain long-term stable and non-subsiding
Second workings	To be carried out only in accordance with an approved Extraction Plan.
Built Features	
Trinity Point Marina Development **Other built features**	Always safe. Serviceability should be maintained wherever practicable. Loss of serviceability must be fully compensated. Damage must be fully repaired, replaced or fully compensated.
Public Safety	
Public Safety	Negligible additional risk.

6.2.3 Proposed Subsidence Criteria – Northern Mining Area

As shown by **Table 6.2** and **Table 6.3**, the subsidence impact performance measures for both the Myuna Consent and CVC Consent are consistent, requiring:

- for biodiversity, negligible environmental consequences
- for built features, to remain safe and serviceable with any damage fully repaired, replaced or fully compensated
- for public safety, negligible additional risk

The Northern Mining Area will therefore be subject to the same performance measures under the CVC Consent as currently apply under the Myuna Consent.

Similarly, vertical subsidence within Zone A is limited under both consents to a maximum of 20 mm.

The Northern Mining Area will fall within the Zone A mining zone under the CVC Consent, where long-term stable mining systems generating up to 20 mm surface subsidence will be utilised (refer to **Figure 3.1**).

6.2.4 Pillar Design Considerations

Strata^2 assessed the pillar design requirements to achieve a vertical subsidence of less than 20 mm across a depth range relevant to the Northern Mining Area. The design considered the use of a bord and pillar mining method utilising a herringbone pillar layout for future Fassifern Seam workings in the proposed Northern Mining Area. Such a design has been successfully employed at the Myuna Colliery for over 30 years (EMM, 2019).

Design calculations considered the geological/geotechnical environment (including rock strength, in-situ stresses, stress strength ratios), pillar design factors (strength, load, width to height ratios) and historic experiences of ground behaviour in the seam under consideration for a range of depths (Strata^2, 2020).

Strata^2 concluded that the adoption of specific design criteria would eliminate the potential for failure (i.e. panel collapse due to the failure of any element in the overall structural system) in the long-term. As the workings fall within the long-term stable category, the design provides for the protection of highly sensitive structures and natural features, including the Lake Macquarie foreshore.

In compliance with the CVC Consent, Great Southern Energy Pty Limited will commission and undertake detailed geotechnical assessments by a suitably qualified geotechnical engineer as part of the company's detailed mine plan design process.

6.2.5 Subsidence Performance and Management

Mine design criteria are used to manage subsidence in the design phase of the operation and the predictions are based on latest pillar design principles, local geological characteristics and results of existing subsidence monitoring data.

The extensive mining history in and around Lake Macquarie has greatly improved the ability to predict subsidence levels and developed mine design guidelines to protect against foreshore, seagrass and lake bed impacts. That combined with the recent history at CVC using similarly designed miniwall panels suggests that predicted subsidence impacts are achievable.

Routine monitoring is undertaken to allow rapid and proactive verification of both initial and final subsidence effects and impacts. The Subsidence Monitoring Program has been prepared to:

- provide data to assist with the management of the risks associated with subsidence
- validates the subsidence predictions
- analyses the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences
- informs the contingency plan and adaptive management process.

Subsidence surveys are required to be undertaken annually as a minimum, with reference monitoring points located on shorelines nearby any mining activities. Shoreline surveys are also undertaken at intervals corresponding with key mini-wall retreat milestones. Bathymetric surveys are also undertaken each year to gauge subsidence levels over the area of secondary extraction undertaken beneath Lake Macquarie, where land-based surveys are not possible.

The subsidence monitoring undertaken allows adaptive measures such as mine design changes, increased barrier pillars, widening of protection zones, etc. to be undertaken in a timely manner to mitigate against and minimise the impact of any unforeseen exceedances.

The subsidence monitoring and management framework for the existing CVC operations is described in detail in the Extraction Plan for each section of the mine. This includes details for the respective triggers/performance indicators (including actual measured subsidence and inspections for environmental impact). These management plans also include specific information regarding the subsidence monitoring requirements (including baseline monitoring), remediation and adaptive management techniques and contingency plans. All of these are then summarised in the Subsidence Management Trigger Action Response Plan (TARP) which aims to consolidate all subsidence management requirements into a central focus point, triggering a response or set of responses commensurate with the nature of the measurement or the impact that has been identified.

The relevant subsidence monitoring and management measure will be continued for the Proposed Modification. All relevant plans will be updated to include mining in the Northern Mining Area, should the Proposed Modification be approved.

6.3 Groundwater

The groundwater impacts associated with mining within the Northern Mining Area have previously been assessed and approved under the Myuna Consent. As outlined in **Section 3.0**, the Proposed Modification would allow for mains development from the existing CVC underground workings to progress into the Northern Mining Area to access the approved coal reserves rather than accessing them from the Myuna workings.

Delta Coal engaged GHD Pty Ltd (GHD) to prepare a Groundwater Impact Assessment (GIA) to determine any incremental impacts of the Proposed Modification on the groundwater environment. A copy of the GIA is contained in **Appendix 4** and a summary of findings presented below.

6.3.1 Existing hydrogeology and groundwater environment

The groundwater sources in the vicinity of the CVC Consent area, which include the Northern Mining 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 5 L/s and/or the total dissolved solids (TDS) concentration is typically greater than 1,500 mg/L (due to the close proximity to Lake Macquarie).

6.3.1.1 Alluvium

The alluvium within and in the vicinity of the CVC Consent area forms an unconfined shallow aquifer. The groundwater flow direction within the alluvium generally reflects the topography with flow towards Lake Macquarie. GeoTerra (2013) suggested that the alluvium would be thin within the CVC Consent area with limited aerial extent, and therefore have no significant water storage or transmitting ability. Alluvial groundwater would be expected to provide baseflow to the ephemeral creeks including Postmistress Creek to the north which is located within the Northern Mining Area along with Wyee Creek, Cobra Creek and Pourmalong Creek to the west, Karignan Creek to the south, Bonny Boy Gully and Tiembula Creek to the east.

The alluvial water sources within the CVC Consent area are covered under the *Water Sharing Plan* (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 WSP area. Sediments within Lake Macquarie are not managed under a WSP. These sediments act as a marine aquifer with aquifer pressures dominated by the water level within Lake Macquarie (GHD 2020).

6.3.1.2 Fractured and porous rock

The porous and fractured rock groundwater sources underlying the CVC Consent area generally occur within weathered rock (Triassic) and coal seams (Permian). These groundwater sources are managed under the *North Coast Fractured and Porous Rock Groundwater Sources WSP*. The piezometric head within the Permian coal seams tends 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 to the north-west of the CVC Consent area. Groundwater tends to flow laterally along sedimentary layers since the vertical hydraulic conductivity is usually at least one order of magnitude lower than the horizontal hydraulic conductivity due to the interbedding of low permeability strata. 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 (GHD 2020).

Active and historical underground coal mining at CVC and other sites is likely to have caused some depressurisation of fractured and porous rock groundwater sources in the vicinity of the CVC Consent area. Previous model predictions indicate that there is likely to be existing depressurisation of Triassic strata as well as of the target coal seams within the Northern Mining Area (GHD 2020).

6.3.1.3 Groundwater use

A search of the Australian Groundwater Explorer (BOM 2019a) and WaterNSW (2020) identified 25 registered bores within an approximate 5 km radius of the Northern Mining Area. Of the registered bores, the majority (21) were registered as test and monitoring bores. Four bores were registered for water supply, including stock watering and domestic supply. No registered bores were identified within the Northern Mining Area. Several shallow test bores were identified within approximately 1 km to the south-west of the Northern Mining Area.

The maximum depth of the registered bores is 61 m, with most of the bores installed to a depth of less than 20 m. Reported groundwater yields are less than 1 L/s. Depths to groundwater are generally shallow (less than 7 m). Overall, the search of the registered bore databases suggests that groundwater use in the vicinity of the Northern Mining Area is limited.

6.3.1.4 Groundwater dependent ecosystems

A search of the Groundwater Dependent Ecosystems Atlas (BOM 2019b) was undertaken to identify groundwater dependent ecosystems (GDEs) near the Northern Mining Area. No high priority GDEs, listed in the relevant WSPs, were identified in the CVC Consent area, including the Northern Mining Area.

A map of terrestrial and aquatic GDEs in the vicinity of the CVC Consent area, classified as either high, moderate of low potential GDEs, is shown in Figure 3-6 of **Appendix 4**. Lake Macquarie is identified as a moderate potential aquatic GDE. High, moderate and low potential terrestrial GDEs were identified within the Northern Mining Area. The high potential terrestrial GDE appears to be associated with Postmistress Creek.

6.3.2 Groundwater modelling

Potential groundwater impacts from the Proposed Modification were predicted by the development and calibration of a numerical groundwater model using MODFLOW-USG software. Full details of model construction, boundary conditions and model calibration are provided in **Appendix 4**.

The calibrated groundwater model was used to make predictions for:

- groundwater inflows into the CVC workings due to mining within the Northern Mining Area
- incremental groundwater drawdown due to mining within the Northern Mining Area, including drawdown at private bores and GDEs
- reduction in baseflow to surface watercourses attributable to mining within the Northern Mining Area.

Three scenarios were modelled:

- No mining (or null) condition: under this condition, no drain cells representing mine workings are turned on. The model runs between 1960 and 2050 with all other boundary conditions active.
- Approved conditions: under this condition, all historical and approved (future) mine workings at CVC, Mannering Colliery, Myuna Colliery and Mandalong Mine are simulated by progressively turning on drain cells in accordance with mining schedules for each site.
- Proposed condition: this scenario includes approved conditions as well as the proposed bord and pillar mining within the Northern Mining Area.

For each scenario, the predictive model used constant recharge rates, assigned based on the percentage of long-term average rainfall.

6.3.3 Modelling Results

The predictive modelling results are presented below.

Groundwater inflows

Proposed bord and pillar mining in the Northern Mining Area is predicted to increase groundwater inflows to CVC mine workings by up to 0.4 ML/day in years 2023 and 2024 (compared to approved conditions). Overall, groundwater inflows are predicted to trend downwards up to the end of mining in 2027 under both approved and proposed conditions. Inflows are not predicted to reach the approved peak of 10.5 ML/day, even under very high hydraulic conductivity and storage values adopted in the uncertainty analysis.

Groundwater drawdown

No drawdown in the water table is predicted due to mining in the Northern Mining Area. In addition, the groundwater model does not predict that there is existing water table drawdown in this area. Drawdown in fractured and porous rock groundwater sources is predicted to occur as a result of the Proposed Modification, particularly in the Permian strata. Drawdown of up to 10 m is predicted to occur in the Munmorah Conglomerate underlying the Northern Mining Area, while drawdown of over 100 m is predicted to occur within Permian strata overlaying the Fassifern Seam. However, no drawdown is predicted to occur at existing private bores in the vicinity of the CVC Consent area.

Baseflow

A reduction in baseflow to ephemeral creeks within the Northern Mining Area, including Postmistress Creek, is not predicted.

6.3.4 Impact assessment

Impacts were assessed in accordance with the criteria from the NSW AIP as described in **Section 5.2.4**.

6.3.4.1 Alluvial groundwater sources

As outlined in **Appendix 4**, there is no mapped alluvium within the Northern Mining Area. The main alluvial deposits in the vicinity of the CVC Consent area occur to the east and are associated with Wyee Creek and Pourmalong Creek.

Water table

No drawdown of alluvial groundwater or the water table is predicted as a result of mining in the Northern Mining Area, therefore there will be no impact on baseflow to ephemeral creeks or GDEs. This includes the high potential terrestrial GDE associated with Postmistress Creek within the Northern Mining Area. Further it is not predicted that there will be drawdown at the shallow private bores located to the west of the Northern Mining Area.

The GIA concludes that the predicted impacts to alluvial groundwater are less than the Level 1 minimal impact considerations for 'Water Table' under the NSW AIP and are therefore considered to be acceptable. Since alluvial groundwater sources are unconfined, the criterion for 'Water Pressure' does not apply.

Groundwater quality

There is no available quality data for shallow groundwater in the vicinity of the CVC Consent area. Since groundwater use is limited, it is considered that the existing beneficial use category for alluvial groundwater and shallow groundwater is 'environmental protection'.

Since there is no drawdown in the water table predicted, it is not expected that there would be a change in shallow groundwater quality attributable to mining in the Northern Mining Area. Hence, the beneficial use category of the alluvial/shallow groundwater is not expected to change and the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

6.3.4.2 Fractured and porous rock groundwater sources

The Triassic and Permian 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.

Water pressure

Groundwater drawdown attributable to the Proposed Modification is predicted to be up to 10 m in the Munmorah Conglomerate and over 100 m within Permian strata overlaying the Fassifern Seam. Current groundwater inflow to CVC resulting in take from the fractured and porous rock groundwater sources is approximately 5 ML/day. This is predicted to reduce over time based on current mine plans, however mining in the Northern Mining Area is predicted to result in an additional take of up to 0.4 ML/day from the fracture and porous rock groundwater sources.

No drawdown is predicted to occur at existing private bores in the vicinity of the CVC Consent area, including the Northern Mining Area. Since no drawdown at private bores is predicted to exceed 2 m, the predicted 'Water Pressure' impacts are less than the Level 1 minimal impact considerations under the NSW AIP and are therefore considered to be acceptable.

Groundwater quality

The Proposed Modification is not predicted to result in leakage from Lake Macquarie to the underlying fractured and porous rock groundwater sources. The take of groundwater into the mine workings will be from the existing storage within the fractured and porous rock. As a result, it is not predicted that groundwater salinity will increase.

The beneficial use category of the fractured and porous rock groundwater source is not expected to change within or outside the CVC Consent area and therefore the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

6.3.4.3 Groundwater licensing

The existing groundwater licence for CVC permits extraction of up to 4,443 ML in any 12 month period from the underground workings. Based on the groundwater model predictions, it is expected that this volume is sufficient to cover the proposed extension of mining into the Northern Mining Area.

6.3.5 Mitigation, monitoring and management

All groundwater impacts attributable to the Proposed Modification have been assessed to be less than the Level 1 impact considerations in the NSW AIP. Therefore ongoing management and mitigation measures will be focused on monitoring, where possible, to validate groundwater model predictions and provide observation data for future model calibration.

Groundwater at CVC is managed in accordance with the *Chain Valley Colliery Groundwater Management Plan* (GeoTerra, 2019). The Groundwater Management Plan outlines groundwater level, quality and quantity monitoring requirements. It also identifies trigger levels and the actions and responses that should be adopted in the case that these triggers are exceeded.

Groundwater monitoring will continue to be undertaken in accordance with the Groundwater Management Plan, including daily metering of dewatering volumes from the underground workings. No additional groundwater monitoring bores have been identified for inclusion in the monitoring program as part of the GIA. The Groundwater Management Plan will be updated to incorporate the Northern Mining Area should the modification be approved.

The groundwater model will be reviewed and revised as required by the Groundwater Management Plan. The review of the groundwater model will include a comparison of modelling results against groundwater monitoring data and mine dewatering volumes.

6.4 Traffic and Transport

The Proposed Modification would result in an increase of approximately 110 FTE employees reporting to CVC. There would be no net increase to employee numbers between the CVC and Mannering Colliery operations and there would be no change to approved trucking rates, routes or hours on the public road network. The shift times for employees reporting to CVC will not change and the increased employee numbers reporting to CVC will be effectively spread proportionally across shifts. Current shift times are set out in **Table 6.4**.

Table 6.4 Current Shift Data

Current	Start	Finish	% Contribution
Weekday Day Shift A	6:00 am	3:30 pm	20 %
Weekday Day Shift B	6:30 am	4:00 pm	15 %
Weekday Afternoon Shift A	2:00 pm	11:30 pm	10 %
Weekday Afternoon Shift B	2:30 pm	12:00 am	15 %
Weekday Night Shift A	10:00 pm	7:30 am	8 %
Weekday Night Shift B	10:30 pm	8:00 am	8 %
Weekend Dayshift A	6:30 am	6:30 pm	6 %
Weekend Dayshift B	7:00 am	7:00 pm	6 %
Weekend Nightshift A	5:00 pm	5:00 am	6 %
Weekend Nightshift B	5:30 pm	5:30 am	6 %
		Total	**100 %**

Redistribution of up to 110 FTE employees from Mannering Colliery to CVC will reduce the number of employees entering and leaving Mannering Colliery at the Mannering Colliery Access Road intersection off Rutteys Road and increase the number using the Rutteys Road/Construction Road intersection. The main potential impact on the road system is therefore associated with the increased traffic using the Ruttleys Road/Construction Road intersection.

6.4.1 Assessment Methodology

A Traffic Impact Assessment (TIA) (refer to **Appendix 5**) has been prepared by GHD which has examined a range of different employee number scenarios. The proposed maximum CVC workforce number is similar to the Medium growth scenario modelled.

In order to identify the existing traffic conditions in proximity to the CVC and Mannering Colliery, weekday AM and PM peak period (Monday 22 June 2020) and weekend peak period (Saturday 20 June 2020) traffic counts were undertaken at the following intersections:

- Ruttleys Road and Construction Road
- Construction Road and CVC site access
- Ruttleys Road and Mannering Colliery access road.

For the intersection of Ruttleys Road/Construction Road and Ruttleys Road/Mannering Colliery access road, the observed traffic network peak hours were identified as the following:

- Weekday 7:45 am – 8:45 am
- Weekday 3:30 pm – 4:30 pm
- Saturday 7:30 am – 8:30 am.

For the intersection of the Construction Road and the CVC site access, the observed peak hours were identified as:

- Weekday 5:15 am – 6:15 am
- Weekday 3:45 pm – 4:45 pm
- Saturday 5:30 am – 6:30 am.

The above data indicates that during weekday morning periods and weekends, peak activity at CVC occurs prior to the general peak activity on the adjoining road network. This is consistent with the staff shifts (refer to **Table 6.4**).

The operation of the intersections of interest has been assessed using SIDRA 8.

SIDRA calculates the amount of delay to vehicles using an intersection and, amongst other performance measures, gives a Level of Service (LoS) rating which indicates the relative performance of traffic movements within the intersection.

Table 6.5 presents the criteria generally applied to intersection performance. The LoS is determined from the calculated delay to traffic movements, which is a representation of driver frustration, fuel consumption and increased travel time. There are six LoS measures ranging from A (very low delay and very good operating conditions) to F (over saturation where arrival rates exceed intersection capacity). Typically, a LoS D or better is considered to be acceptable, however, a LoS E may be acceptable if it also operates with a low degree of saturation.

Table 6.5 Intersection Level of Service Criteria

LoS	Average Delay/ Vehicle (sec)	Traffic Signals & Roundabouts	Give-way & Stop signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28 to 42	Satisfactory	Satisfactory, but accident study required
D	42 to 56	Operating near capacity	Near capacity, accident study required
E	56 to 70	At capacity, excessive delays; roundabout requires other control mode	At capacity; requires other control mode
F	Exceeding 70	Unsatisfactory; requires additional capacity	Unsatisfactory, requires other control mode.

The results of the SIDRA intersection modelling analysis, based on the existing traffic volumes and road geometry, indicate that all of the intersections of interest currently operate with a good LoS, at LoS A, during the weekday AM and PM and Saturday peak periods.

The TIA has modelled intersection performance with three increased employee number scenarios. The assessment has assumed:

- the administration staff will access the collieries in the weekday AM peak hour and exit it in the weekday PM peak hour
- the administration staff do not work on Saturdays
- for the Ruttleys Road/Construction Road intersection, the additional weekday day shift access the collieries in the 7:45 – 8:45 weekday AM peak hour and exit it in the weekday PM peak hour
- for the Construction Road/CVC intersection, day shift staff access the collieries in the 5:15 - 6:15 am weekday AM peak hour and exit it in the weekday PM peak hour
- the weekday afternoon shift does not access/egress the site in the weekday AM or PM peak hours
- the weekday night shift will exit the collieries during the weekday AM peak hour
- the weekend day shift access the collieries in the Saturday peak hour
- the weekend night shift exit the collieries in the Saturday park hour.

The assumptions for the weekday Rutteys Road/Construction Road intersection are considered to be conservative as the additional modelled day shift employees are unlikely to arrive during this period.

Coal trucks approved under the CVC consent were not operating at the time of the assessment, however the SIDRA assessment has assumed that in the 2030 horizon year that 32 coal trucks will enter and exit the CVC site in each peak hour of analysis.

Linear annual growth of non-CVC/Mannering Colliery traffic of 2.1% relative to the 2020 traffic survey data for the 2030 modelled horizon has been applied to the assessment, based on the *Greater Lake Munmorah Structure Plan Road Development Strategy* (GHD 2020).

6.4.2 Predicted Traffic Impacts

The results of the SIDRA modelling indicate that the intersections of interest are expected to continue to operate with a good level of service, at LoS A, in the 2030 horizon year for all three growth scenarios. Accordingly, the proposed change in employee numbers between the two operations is not predicted to have any adverse impacts on the traffic network. No changes to existing intersection arrangements are required to accommodate the employee number changes.

6.5 Greenhouse Gas Emissions

The Proposed Modification is not anticipated to result in any increase in greenhouse gas emissions beyond that which are currently approved in NSW as:

- it involves the mining of coal which is currently approved to be mined by Myuna Colliery
- it does not increase the life of approved operations at either CVC or Mannering Colliery
- it does not alter the currently approved production rates at CVC or Mannering Colliery.

While the Proposed Modification does not increase approved coal production rates, it does change the destination of the coal mined within the Northern Mining Area from the Eraring Power Station to VPPS. A Greenhouse Gas and Energy Assessment (GHGEA) has been prepared to support the preparation of the SEE, and includes greenhouse gas emission projections, an assessment of climate change impacts and an evaluation of greenhouse gas mitigation options (refer to **Appendix 6**). This GHGEA includes an assessment of all relevant downstream emissions, to ensure the Consent Authority can meet the requirements of Part 3 clause 14 (2) of the Mining SEPP.

The scope of the GHGEA includes:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification
- estimating energy use directly associated with the Proposed Modification
- qualitatively assessing how the Proposed Modification's greenhouse gas emissions may impact the environment
- estimating the impact of the Proposed Modification's emissions on State, national and international greenhouse gas emission targets/policies
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions of the Proposed Modification and ensure energy use efficiency.

6.5.1 Impact Assessment

The greenhouse gas emissions associated with the Proposed Modification are summarised in **Table 6.6** (refer to **Appendix 6** for further detail). Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Proposed Modification. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

Table 6.6 Summary of the Proposed Modification's greenhouse gas emissions

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Operation	Scope 1 (Direct)	Diesel use	2,607	1,235,007
		Fugitive emissions	1,232,400	
	Scope 2 (Indirect)	Electricity	36,560	36,560
	Scope 3 (Indirect)	Product use	6,334,146	6,343,022
		Associated with energy extraction and distribution	4,196	
		Product transport	4,680	
Total greenhouse gas emissions associated with the Proposed Modification				**7,614,589**

The Proposed Modification is forecast to generate approximately 1,235,000 t CO_2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. At maximum allowable production, the Proposed Modification has the potential to generate approximately 998,000 t CO_2-e of Scope 1 emissions per annum. Approximately 82% of the fugitive emissions forecast in **Table 6.6** are legacy fugitive emissions which are already approved under the respective consents for CVC and Mannering Colliery; the virgin gas content of the target resource in the Northern Mining Area, has the potential to generate approximately 228,000 t CO_2-e fugitive emissions.

It is noted however that these emissions would occur irrespective of whether the Proposed Modification is approved, as CVC would mine other areas within the approved mining footprint rather than the Northern Mining Area and this resource could also be mined by Myuna Colliery.

The Proposed Modification is forecast to be associated with approximately 36,560 t CO_2-e of Scope 2 emissions from consuming electricity. As with the Scope 1 emissions, these emissions would occur irrespective of whether or not the Proposed Modification is approved as similar emissions would result from the extraction of coal from other areas within the approved CVC mining area.

The mining of the coal in the Northern Mining Area would result in approximately 6,344,000 t CO_2-e of Scope 3 emissions. Scope 3 emissions will be generated by third parties who transport and consume coal products. These emissions would arise had this resource been mined by Myuna Colliery, as is currently approved.

The close proximity of the CVC/Mannering complex to VPPS assists in reducing transport related emissions associated with coal used by the VPPS. Coal would otherwise need to be transported from other, more distant operations if not obtained from the Delta Coal operations. This saving has been quantified as approximately 750 t CO_2-e.

6.6 Social

Social impact assessment for State significant mining projects is guided by the *Social Impact Assessment Guideline for State Significant Mining, Petroleum and Extractive Industry Development* (DPE 2017) (SIA Guideline). As noted in the Introduction to the SIA Guideline:

> *This guideline also applies to applications to modify an approved State significant resource project where:*
>
> - *The application is submitted after the date of publication of this guideline*

- *The social impacts associated with the proposed modification are new or different (in terms of scale and/or intensity) to those that were approved under the original consent.*

The Proposed Modification seeks to extend the CVC consent boundary to incorporate the Northern Mining Area and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations rather than via Myuna's operations. Delta Coal also proposes to increase the number of employees reporting to the CVC pit top by 110 FTE's from approximately 220 to approximately 330 FTE's, to reflect the increasingly integrated management of Delta Coal employees between CVC and Mannering Colliery. This increase comprises employees currently reporting the adjacent Mannering Colliery Pit Top and does not represent an increase in the total number of employees accessing the combined CVC and Mannering Colliery operations. There are no other changes proposed, including no change to the mining method, approved subsidence impacts, production rate or surface facilities. The social impacts of the Proposed Modification are therefore not new or different (in terms of scale and/or intensity) from those approved under the existing CVC, Myuna and Mannering Consents and therefore it is considered that the SIA Guideline do not apply to Modification 4. DPIE confirmed this approach via correspondence dated 31 October 2019 and 13 July 2020.

The following sections provide a summary of the existing social impacts approved under the CVC Consent and the outcome of community stakeholder engagement activities undertaken for the Proposed Modification.

6.6.1 Existing Social Impacts

A Social Impact Assessment (SIA) was undertaken for the existing operations in 2013 (EMM, 2013). The SIA involved the following steps:

- documentation of the social aspects of the project, including workforce characteristics and its existing residential distribution
- documentation of the relevant local and regional policy context
- development of community profiles for the primary and secondary assessment areas
- consultation with key stakeholders, including landowners, community groups, councils, government agencies and service providers
- assessment of potential impacts of the project on the primary and secondary assessment areas
- analysis of potential cumulative impacts of the project and other major projects that would occur concurrently
- development of appropriate measures to manage and monitor any potential adverse social impacts and provide for the enhancement of positive impacts
- identification of ongoing monitoring processes to ensure social impacts are responsively managed and reviewed over time.

6.6.1.1 Stakeholder Engagement

Matters raised by the community and special interest groups during the stakeholder engagement process for the previous SIA are summarised in **Table 6.7**.

Table 6.7 Matters Raised by Community and Interest Groups

Theme	Matter Raised
The Project	• mine design • project timeframe • timely access to project information • extent of mine extension under Lake Macquarie • extension of mining under existing residential areas • mining technique to be employed
Subsidence	• extent of subsidence and impact on benthic communities • impacts on existing and proposed infrastructure • property damage from subsidence • impacts on the beds of Lake Macquarie
Noise and vibration	• consideration of prevailing winds • proposed monitoring locations
Community	• design, implementation and management of community trust
Traffic and transport	• road maintenance contribution requirement to Wyong Shire Council (now Central Coast Council) • impact from change in hours for coal haulage • approvals for the haul road • ongoing coal haulage arrangements
Air quality	• proposed monitoring locations
Ecology	• impacts on seagrass • impacts on terrestrial vegetation from civil works
Consultation	• incorporation of matters raised from neighbouring suburbs
Employment	• number of employees • source of employees • maintaining employment of workforce to activate northern Wyong LGA • flow-on effects for local business with job creation

6.6.1.2 Previous SIA Outcomes

The SIA undertaken for the existing CVC operations concluded:

- the project would not increase the region's population, adverse social impacts on community infrastructure and services would be negligible
- the project would enable continued support to the local community as a direct and indirect local employer, economic contributor and community partner
- the project would have no noticeable effects on the social amenity of the surrounding areas
- LakeCoal (the previous operator) had implemented a range of measures to actively communicate and inform local stakeholders of its activities and to ensure it is able to identify opportunities to improve local amenity
- LakeCoal would continue to address any project-related concerns with local stakeholders during the EIS process and throughout the life of the mine

- although the project would not increase the workforce numbers, continued operations would provide sustained income, ongoing employment and positive flow-on effects
- the presence of the workforce would also maintain positive impacts for the local economy due to demand for goods and services for other services and industries such as retail trade, hospitality, hiring and construction. Conversely, the job losses that would result from the mine closure, should approval for the project not be granted, would negatively affect the social wellbeing of the local area.

6.6.2 Existing Social Management and Mitigation Measures

There are a number of management and mitigation measures currently implemented for the existing approved operations including in relation to community engagement, social amenity and monitoring. These are summarised below:

Community Engagement

Delta Coal continue to keep the local community informed of its mining operations and performance by:

- maintaining open and constructive communication with affected individuals and groups
- participating in the CCC
- providing environmental monitoring data and other relevant information in a timely manner via the Delta Coal website.

Social amenity

Factors affecting social amenity from the existing operations include traffic, air quality, noise and visual impacts. A detailed description and listing of the proposed management and monitoring measures for these environmental aspects can be found in the relevant management plans for CVC's operations (refer to **Section 7.0**).

Monitoring

Delta Coal monitors and reviews potential impacts associated with their operations over time. An important component is the continued implementation of its existing engagement tools to ensure:

- community issues and actual and/or perceived impacts from CVC's activities are understood
- working partnerships with stakeholders are maintained and established to address community needs
- effective management of CVC's social impacts.

Key activities undertaken include:

- regular liaison with relevant government agencies and councils
- regular CVC updates with landowners and local residents through the CCC
- providing regular updates and reporting through CVC's website
- considering individual sponsorship opportunities throughout the life of the operations
- continued payments, throughout the life of the operations, to the community fund established.

6.6.3 Proposed Modification Community Engagement

As outlined in **Section 4.1**, Delta Coal is committed to engaging with the community and other stakeholders regarding its activities. Delta Coal has undertaken the following engagement activities specific to the Proposed Modification:

- provided regular updates to the combined CVC and Mannering Colliery CCC on the Proposed Modification and the progress of associated environmental assessments
- selection of a member from Silverwater to become a member of the combined CVC and Mannering Colliery CCC. The new committee member has attended subsequent quarterly CCC meetings
- distributed community newsletters to residents, including residents in the suburbs of Brightwaters, Silverwater, Mirrabooka and Sunshine, providing information on the Proposed Modification, along with an opportunity to provide input on the proposal
- information on the proposal has been available on the Delta Coal website since February 2020
- facilitation of a community information session at the Bonnells Bay community hall with plans/display boards/frequently asked question sheets all providing information on the Proposed Modification, current operations and longer-term mining approvals and tenements to community members

Issues raised by the community and other stakeholders as part of this engagement process are summarised in **Section 4.1**.

6.6.4 Proposed Modification Social Impacts

The Proposed Modification does not propose any change to approved operations that alter the location, scale or intensity of approved operations. No changes to the mining method, approved subsidence impacts, production rate or surface facilities are proposed. The social impacts of the Proposed Modification are therefore not new or different (in terms of scale and/or intensity) from those approved under the existing CVC and Myuna Consents.

As outlined in **Section 3.0**, Delta Coal is proposing to increase the number of employees reporting to the CVC pit top by 110 FTE employees, from approximately 220 to approximately 330 FTE employees, to reflect the increasingly integrated management of Delta Coal employees between CVC and Mannering Colliery. This increase comprises employees currently reporting the adjacent Mannering Colliery pit top and does not represent an increase in the total number of employees accessing the combined CVC and Mannering Colliery operations. The Mannering Colliery and CVC pit top facilities are located approximately 1 km from each other and are both accessed off Ruttleys Road, Mannering Park. The relevant access points off Ruttleys Road are approximately 500 m apart. No residences are located on this 500 m section of Ruttleys Road. Other than the change to traffic movements at the respective intersections, there would be no other impact on other road users or neighbours. The minor change in employee location will not affect performance of the broader road network (refer to **Section 6.4**) and would not result in any change to traffic and noise impacts at existing neighbours.

6.6.5 Proposed Modification Mitigation and Management Measures

Delta Coal will continue to consult with residents, including those in the suburbs of Brightwaters, Mirrabooka, Silverwater and Sunshine as part of their ongoing engagement activities.

In addition, Delta Coal will continue the management and mitigation measures for CVC, as outlined in **Section 6.3.5**.

7.0 Environmental and Social Mitigation and Management Measures

Delta Coal is committed to operating in a socially and environmentally responsible manner through the application of an Environmental Management System (EMS). The Delta Coal EMS is based on the ISO 14001 standard and aims to provide a consistent approach to integrate environmental management at all levels of the organisation.

As required by the CVC Consent, CVC operates under a number of environmental management plans, including:

- Air Quality Management Plan
- Biodiversity Management Plan
- Road Transport Protocol and Coal Haulage Drivers code of conduct
- Environmental Management Strategy
- Heritage Management Plan
- Noise Management Plan
- Water Management Plan (including Groundwater Management Plan)
- Seagrass Management Plan
- Benthic Communities Management Plan
- Rehabilitation Management Plan
- Public Safety Management Plan

Mannering Colliery also operates under an EMS in accordance with the Mannering Consent. All management and mitigation measure required under the Mannering Colliery EMS will continue to be implemented in relation to the pit top facility where coal from CVC is received.

All aspects relating to environmental management at CVC will continue in accordance with the CVC Consent (as modified). The existing CVC EMS and management plans are generally considered suitable to cover the Proposed Modification (i.e. addition of mining within the Northern Mining Area). Relevant management plans will be updated where relevant to address the Proposed Modification. Any updates to management plans will be undertaken in consultation with relevant authorities.

If the Proposed Modification is approved, the following additional management measures are proposed:

Subsidence

- The CVC Built Features Management Plan and Public Safety Management Plan will be updated to include mining within the Northern Mining Area.

Groundwater

- The Groundwater Management Plan will be updated to incorporate the Northern Mining Area should the modification be approved.

8.0 Justification and Conclusion

This section provides a conclusion discussing the justification for the Proposed Modification, taking into consideration the environmental, social and economic impacts of the Proposed Modification and the suitability of the site, to assist the consent authority to determine whether or not the Proposed Modification is in the public interest.

8.1 Environmental Impacts

The environmental impacts associated with the Proposed Modification have been assessed and approved previously under the CVC Consent and Myuna Consent. As detailed in **Section 6.0**, the environmental impacts of the Proposed Modification have been identified and subject to relevant environmental assessment. The Proposed Modification constitutes a minor change to approved underground mining operations at CVC that will not result in any substantive change in approved environmental or social impacts of the approved CVC and Myuna developments. It is noted that impacts would occur irrespective of whether the Proposed Modification is approved, as mining within the Northern Mining Area could be undertaken by Myuna Colliery under the Myuna Consent.

There will be no change to the existing CVC mining method, approved subsidence impacts, production rate, surface infrastructure, maximum road coal haulage or development consent period.

The proposed changes in employment result in a redistribution of employees from Mannering Colliery to CVC but does not affect shift arrangements or overall employment numbers. Impacts associated with the proposed employee number changes are solely associated with increased traffic movements through the Rutteys Road/Construction Road intersection and the Construction Road/CVC Access Road intersections at shift changes. These potential impacts have been assessed and all affected intersections continue to operate at a good LoS for the life of approved operations.

8.2 Ecologically Sustainable Development

An objective of the EP&A Act is to encourage Ecologically Sustainable Development (ESD) within NSW. This section provides an assessment of the Proposed Modification in relation to the principles of ESD.

To justify the Proposed Modification with regard to the principles of ESD, the benefits of the Proposed Modification in an environmental and socio-economic context should outweigh any negative impacts. The principles of ESD encompass the following:

- the precautionary principle
- inter-generational equity
- conservation of biological diversity
- valuation and pricing of resources.

Essentially, ESD requires that current and future generations should live in an environment that is of the same or improved quality than the one that is inherited.

8.2.1 The Precautionary Principle

The EP&A Regulation defines the precautionary principle as:

> *'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.'*

In order to achieve a level of scientific certainty in relation to potential impacts associated with the Proposed Modification, detailed assessment of key issues has been conducted and is documented in this SEE. It is noted that the Northern Mining Area is currently approved for mining from the Myuna Colliery operation. The Proposed Modification involves the same mining methods as those currently approved for Myuna Colliery and the impacts associated with those operations have been previously assessed and approved.

The decision-making process for the design, impact assessment and development of management processes has been transparent in the following respects:

- Government authorities, landholders potentially affected by the Proposed Modification, the local community, and other stakeholders were consulted during SEE preparation (refer to **Section 4.0**). This enabled comment and discussion regarding potential environmental impacts and proposed environmental management procedures.
- The community has been engaged throughout the assessment of the Proposed Modification through a range of mechanisms including community information sessions and community newsletters amongst other mechanisms (refer to **Section 4.0**) which provided landholders and stakeholders with information.
- Delta Coal implements a comprehensive EMS, and related environmental management programs, that seek to implement best practice management. The Proposed Modification will incorporate the practices implemented and demonstrated to be effective at CVC and the existing EMS will be revised to incorporate the Proposed Modification.
- An auditing and review process is an integral component of the EMS, providing for verification of the Proposed Modification performance by independent auditors and relevant government agencies. The Proposed Modification will implement an auditing and verification process consistent with that currently undertaken at the current CVC operations.

8.2.2 Intergenerational Equity

The EP&A Regulation defines the principal of intergenerational equity as:

> *'...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 between generations. It requires that the needs and requirements of today's generations do not compromise the needs and requirements of future generations in terms of health, biodiversity and productivity.

The objectives of the Proposed Modification are to:

- conduct mining in an environmentally responsible manner to minimise project-specific and cumulative environmental and social impacts, and make efficient use of the available coal resource
- maintain or reduce impacts of CVC by incorporating mitigation measures into the project design, such as the first workings mine design
- continue to develop CVC with a long-term focus on:
    - maximising efficiency and coal resource recovery
    - optimising the use of existing infrastructure
- maintaining and extending the employment opportunities for Delta Coal employees
- co-existing with the local community.

The design of the Proposed Modification and commitment to the management of environmental issues seeks to maintain the health, diversity and productivity of the environment for future generations through the use of long term stable first workings mining methods. With the Proposed Modification, CVC will continue to make a significant contribution to maintaining services in the community through the direct and flow on effects of employee and operational expenditure and through development contributions in accordance with the EP&A Act.

The Proposed Modification is unlikely to result in any increase in greenhouse gas emissions beyond what is currently approved under the Myuna, CVC and Mannering Colliery consents as the Proposed Modification does not increase the volume of coal approved to be mined from these operations or the life of mining operations. If the Proposed Modification is not approved, the VPPS would still need to obtain coal from alternative sources or different mining areas within the CVC and Mannering Colliery approved mining areas.

8.2.3 Conservation and Biological Diversity

The EP&A Regulation identifies that the principal of conservation of biological diversity and ecological integrity should be a fundamental consideration in the decision-making process. The conservation of biological diversity refers to the maintenance of species richness, ecosystem diversity and health and the links and processes between them. As outlined in **Section 3.0**, the Proposed Modification will not result in any additional disturbance beyond what is currently approved, nor will it result in any change in indirect impacts associated with subsidence. As a result, the Proposed Modification will not result in any change in impacts to ecosystem and habitat values.

8.2.4 Valuation of Pricing Resources

The goal of improved valuation of natural capital has been included in Agenda 21 of Australia's Intergovernmental Agreement on the Environment. The principle has been defined in the EP&A Regulation as follows:

> *'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; and*

(iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.'

Project considerations have included the costs of management measures to minimise potential environmental and social impacts. In many cases, operational efficiencies are also associated with improved environmental outcomes. For example, the use of existing underground coal transfer linkages reduces total noise and dust emissions and diesel use (with associated greenhouse gas and particulate emission reductions). The Proposed Modification also optimises the valuation and pricing of the coal resources with minimal impact by optimising available use of the existing infrastructure and equipment.

8.3 Conclusion

The Proposed Modification seeks to extend CVC's mining operations into an area of the Fassifern Seam that is currently approved for mining under the Myuna Consent. The effect of this change would be that coal within the Northern Mining Area would be accessed from the south via CVC workings, rather than from the north via Myuna Colliery workings. No change to approved subsidence limits, mining methods, production rate or surface facilities is proposed.

The Proposed Modification constitutes a minor change to an existing approved underground mine and is considered substantially the same as the development approved under the CVC and Myuna Consents.

The Proposed Modification will allow for a reliable and cost-effective supply of coal for the VPPS through the Delta Coal assets with no increase in adverse environmental or social impacts beyond those approved through the CVC Consent and Myuna Consent.

The Proposed Modification has been assessed against the principles of ESD as required by the EP&A Act. This assessment has indicated that the Proposed Modification is consistent with the principles of ESD.

The SEE demonstrates that the Proposed Modification can be effectively managed to meet current approved environmental performance measures and without any change to existing approved impacts on the local environment or community.

9.0 References

Centennial Coal Company Limited, 2014. *Environmental Assessment Myuna Colliery Section 75W Modification to Project Approval PA 10_0080*.

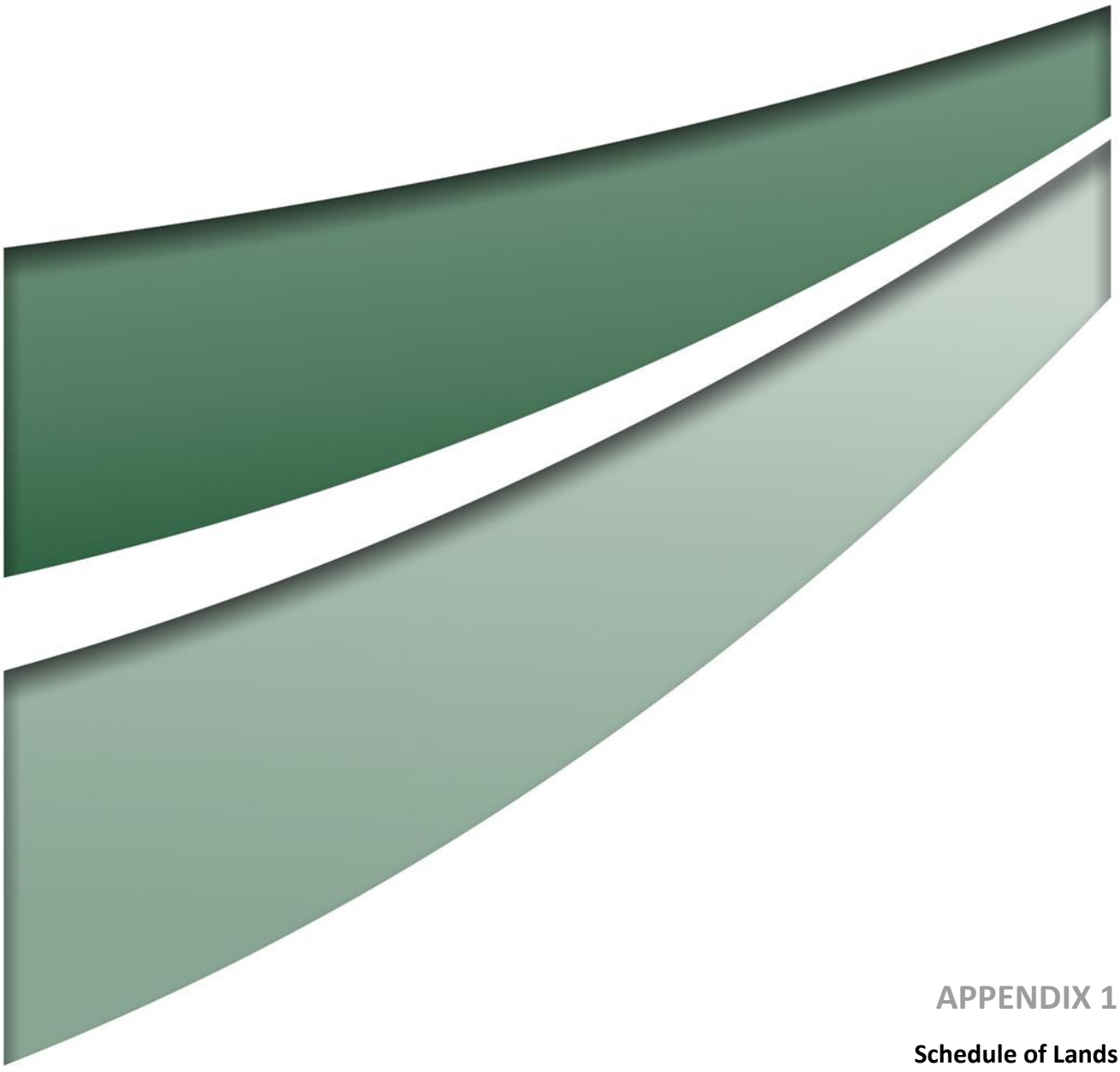
Centennial Coal Company Limited, 2015. *Mining Operations Plan, Rehabilitation Management Plan. Myuna Colliery January 2016 to December 2022*.

Commonwealth of Australia, 2014. *Background review: Subsidence from coal mining activities*.

EMM, 2013. *Mining Extension 1 Project – Environmental Impact Statement.* Prepared for LakeCoal Pty Ltd.

EMM, 2019. *Statement of Environmental Effects, Chain Valley Colliery – Modification 3.* Prepared for Great Southern Energy Pty Ltd (trading as Delta Coal).

Strata^2, 2020. *Proposed Extension to the Northern Mining Area – Panel Design Criteria for Negligible Surface Effects.* Prepared for Delta Coal, Chain Valley Colliery.



APPENDIX 1

Schedule of Lands

APPENDIX 1
SCHEDULE OF LAND

Notes:

1. All proposed secondary extraction for the Project (Mining Extension 1) is to occur under Lake Macquarie.
2. The surface facilities for the Colliery are limited to "pit top area" adjacent to Vales Point Power Station, and the "ventilation shaft site" at Summerland Point.
3. Refer to Figure 1 of Appendix 2 for the Site.

Project Related Surface Facilities

Pit Top Area	
Lot	Deposited Plan
A	379918
B	379918
C	349733
A	187570
1B	339441

Ventilation shaft site	
Lot	Deposited Plan
1	226133

All other areas within the Site

Lot	Deposited Plan
7339	1167067
7330	1148105
593	727722
594	727722
D	349733
1	410653
23	708344
21	708344
2	1043151
426	755266
427	755266
136	755266
2	515214
1	515214
1	214300
2	214300
167	755266
1	388154
144	661695
19	25593
20	25593
21	25593
22	25593
23	25593
24	25593
25	25593
26	25593
27	25593
58	31306
59	31306
60	31306

Lot	Deposited Plan
63	31306
149	31306
150	31306
151	31306
152	31306
153	31306
154	31306
155	31306
156	31306
157	31306
158	31306
159	31306
160	31306
161	31306
162	31306
163	31306
164	31306
165	31306
166	31306
167	31306
168	31306
169	31306
170	31306
171	31306
172	31306
173	31306
174	31306
243	31306
244	31306
245	31306
246	31306

Lot	Deposited Plan
249	31306
250	31306
251	31306
252	31306
253	31306
254	31306
255	31306
256	31306
257	31306
258	31306
259	31306
37	31322
38	31322
39	31322
40	31322
41	31322
42	31322
43	31322
44	31322
45	31322
32	13123
33	13123
34	13123
35	13123
36	13123
37	13123
38	13123
39	13123
40	13123
41	13123
168	13123

All other areas within the Site

Lot	Deposited Plan
61	31306
62	31306
184	31306
185	31306
186	31306
20	708344
19	708344
18	708344
17	708344
34	714879
33	714879
32	714879
31	714879
64	31306
65	31306
66	31306
67	31306
68	31306
69	31306
70	31306
71	31306
72	31306
73	31306
74	31306
75	31306
76	31306
77	31306
78	31306
79	31306
139	31306
140	31306
141	31306
142	31306
143	31306
144	31306
145	31306
146	31306
147	31306
148	31306
175	31306
176	31306
177	31306
178	31306
179	31306
180	31306
181	31306
187	31306
188	31306
189	31306

Lot	Deposited Plan
247	31306
248	31306
238	31306
239	31306
240	31306
241	31306
242	31306
46	31322
47	31322
48	31322
78	31322
4	981106
3	981104
11	13120
12	13120
13	13120
14	13120
15	13120
16	13120
17	13120
18	13120
19	13120
20	13120
21	13120
22	13120
23	13120
24	13120
60	13120
30	13123
31	13123
A	368634
100	1065718
102	1065718
20	1113256
7329	1148149
5	981103
9	13120
100	713777
25	13120
26	13120
27	13120
28	13120
29	13120
1	1221849
2	1221849
3	1221849
4	1074358
	93941
	93945

Lot	Deposited Plan
182	31306
183	31306
243	8055
241	8055
172	8055
2	803077
3	568311
242	8055
244	8055
179	8055
250	8055
185	8055
180	8055
183	8055
249	8055
240	8055
178	8055
2	568311
181	8055
C	25385
191	8055
B	25385
245	8055
175	8055
78	8055
173	8055
176	8055
76	8055
177	8055
251	8055
248	8055
246	8055
3	803077
1	568311
184	8055
4	568311
174	8055
247	8055
D	25385
190	8055
E	25385
1	803077
1	204202
1	551113
1	1074358
3	1074358
2	1074358
751	1099436
752	1099436

All other areas within the Site

Lot	Deposited Plan
190	31306
191	31306
192	31306
193	31306
194	31306
195	31306
78	13123
119	13123
103	13123
15	13123
2	204202
105	13123
122	13123
109	13123
6	519261
1	621171
2	1013763
111	13123
69	13123
13	13123
3	250973
124	13123
23	13123
802	1038413
721	537942
116	13123
191	880592
126	13123
131	13123
822	588493
3	621171
772	619779
7	13120
91	880881
45	13120
41	872109
3	13120
99	13123
42	872109
37	13120
2	621171
39	13120
49	13120
153	17367
773	619779
771	619779
112	13123
82	13123
43	13123

Lot	Deposited Plan
10	1235493
11	1235493
9	1235493
189	8055
252	8055
186	8055
127	13123
47	13120
2	806513
135	8055
117	8055
2	551787
45	15556
71	15556
100	790729
1	551787
69	27749
87	8055
39	15556
76	15556
202	8055
104	8055
197	8055
101	790729
53	27749
49	27749
254	8055
81	8055
199	8055
138	8055
41	15556
12	15556
44	27749
25	27749
54	15556
126	8055
1482	562711
52	15556
208	8055
113	8055
70	27749
56	27749
24	15556
228	8055
88	8055
132	8055
60	15556
17	28068
56	13123

Lot	Deposited Plan
753	1099436
7309	1141468
20	1075811
21	1075811
722	537942
5	1074358
121	13123
10	28068
143	13123
154	13123
47	13123
98	13123
104	13123
125	13123
65	13123
22	13123
14	13123
3	28068
151	13123
110	13123
16	13123
117	13123
156	17367
204	1017819
68	13123
142	13123
96	13123
64	13123
123	13123
15	538780
873	733417
150	13123
90	13123
130	13123
13	28068
22	1029069
42	13123
7	13123
153	13123
93	13123
152	13123
192	880592
115	13123
18	13123
4	250973
87	13123
157	13123
51	13123
54	13123

All other areas within the Site

Lot	Deposited Plan
141	13123
120	13123
108	13123
5	981103
66	13123
14	28068
106	13123
45	13123
50	13123
3	981104
1	542486
44	13123
862	557889
2	542486
75	13123
49	13123
73	13123
56	13120
58	13120
147	13123
1	806513
35	13120
43	13120
5	13120
42	13120
8	13120
1	13120
33	13120
31	13120
46	13120
18	527120
145	13123
55	13120
54	13120
9	13120
28	13120
2	13120
450	818534
3	579042
48	13120
44	13120
84	13123
29	13120
52	13120
100	713777
4	13120
1	579042
51	13120
146	13123

Lot	Deposited Plan
20	13123
76	13123
72	13123
152	17367
5	519261
205	1017819
92	13123
522	543408
80	13123
521	543408
30	13120
83	13123
34	13120
36	13120
351	840188
32	13120
101	558722
8	524374
102	558722
86	13123
821	588493
6	13120
2	579042
2	270423
6	270423
1	270423
4	270423
1	1107356
2	1107356
1691	1110053
1693	1110053
1692	1110053
2144	1124129
7311	1141467
7306	1146817
101	1165194
154	17367
5	270423
42	1073017
60	1074161
872	733417
51	27749
103	15556
11	13123
12	13123
21	13123
43	1073017
41	1073017
61	1074161

Lot	Deposited Plan
9	13123
77	13123
149	13123
19	13123
48	13123
102	13123
67	13123
156	13123
114	13123
89	13123
91	8055
46	13123
831	598304
121	15556
6	15556
158	8055
69	15556
92	8055
3	561577
218	8055
210	8055
193	8055
30	15556
66	27749
63	27749
9	15556
14	15556
31	15556
781	1060935
54	27749
105	8055
123	8055
58	27749
74	15556
50	27749
61	15556
233	8055
110	15556
43	27749
102	8055
2	15556
46	27749
17	15556
60	27749
41	27749
29	15556
36	27749
20	15556
8	15556

All other areas within the Site

Lot	Deposited Plan
38	13120
155	17367
57	13120
50	13120
7	524374
861	557889
40	13120
144	13123
911	747550
53	13120
912	747550
352	840188
41	13120
4	981106
13	15556
260	8055
124	8055
38	27749
157	8055
48	15556
27	27749
198	8055
195	8055
782	1060935
812	816616
32	15556
155	8055
134	8055
130	8055
75	15556
15	15556
3	15556
256	8055
26	27749
51	15556
232	8055
205	8055
164	8055
10	15556
128	8055
136	8055
86	15556
201	843074
38	15556
1	561577
833	598304
235	8055
112	15556
220	8055

Lot	Deposited Plan
63	1074161
62	1074161
3	270423
1	1088536
202	1093288
201	1093288
139	8055
14	538780
46	15556
113	15556
21	1029069
119	8055
230	8055
25	15556
211	8055
112	8055
142	8055
227	8055
28	15556
109	15556
142	15556
223	8055
77	15556
215	8055
2	375836
31	27749
43	15556
59	27749
224	8055
53	15556
107	8055
117	15556
88	15556
202	1020262
236	8055
19	15556
1	250973
47	27749
115	8055
89	8055
106	8055
35	27749
133	8055
34	27749
154	8055
42	27749
72	15556
21	15556
207	8055

Lot	Deposited Plan
203	8055
68	27749
49	15556
93	8055
1	15556
67	15556
151	734618
22	15556
62	15556
23	27749
21	27749
122	8055
96	8055
137	8055
105	15556
116	15556
192	1046133
50	15556
100	8055
32	524726
27	15556
201	8055
159	8055
107	15556
64	15556
33	15556
95	8055
24	27749
114	8055
111	15556
7	15556
204	8055
259	8055
118	15556
632	872639
255	8055
114	15556
37	27749
61	27749
44	15556
66	15556
231	8055
216	8055
70	15556
108	8055
217	8055
116	8055
229	8055
129	8055

All other areas within the Site

Lot	Deposited Plan
40	27749
65	15556
225	8055
125	8055
65	27749
226	8055
194	8055
192	8055
57	15556
209	8055
36	15556
2061	1011261
121	8055
147	8055
115	15556
871	733417
47	15556
39	27749
40	15556
52	27749
28	27749
97	8055
200	843074
67	27749
58	15556
23	15556
120	15556
129	13123
1	505798
18	28068
10	13123
155	13123
97	13123
8	13123
113	13123
41	13123
118	13123
39	13123
801	1038413
85	13123
167	13123
55	13123
81	13123
128	13123
91	13123
40	13123
107	13123
203	1020262
79	13123

Lot	Deposited Plan
98	8055
127	8055
120	8055
48	27749
101	15556
101	8055
234	8055
33	524726
832	598304
156	8055
191	1046133
111	8055
42	15556
237	8055
219	8055
57	27749
34	15556
222	8055
196	8055
3	375836
212	8055
811	816616
73	15556
90	8055
26	15556
28	13123
25	13123
24	13123
36	13123
31	13123
94	13123
35	13123
26	13123
30	13123
38	13123
29	13123
168	13123
27	13123
37	13123
185	15556
134	15556
102	844302
136	15556
139	15556
125	15556
101	844302
137	15556
131	859693
126	15556

Lot	Deposited Plan
29	27749
238	8055
2	561577
5	15556
30	27749
239	8055
55	15556
59	15556
4	15556
82	740968
37	15556
18	15556
221	8055
68	15556
253	8055
131	8055
62	27749
2062	1011261
141	15556
138	15556
133	15556
45	654334
132	15556
129	15556
131	15556
98	15556
130	17367
59	17367
134	17367
37	17367
127	17367
73	17367
24	17367
1	13123
148	17367
161	17367
6	13123
158	13123
222	833454
105	17367
12	17367
395	755242
A	365476
69	17367
50	17367
162	13123
70	17367
48	17367
81	17367

All other areas within the Site

Lot	Deposited Plan
15	28068
70	13123
100	13123
95	13123
148	13123
63	13123
5	250973
11	15556
22	27749
64	27749
16	15556
55	27749
103	8055
88	13123
631	872639
110	8055
200	8055
99	8055
109	8055
106	15556
140	8055
56	15556
2	28068
4	13123
46	654032
123	17367
140	13123
3	251160
159	13123
138	13123
80	17367
4	251160
394	755242
398	755242
396	755242
25	17367
67	17367
5	251160
65	17367
93	17367
96	17367
21	17367
106	17367
151	854877
162	17367
82	17367
126	17367
118	17367
57	17367

Lot	Deposited Plan
187	15556
6	251160
3	13123
55	17367
95	17367
2	13123
77	17367
116	17367
79	15556
66	17367
140	15556
132	859693
2	634668
130	15556
123	15556
206	15556
128	15556
135	15556
124	15556
186	15556
127	15556
179	15556
201	700345
158	17367
163	17367
49	17367
147	17367
149	17367
142	852383
92	17367
94	17367
72	17367
164	17367
58	17367
64	17367
43	17367
76	17367
139	17367
97	17367
11	17367
14	17367
150	17367
145A	17367
78	17367
115	17367
140	17367
131	17367
107	17367
129	17367

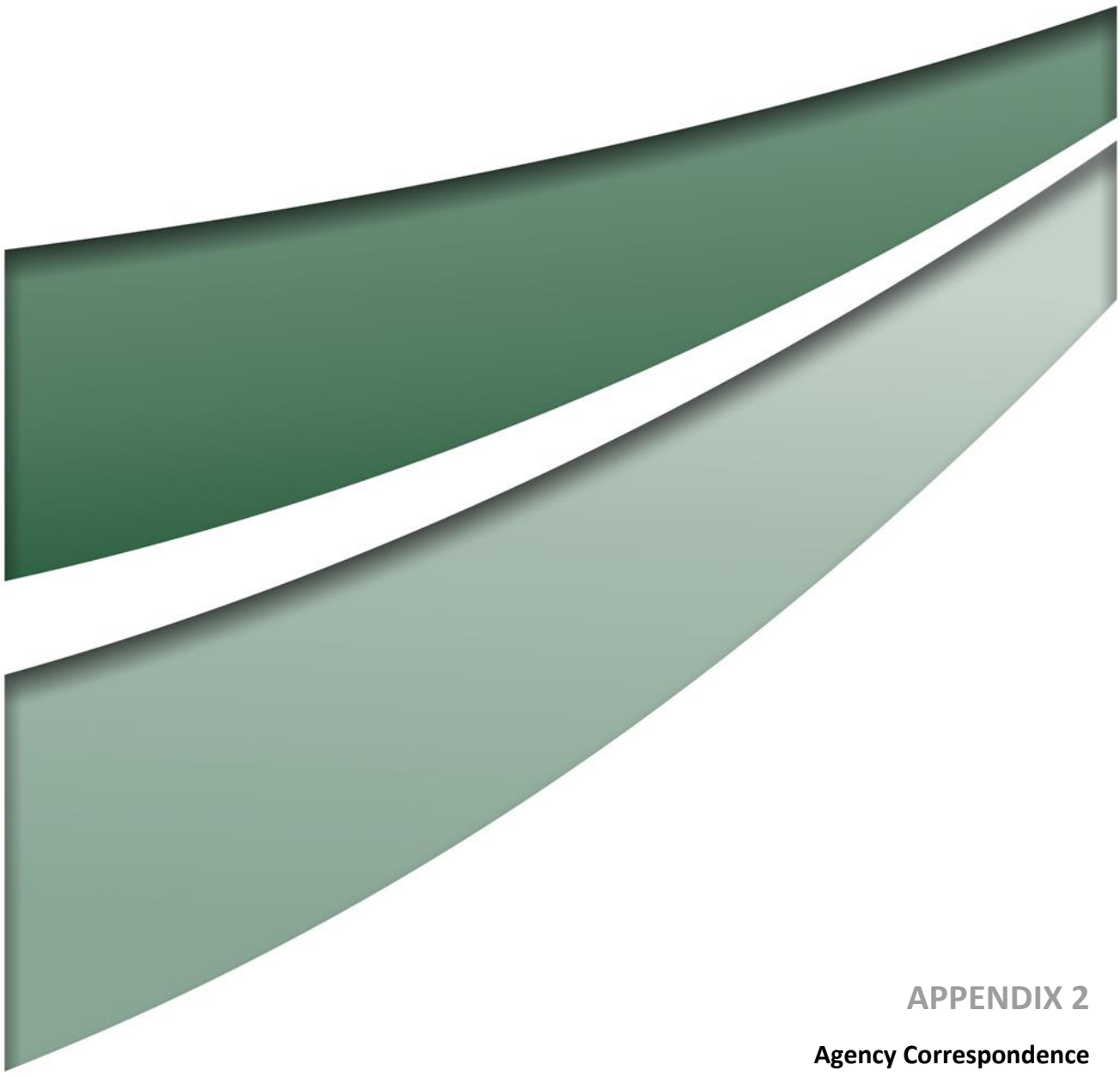
Lot	Deposited Plan
387	755242
54	17367
160	17367
144	17367
124	17367
74	17367
112	17367
102	17367
139	13123
51	17367
40	17367
101	17367
2	251160
109	17367
223	833454
141	17367
138	17367
9	28068
500	755242
145	17367
62	17367
44	17367
110	17367
60	17367
35	17367
39	17367
7074	1029683
111	17367
108	17367
100	17367
136	17367
103	17367
13	17367
397	755242
7015	1119454
470	1118245
7323	1141840
102	1165194
1	1185308
2	1185308
1572	1043970
10	1071069
3991	1136246
7322	1141840
7	1228566
6	1228566
5	1228566
4	1228566
3	1228566

All other areas within the Site

Lot	Deposited Plan
89	17367
122	17367
164	13123
10	17367
63	17367
146	17367
36	17367
120	17367
113	17367
142	17367
41	17367
137	17367
117	17367
152	854877
98	17367
121	17367
151	17367
119	17367
B	365476
128	17367
5	13123
99	17367
165	17367
61	17367
135	17367
165	13123

Lot	Deposited Plan
1	251160
52	17367
133	17367
53	17367
166	13123
388	755242
390	755242
389	755242
68	17367
125	17367
38	17367
143	17367
141	852383
160	13123
75	17367
161	13123
114	17367
71	17367
132	17367
163	13123
56	17367
166	17367
159	17367
104	17367
42	17367
79	17367

Lot	Deposited Plan
2	1228566
1	1228566
8	1228566
4	28068
71	13123
74	13123
59	13120
1001	1253581
1002	1253581
99	15556
316	755242
471	1118245



APPENDIX 2

Agency Correspondence

Planning, Industry & Environment

Mr Chris Armit
Environment and Community Coordinator
Great Southern Energy (t/as Delta Coal)
Chain Valley Colliery
Off Construction Road
Off Ruttleys Road
Mannering Park New South Wales 2259

09/11/2020

Dear Mr Armit

Chain Valley Colliery Modification 4 (SSD-5465)
Preparation of a Modification Application

I refer to your correspondence concerning the proposed Chain Valley Colliery Modification 4 (SSD-5465).

The Department refers to its previous correspondence of 31 July 2019 confirming the proposed approach to preparing a modification application and is satisfied that the application may be progressed.

Your next step will be to lodge your modification application through your dashboard on the Departments Major Projects website http://www.planningportal.nsw.gov.au/major-projects

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

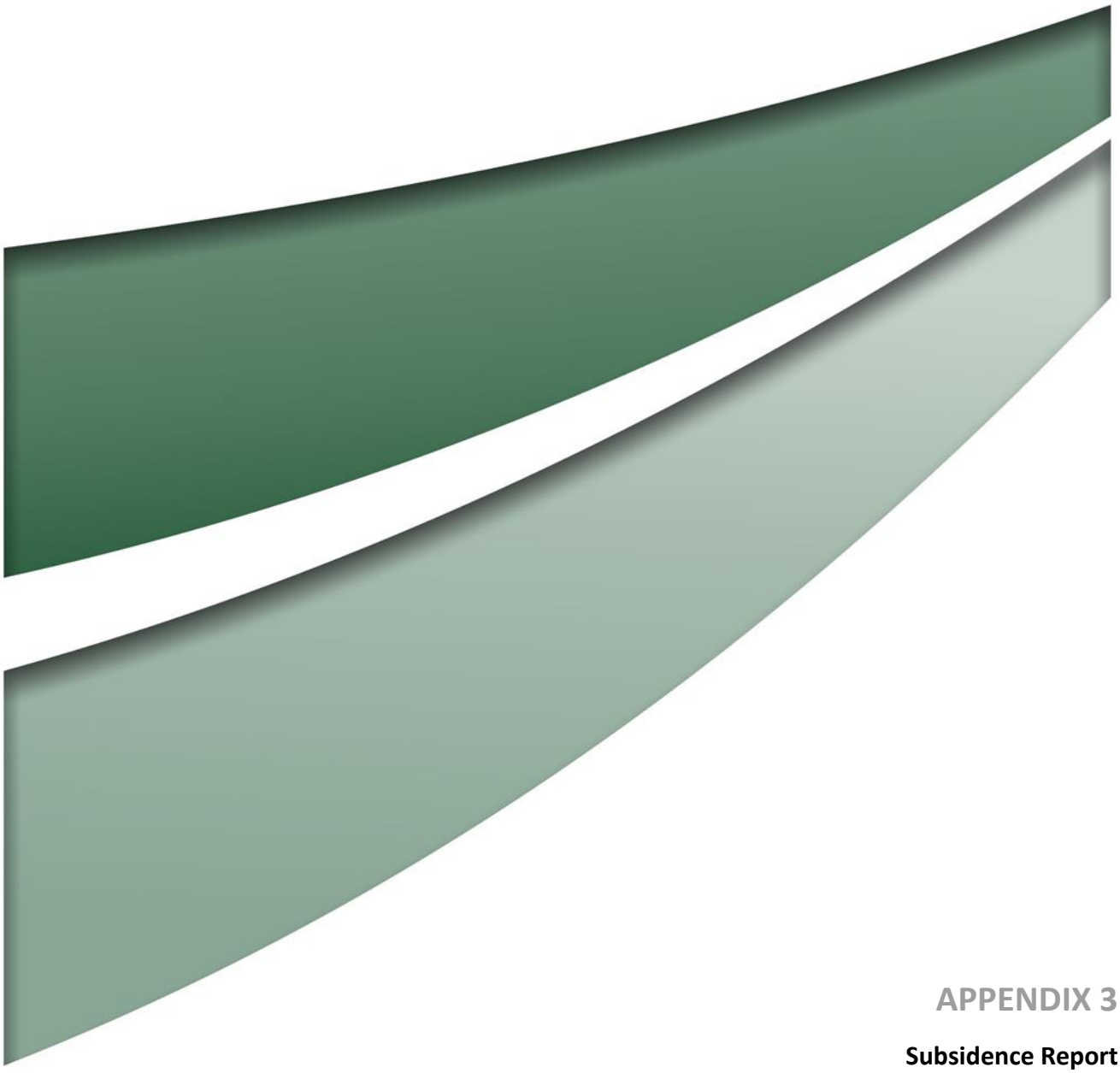
This approval would be in addition to any approvals required under NSW legislation and it is your responsibility to contact the Commonwealth Department of Agriculture, Water and Environment to determine if an approval under the EPBC Act is required (http://www.environment.gov.au or 6274 1111).

If you have any questions, please contact Melissa Anderson on 8275 1392.

Yours sincerely,

Colin Phillips

Colin Phillips
Team Leader
Resource Assessments (Coal & Quarries)



APPENDIX 3

Subsidence Report

STRATA²
Ground Control Consulting

DELTA COAL
CHAIN VALLEY COLLIERY

Proposed Extension to the Northern Mining Area – Panel Design Criteria for Negligible Surface Effects

MARCH 2020

Report No: CHV-016-Rev0

ABN 19 622 292 460
First Floor, Building B, Edgeworth Town Square
720 Main Road
Edgeworth NSW 2285

REPORT TO : Dave McLean
General Manager
Delta Coal

REPORT ON : Proposed Extension to the Northern Mining Area – Panel Design Criteria for Negligible Surface Effects

REPORT NO : CHV-016-Rev0

REFERENCE : PO D107728

Rev	Date	Prepared	Status	Signature
A	20/01/2020	D. Hill	Draft	
0	31/03/2020	D. Hill	Final	

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	GEOLOGICAL / GEOTECHNICAL ENVIRONMENT	1
2.1	Geology	1
2.2	Rock Strength	2
2.3	*In Situ* Stress	2
2.4	Stress Strength Ratio	3
3.0	PILLAR DESIGN METHODOLOGY	4
3.1	Pillar Strength Formulae	4
3.2	Pillar Load	5
3.3	The Importance of Pillar Width to Height (w/h) Ratio	5
3.4	Summarised Composite Design Criteria based on FoS and w/h Ratio	6
3.5	Pillar Design Outcomes	7
3.5.1	Depth Sensitivity	7
3.5.2	Comparison with Design Approaches from Adjacent Mines	8
3.5.3	“Dog-Kennel” Pillar Design	8
4.0	CONCLUDING REMARKS	8
5.0	REFERENCES	9

1.0 INTRODUCTION

This report addresses the design of a "herringbone" pillar layout for future Fassifern Seam workings in the proposed extension to the Northern Mining Area ("NMA"). The area of interest is shown in **Figure 1** and the layout is shown schematically in **Figure 2**. The system initially involves the drivage of a mains panel up to five headings wide. Either side of this mains, individual panels are developed by driving a "sub-mains" three-headings wide. From the sub-mains, "run-out" roadways are driven, typically 80m long (mainly limited by wheeling distances). Finally, stubs or "free cuts" are driven from these run-out roadways to form the final pillars; depending on the ground conditions and serviceability requirements of these free cuts, they may or may not remain unsupported (for example, some are bolted to facilitate long-term return airway ventilation).

The main geotechnical design issues / constraints for this system in the NMA Extension are as follows:

i) The cover depth is typically 150m to 190m, but reduces to 140m in the east, see **Figure 1**.

ii) The FAS working section varies between 3.4m and 4m, thinning slightly to the east, see **Figure 3**.

iii) The total resource area is about 1.8km² and much of the surface would be considered sensitive to subsidence effects; key features are the lake foreshore zones, including the Lake Macquarie State Conservation Area, as well as residential areas.

iv) Accordingly, it is suggested that the workings be designed to be long-term stable and result in negligible subsidence (defined for this purpose as vertical subsidence of ≤ 20mm).

v) There are no other existing workings, multi-seam or adjacent, that represent a potential interaction issue; the closest approach of the Myuna Colliery Fassifern Seam workings to the north of the area of interest is a distance of ~96m.

vi) Stable unsupported stubs are critical to the productivity of the herringbone system. This issue was addressed in previous **Strata² Report No. CHV-005 (2019)** and a standard stub width of 5.5m is assumed herein.

vii) The interval between stubs is partly a function of the required pillar size, but also dictated by the need to separate the adjacent alternating stubs for roof control purposes, thereby forming isolated three-way intersections. Practically, allowing for break-offs, this dictates a minimum stub (solid) interval of around 19m.

It should be apparent from the preceding points that design of a herringbone panel geometry requires some compromise and also a focus on maintaining flexibility wherever possible. In this regard, the design process summarised herein has sought to learn from the relevant experiences of other mines, most notably the herringbone operation at the adjacent Myuna Colliery, where the system has been employed successfully for a number of years.

2.0 GEOLOGICAL / GEOTECHNICAL ENVIRONMENT

2.1 Geology

The following comments are made regarding the extension area:

i) Four boreholes intersect the Fassifern Seam (FAS) in the area of interest: EWN7, EER32, EER33 and EER34, see **Figure 3**. The borehole logs are provided as **Figures 4** to **7**, noting that in the case of the EER series boreholes, information is available for the immediate seam section only.

ii) The B Ply, separating the FAS and the overlying Chain Valley (CHV) Seam, is only ~0.1m thick. It thickens to the SE of the area of interest.

iii) The Chain Valley Seam (CHV) is itself split by the A Ply into the Chain Valley Upper Ply (CHU) and Chain Valley Lower Ply (CHL). The A Ply thickness averages 0.2m. The CHU and CHL average 0.7m and 0.5m in thickness respectively.

iv) The Awaba Tuff (AWT) overlies the CHV and is 10-15m thick.

v) The FAS floor comprises interbedded coal, shale and claystone units, with a combined thickness of 0.4m to 1.2m. This is underlain in turn by shale and claystone units.

vi) The inferred major geological structures (faults and dykes) are aligned orthogonally, NE-SW and NW-SE, see **Figure 8**. The NW-SE structure set comprises dykes and normal faults, whereas the main feature of the NE-SW set is the large reverse fault that forms the NW boundary of the CVC MW7-12 area and is likely to form the NW boundary of the workings in the NMA Extension.

2.2 Rock Strength

The mine has undertaken an underground coring, geotechnical logging and testing programme in the workings immediately to the south of the area of interest. The associated UCS profile, **Figure 9**, is consistent with those determined for adjacent areas, including Mannering North (**Strata² Report No. CHV-014, 2019**). In summary, the significant features are:

- The Awaba Tuff is moderately strong to strong, having a UCS of 20-70MPa.
- The tuffaceous sandstone comprising the B Ply is also moderately strong to strong, with a UCS of 10-60MPa.
- The coal plies are moderately strong, with a UCS of 15 to 25MPa.

From a pillar design perspective, a key issue is the reducing thickness of weak claystone layers within 2m of the working floor towards the north. In previous studies, for areas to the south, “weak floor” has been defined as a total thickness of ≥ 1m of rock with a UCS of ≤ 5MPa, within 2m of the immediate floor. Accordingly, the Fassifern Seam floor strength has tended to be categorised as “marginally weak” and a conservative pillar design approach has been applied. However, in the proposed NMA Extension and adjacent northern areas, the floor is not regarded as weak (i.e. <1m of sub-5MPa material).

2.3 *In Situ* Stress

At CVC, the major horizontal stress direction was measured at 290° (i.e. WNW-ESE) at 62C/T in the Fassifern Seam North Mains (**Coffey, 2015**). Coffey undertook two measurements, at a depth of 195m, and the results indicated that the major horizontal stress, σ_1, varied from 14
.3 to 24.7MPa, depending on the Awaba Tuff Youngs Modulus (E), which varied between 12.0 and 24.4GPa.

Normalising the results to an “average” rock (E = 15GPa) generates the following results:

- the major horizontal stress, σ_1, ranged narrowly between 15.9 and 17.4MPa and
- the minor horizontal stress, σ_2, ranged narrowly between 7.3 and 11.1MPa.

Vertical stress, σ_V, would be around 5MPa, given the depth at the test site, and it is concluded that:

- the ratio of σ_1 to σ_V is ~3.3 and
- the ratio of σ_2 to σ_V is ~1.9.

Further insight can be gained from the Australian coal mines’ major horizontal stress database, as summarised in **Figures 10a/b**.

The following comments are made regarding the database:

i) **Figure 10a** illustrates the major horizontal stress versus depth relationship. Significant scatter is evident for all coalfields.

ii) **Figure 10b** again illustrates the major horizontal stress versus depth relationship, but in this case with the results "normalised" to a rock of average stiffness (15GPa). This normalisation process tends to reduce the scatter.

iii) **Figure 10b** also shows four trendlines, namely:

- Green and red dashed lines representing major horizontal stresses of two and three times the vertical ("2V" and "3V") respectively, which historically have represented the expected design range.
- A solid blue line, representing the regression line for a statistical back-analysis of NSW data conducted by **Mark and Gadde (2010)**.
- A solid black line, representing the regression line for a statistical back-analysis of global data, again conducted by **Mark and Gadde (2010)**.

iv) Following the normalisation process, **Figure 10b**, the CVC data points agree closely. Both CVC measurements plot slightly beyond the 3V Line (i.e. higher than might be expected).

v) There are numerous potential explanations for the relatively high CVC results, including:

- The variability of the mechanical properties of the Awaba Tuff in the FAS roof.
- Measurement errors.
- The location of the measurement site adjacent to an area of active mini-wall extraction, creating the possibility of stress-shadow or, conversely, concentration effects.

vi) The influence of adjacent workings / goaf areas at the CVC measurement site might also at least partially explain the WNW-ESE orientation of σ_1. Mapping at CVC suggests that swings in the major horizontal stress direction can occur over short distances on drivage.

Overall, the stress measurements tend to confirm that the *in situ* horizontal stress is variable and can be locally aggressive. However, given that the average depth in the area of interest is only ~140m, it is considered likely that stress magnitudes will be moderate and relatively favourable for the proposed herringbone operation.

2.4 Stress Strength Ratio

Roadway roof behavior is a function of the geotechnical environment, the excavation geometry and the support regime. The influence of the geotechnical environment can be estimated using the "Stress Strength Ratio" (SSR) approach. SSR is simply the depth / CMRR ratio, where CMRR is the "Coal Mine Roof Rating", an empirical measure of the roof rock mass strength or "Structural competency" (**Molinda and Mark 1994**).

Australian coal mine experience indicates that the following guidelines can be applied:

- SSR ≤ 5: favourable roof conditions
- SSR >5, ≤ 11: favourable to moderate roof conditions
- SSR >11, ≤ 20: moderate to poor roof conditions

- SSR >20: poor to very poor roof conditions

The FAS roof is quite consistent through the area of interest and a CMRR of 34 is representative, based on the data from the geotechnical log of the underground borehole immediately to the south, see **Figure 11**. Adopting a CMRR of 34 results in SSR values of 4.1 to 5.6 across the 140m to 190m depth range, with an average of ~4.7. As indicated above, such SSR values typically equates to favourable roof conditions and relatively low roof support densities. However, it is also noted that the SSR is >5 at depths of >170m, which is likely to necessitate reduced cut distances and also a reduction in free cut width in the areas affected.

3.0 PILLAR DESIGN METHODOLOGY

3.1 Pillar Strength Formulae

An empirical design approach, utilising the UNSW coal pillar strength formulae (**Salamon *et al*, 1996**), is considered most appropriate for the assessment of pillar stability in this case. When applying these formulae, it is common in Australia to use the term "Factor of Safety" (FoS), where FoS = pillar strength / pillar stress.

The UNSW formulae are founded on extensively researched and broadly-based databases of mining experience. These formulae represent the culmination to-date of work commenced almost 60 years ago in South Africa after the 1960 Coalbrook disaster (**Salamon and Munro, 1967**). A combined Australian and South African database has been applied to the derivation of formulae that are considered widely applicable.

The range of parameters within the UNSW combined failed and intact pillar database can be summarised as follows:

- Depth: 20m to 510m
- Mining Height: 1.0m to 9.2m
- Smallest Pillar Dimension: 2m to 32m
- Bord Width: 3.7m to 15.0m
- Percentage Extraction: 30% to 90%
- Width to Height (w/h) Ratio: 0.9 to 11.2
- Time to Failure: 0 to >80 years

The strength formula for Australian coal pillars with w/h ratios of >5 is as follows:

$$\text{Strength, } \sigma_s = 27.63\Theta^{0.51}(0.29*((w_m/5h)^{2.5} - 1) + 1)/(w_m^{0.22} \times h^{0.11})$$

where:

w_m = minimum pillar width (m)
h = roadway height (m)
Θ = a dimensionless 'aspect ratio' factor for rectangular pillars defined by **Salamon *et al,* 1996**.

For pillars with w/h ratios of ≤ 5, the strength formula is as follows:

$$\sigma_s = 8.6(w_m\Theta)^{0.51}/h^{0.84}$$

FoS can be related to the nominal probability of failure of a panel of pillars. A probability of stability of 99.9% is attained at a Factor of Safety of 1.63, see **Figure 12**, and further increases in FoS have little effect, as the probability of stability curve approaches 100% asymptotically. From a risk management perspective, increasing the FoS beyond 1.63 can only reduce the failure probability by <0.1%.

The consequences of collapse are a key consideration, as these determine the acceptable probability of failure, which in turn allows an appropriate FoS to be determined. For example, prudent risk

management suggests that the probability of failure for long-term first workings panels beneath sensitive surface structures should be negligible. In Australia, long-life critical pillars (e.g. in main headings and for the protection of surface infrastructure) are often designed to an FoS of ≥ 2.11, which equates to a nominal failure probability of one panel in a million. This reduces the probability of failure to a level that would be considered acceptable in other key fields of public interest.

It should be understood that the nominal probability of failure is related to the life-time of the pillar database that underpins the design methodology; currently the average is approximately sixty years (i.e. of the order of 120 years of coal pillar history is available). The annualised probability of failure (a concept more commonly applied in engineering practice) is therefore about one-sixtieth of the nominal failure probability.

The South African and Australian databases from which the UNSW formulae were derived cover a broad range of roof and floor materials, including mudrocks, coal, siltstones and sandstones. Therefore, these materials and the variability in strength that may be associated with them are implicitly recognised and largely catered for in the FoS approach. Uncertainty associated with the natural variability in coal measures strata often prohibits design to low FoS values. Geological variability partly accounts for the scatter in the population of failed pillar cases and usually necessitates design to FoS values of >1.5, equivalent to low failure probabilities. Back analysis indicates that incidences of pillar instability traditionally associated with weak floor, for example, can often be explained in terms of conventional empirical design criteria.

Similarly, the database encompasses pillars in a significant number of seams in different geotechnical environments; consequently, the existence of pillar weaknesses is very largely reflected and implicit within the variability in the failed and intact pillar cases, such that these weaknesses are again very largely catered for by adopting appropriate FoS values.

In summary, it is evident from **Figure 12** that provided the workings under consideration are designed to a minimum system FoS of around 1.6, it is necessary to look beyond this concept to obtain any further assurance of long-term stability that may be required. Issues requiring particular attention are:

- The loading history of the pillars.
- The width to height (w/h) ratio of the pillars.

3.2 Pillar Load

For a first workings only scenario involving a regular array of pillars in panels that are moderately wide with respect to the depth, the loading environment can be reasonably approximated to tributary area loading, with each pillar carrying the overburden load due to the overlying column of rock to surface and no appreciable load transfer to the stiffer elements in the system (e.g. the barrier pillars). The tributary area concept is illustrated in **Figure 13**.

3.3 The Importance of Pillar Width to Height (w/h) Ratio

The role of increasing w/h ratio in enhancing coal pillar stability has long been known. Back analysis of case histories from South Africa, Australia and elsewhere has shown that w/h ratio exerts a major influence on coal pillar strength. At low w/h ratios (<3) overloaded coal pillars tend to fail in a brittle, uncontrolled fashion, whereas at greater w/h ratios (>4) the overloaded pillars demonstrate a more plastic form of deformation: significant displacement may still take place in the form of roof to floor convergence, as well as rib spall, but the pillar core remains confined and tends to retain its load carrying ability, generally without failing in the commonly understood sense.

This was illustrated by **Madden (1987)** with laboratory UCS tests on sandstone discs during the initial practical development of the squat pillar formula (he used sandstone because coal samples are more heterogeneous and difficult to prepare). It was also shown by **Das (1986)** in tests on Indian coals, see **Figures 14a/b**. The potential impact of localised geological structures, such as faults, also diminishes rapidly as pillar w/h ratio increases, as illustrated schematically in **Figure 15**. International coal industry experience confirms the importance of w/h ratio to stability; incidences of collapse are concentrated at low w/h ratios, even in known weak floor environments.

Pillar width to height ratio, applied in conjunction with other design criteria, such as FoS, is a useful indicator of design reliability. This is illustrated in **Figure 16**, which presents the FoS versus w/h ratio relationship for a combined database of failed South African and Australian bord and pillar panels, plus a database of highwall mining failed pillar cases (**Salamon *et al* 1996, Madden and Hardman, 1992, SEA, 2001**).
These three databases are highly complementary in nature, reflecting the experiences of the respective industries. For example, the Australian data provides insight with regard to pillar behaviour at relatively high w/h ratios and furnishes the failed case at the w/h ratio of 8.2. In contrast, the South African industry has a high proportion of mining geometries with lower w/h ratios, which is partly reflected in the maximum w/h ratio of only 3.7 for a South African failed case. Similarly, the highwall mining failed pillar cases cover the lower end of the range of w/h ratios, from 0.6 to 1.4.

There are no failed cases in the combined database with a w/h ratio of greater than 8.2, even at a very low FoS, and there is only one failed case at a w/h ratio of >5. The highest FoS assigned to a bord and pillar collapse is 2.1 and this was associated with a w/h ratio of only 2.2. Although there are failed highwall mining pillars with Factors of Safety of >2, all of them have pillar w/h ratios of <2.

A limit envelope can be defined for the database of failed cases (**Hill, 2005**), illustrated by the curve and given by the following equation:

$$\text{w/h ratio} = 22.419e^{-1.148*(\text{Factor of Safety})}$$

Beyond this envelope, there is no precedent for failure within the three databases. It is worth noting that the exclusion of the highwall mining pillar data would not materially change the shape of this limit envelope.

In the case of long life (>5 years) pillars, if it is reasonable to assume that the pillars are, or will at some point in the future, be subjected to full tributary area loading, then it is generally considered prudent to design the pillars to be outside (i.e. above) the envelope defined by this equation, even though there are many examples of stable pillars that fall within it.

Furthermore, in the case of critical, long-life pillars, it is considered prudent to allow an additional margin beyond this curve. Strata Engineering generally suggests a 20% margin, which is defined by the second (i.e. outer) curve in **Figure 16** and the following equation:

$$\text{w/h ratio} = 26.903e^{-0.957*(\text{Factor of Safety})}$$

3.4 Summarised Composite Design Criteria based on FoS and w/h Ratio

As previously indicated, coal pillar design criteria should reflect the specific requirements and nature of the workings (e.g. short-term production panel, as opposed to long-life pillars with surface protection constraints). The general approach can be summarised as follows:

i) Short-term production workings, with considerable local knowledge: design may be within the failed pillar database limit envelope, under controlled circumstances.

ii) Short-term production workings (general): design on the basis of being beyond the failed pillar database limit envelope.

iii) Key underground workings, for example main headings, with medium to long-term serviceability / stability requirements: design on the basis of the limit envelope plus 20% (i.e. the outer database curve).

iv) Underground workings beneath critical, highly sensitive surface structures and / or features (e.g. key infrastructure, such as railways / waterways): design on the basis of a minimum w/h ratio of five (i.e. squat pillars) with a minimum nominal FoS of 2.11 according to the **Salamon *et al* (1996)** formulae (i.e. a probability of failure of ≤ 1 in a million).

These criteria are guidelines; it remains important to give specific attention to the geotechnical / mining environment, including historical experiences of ground behaviour in the seam under consideration. The net effect of adopting these guidelines is shown in **Figure 17**.

Given the subsidence constraints in the NMA Extension area, the workings are considered to fall into the most onerous Category (iv); long-term pillar stability is required for the protection of highly sensitive structures and natural features, including the foreshore. The pillar design criteria are therefore:

- **a FoS of ≥ 2.11 and**
- **a w/h ratio of ≥ 5.**

The adoption of these design criteria is considered to eliminate the potential for failure in the long-term, noting that in this context, "failure" means panel collapse due to the failure of any element (i.e. roof, floor or the pillar) in the overall structural system.

3.5 Pillar Design Outcomes

3.5.1 Depth Sensitivity

The design outcomes for cover depths of 100m to 190m are summarised in **Table 1**.

Table 1: Herringbone Pillar Design for <20mm of Subsidence, at Depths of up to 190m

Roadway Width (m)	Depth (m)	Pillar						Stub		Pillar FoS (Salamon)
		Height (m)	Width (m)	Length (m)	w/h Ratio	Stress (MPa)	Strength (MPa)	Interval (m)	Length (m)	
5.5	140	3.3	16.5	24.5	5.0	5.7	14.0	19.1	14.1	2.45
5.5	160	3.3	16.5	24.5	5.0	6.5	14.0	19.1	14.1	2.14
5.5	170	3.1	16.5	24.5	5.3	6.9	14.8	19.1	14.1	2.13
5.5	180	3.1	17.5	24.5	5.6	7.2	15.4	20.2	14.1	2.12
5.5	190	3.0	18.0	24.5	6.0	7.6	16.0	20.8	14.1	2.11
5.5	140	3.3	16.5	24.5	5.0	5.7	14.0	Mains - rectangular pillars		2.45
5.5	160	3.3	16.5	24.5	5.0	6.5	14.0	Mains - rectangular pillars		2.14
5.5	190	3.3	20.5	24.5	6.2	7.4	15.7	Mains - rectangular pillars		2.13
5.5	140	3.6	24.5	24.5	6.8	5.3	15.9	Mains - square pillars		3.02
5.5	180	3.9	24.5	24.5	6.3	6.8	14.4	Mains - square pillars		2.13
5.5	190	3.7	24.5	24.5	6.6	7.1	15.3	Mains - square pillars		2.15

The following comments are made regarding these results:

i) A uniform roadway and stub width of 5.5m is assumed. In practice, it is likely that reduced stub widths of ≤ 5.2m would promote improved stub roof stability at depths of >170m.

ii) The stub interval is the solid dimension between stubs, whereas pillar width is the minimum solid (plan) dimension (i.e. the perpendicular distance between adjacent stubs, allowing for the 60° stub angle).

iii) In production panels, the design focuses on minimising the stub interval; these range from 19.1m to 20.8m. This is achieved by restricting mining heights to a range of 3.0m to 3.3m.

iv) In the main headings, two options are available: (a) adopt a constant drivage height of 3.3m and reduce the pillar width, thereby narrowing the mains or (b) work to 30m square centres and increase the height where appropriate (potentially by taking bottom coal on the retreat).

v) A maximum (solid) pillar length of 24.5m is stipulated, to facilitate a consistent design stub length of 14m.

vi) Pillar stresses are low (<8MPa), which is also favourable.

vii) Pillar w/h ratios range from 5.0 to 6.8, consistent with the design criteria.

viii) Factors of Safety range from 2.11 to 3.02, again consistent with the design criteria.

3.5.2 Comparison with Design Approaches from Adjacent Mines

In designing the "Zone A" pillars for a maximum of 20mm of subsidence at Myuna Colliery immediately to the north, **Seedsman (2010)** stipulated a minimum pillar Factor of Safety of 2.11, equivalent to a nominal probability of failure of one panel in a million, according to the power law formulae of **Salamon *et al* (1996)**. As noted in **Section 3.5.1**, the proposed NMA Extension FoS values range upwards from 2.11. The approach recommended herein is consistent with the Myuna approach and the design aim of ≤ 20mm of subsidence in the long-term.

3.5.3 "Dog-Kennel" Pillar Design

The smaller "dog-kennel" pillars at the start of each successive run-out should be designed according to **Table 2**, where the stub interval is the solid dimension defined in **Figure 18** for a worked example. This will ensure that the design criteria are met across the potential depth and mining height range. Note that the solid stub intervals result in minimum plan dimensions that are consistent with the criteria put forward in **Section 3.4** and also the regulatory minimum of "10m or 1/10 of the depth, whichever is the greater" rule.

Table 2: Solid Stub Interval Dimensions for "Dog Kennel" Pillars

Depth (m)	Mining Height (m)		
	3.2	3.6	3.9
≤ 150	12.5	14.5	15.8
170	13.6	16.6	19.1
190	16.0	19.6	24.1

4.0 CONCLUDING REMARKS

This report has addressed pillar design requirements to achieve ≤ 20mm of subsidence across the depth range relevant to the area of interest in the NMA Extension.

5.0 REFERENCES

Coffey (2015). **Rock Stress Measurements by Overcoring at Chain Valley Colliery.** Report No. MINEABT00633AC-AB to LDO Group.

Das, M. (1986). **Influence of Width to Height Ratio on Post-failure Behaviour of Coal**. International Journal of Mining and Geological Engineering, 4:79-87.

Hill, D.J. (2005). **Coal Pillar Design Criteria for Surface Protection**. Proceedings of the AusIMM Coal-2005 Conference, Brisbane.

Madden, B. J. (1987). **Coal Pillar Design – Can Increased Extraction be Achieved Safely?** Mine Safety and Health Congress, Johannesburg.

Madden, B.J. and Hardman, D.R. (1992). **Long-Term Stability of Bord and Pillar Workings**. Proc. of Symposium on Construction over Mined Areas, Pretoria.

Mark, C. and Gadde, M. (2010). **Global Trends in Coal Mine Horizontal Stress Measurements**. Proceedings: Coal 2010, 10th AUSIMM Underground Coal Operators' Conference, Wollongong.

Molinda, G.M. and Mark, C. (1994). **Coal Mine Roof Rating (CMRR): A Practical Rock Mass Classification for Coal Mines.** USBM Information Circular (IC) 9387.

Salamon, M.D.G. and Munro, A.H. (1967). **A Method of Designing Bord and Pillar Workings**. Journal of the South African Institute of Mining and Metallurgy.

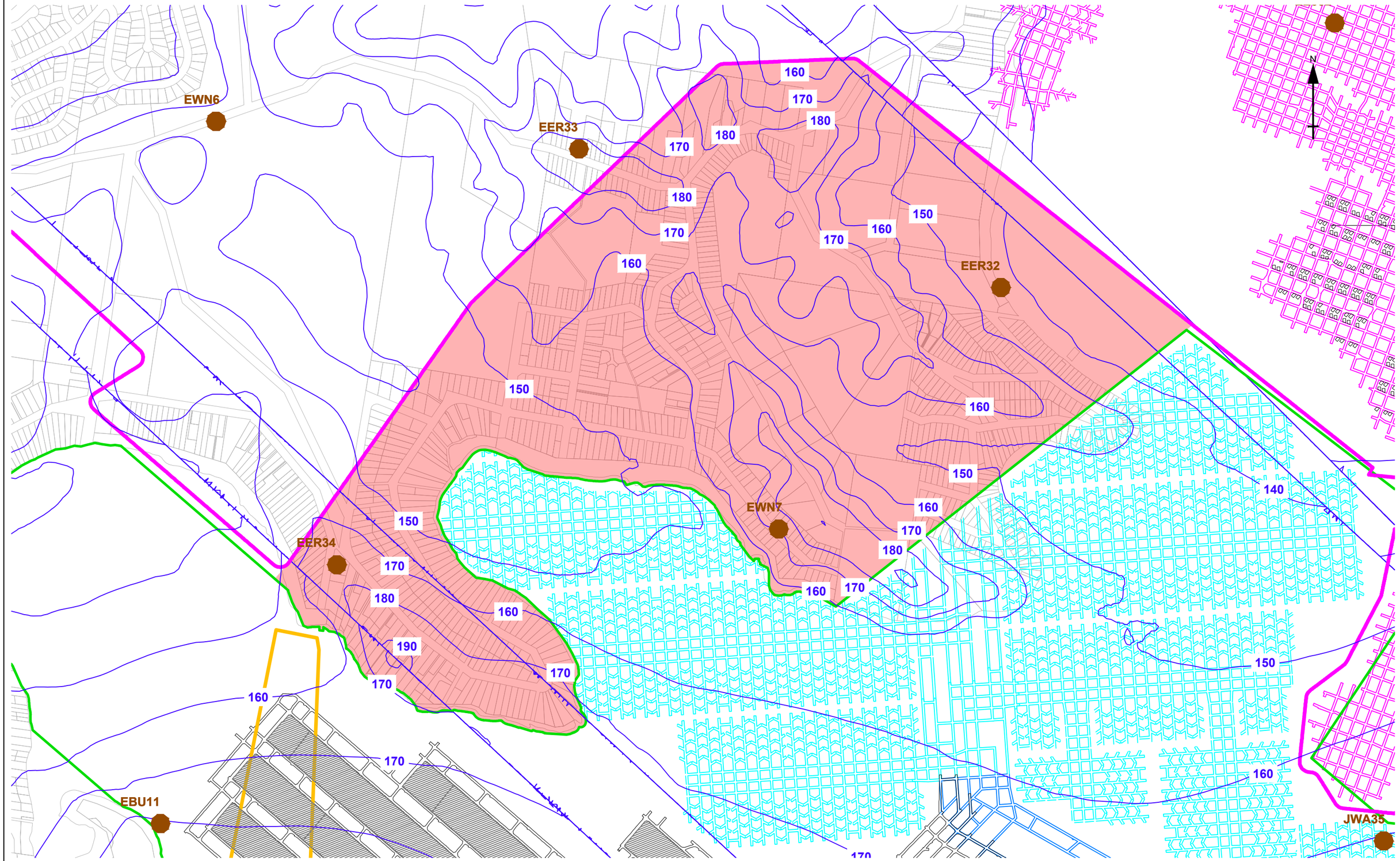
Salamon, M.D.G., Galvin, J.M., Hocking, G. and Anderson, I. (1996). **Coal Pillar Strength from Back Calculation**. Research Report RP 1/96, Joint Coal Board Strata Control for Mine Design Project.

Seedsman Geotechnics (2010). **Designing to Subsidence Constraints at Myuna Colliery**. Report No. aecom-01 (Revision 1).

Strata Engineering (2001). **A Review of the Geotechnical Design Aspects Highwall Mining Based on a Back-Analysis of Australian Experiences**. Report No. 00-001-RCH/1 to Roche Mining.

Strata^2 (2019). **Geotechnical Aspects of Herringbone Pillar Design.** Report No. CHV-005-RevD to Lake Coal.

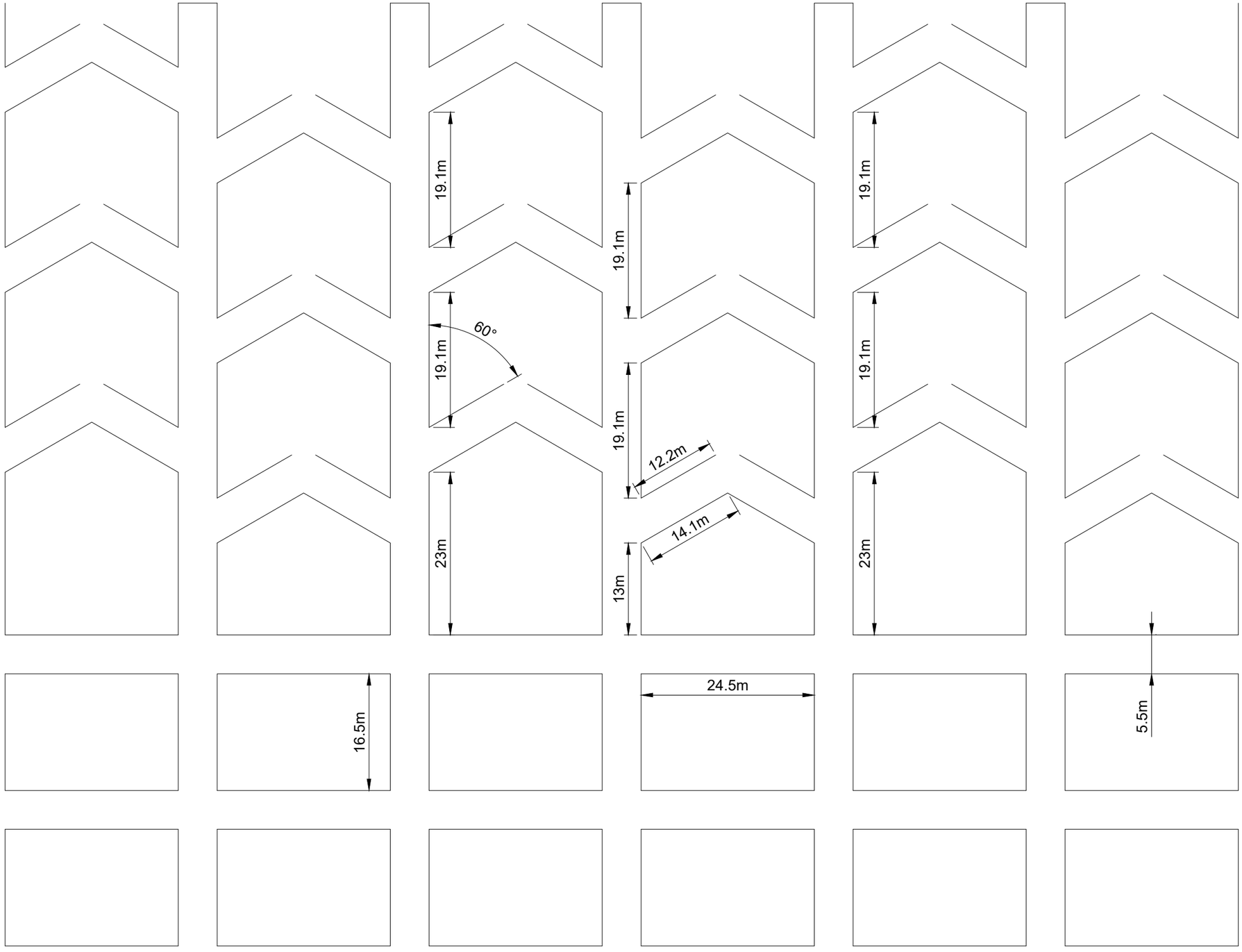
Strata^2 (2019). **Proposed Herringbone Layout for Mannering North - Design Criteria for Negligible Surface Effects**. Report No. CHV-014-RevA to Delta Coal.



Key:

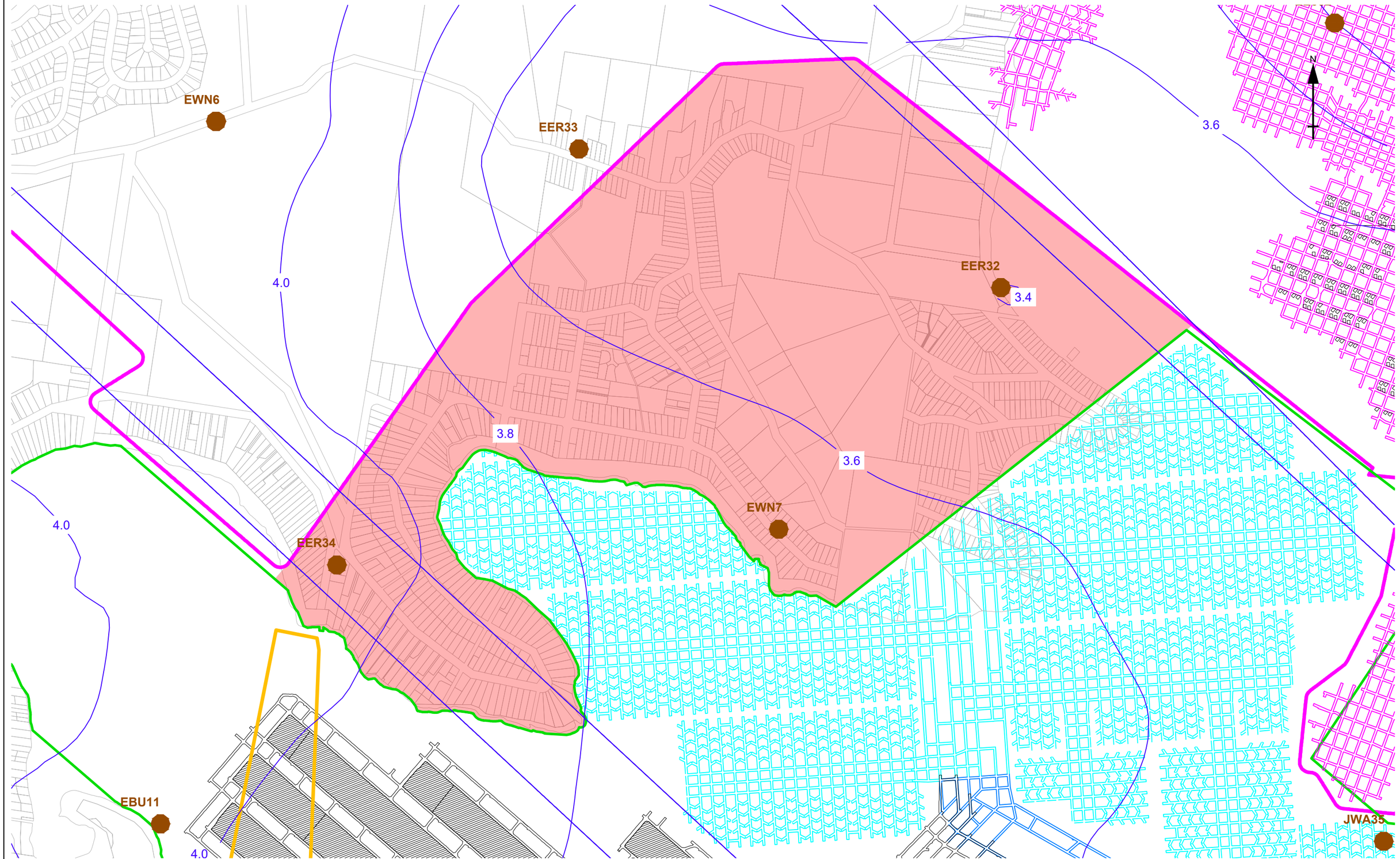
- Proposed Northen Mining Area Extension
- Depth of Cover (m)
- EER32 - Borehole
- Delta Coal Lease Holding
- SSD-5465 Existing Consent Boundary
- MP06_0211 Existing Consent Boundary
- Existing Mine Workings (Fassifern Seam)
- Proposed Mine Workings (SSD-5465)

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Mine Plan Showing Depth of Cover of FAS Seam, Boreholes Location and Proposed Northern Mining Area Extension
Date:	23.03.20		
	STRATA^2	**Ref:**	CHV-016
		Revision No:	0
		Scale:	NTS
		Figure No:	1



Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Schematic Showing Typical Herringbone Pillar Layout
Date:	15.01.20		
		Ref: CHV-016	**Revision No:** 0
		Scale: NTS	**Figure No:** 2

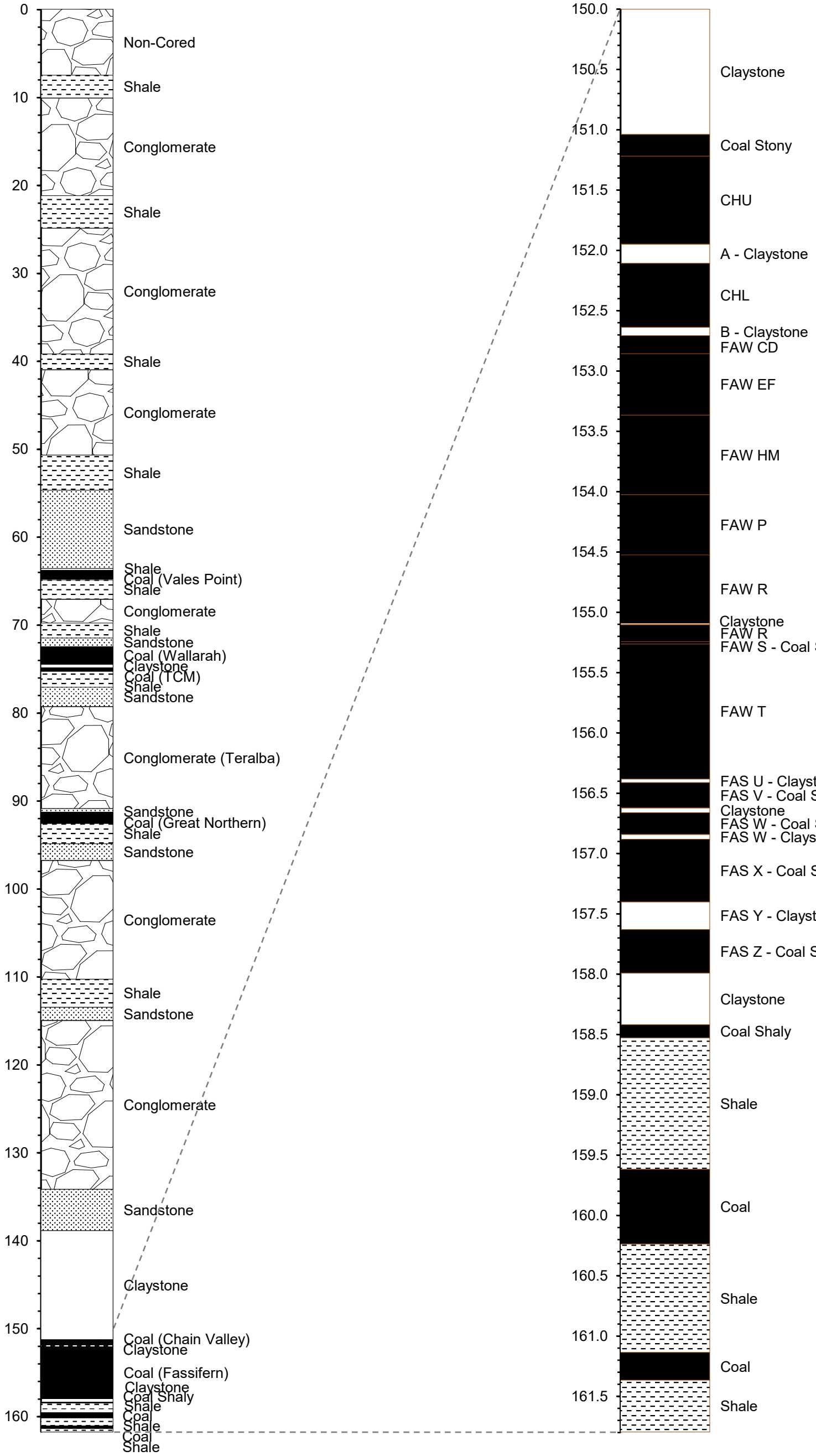
STRATA²



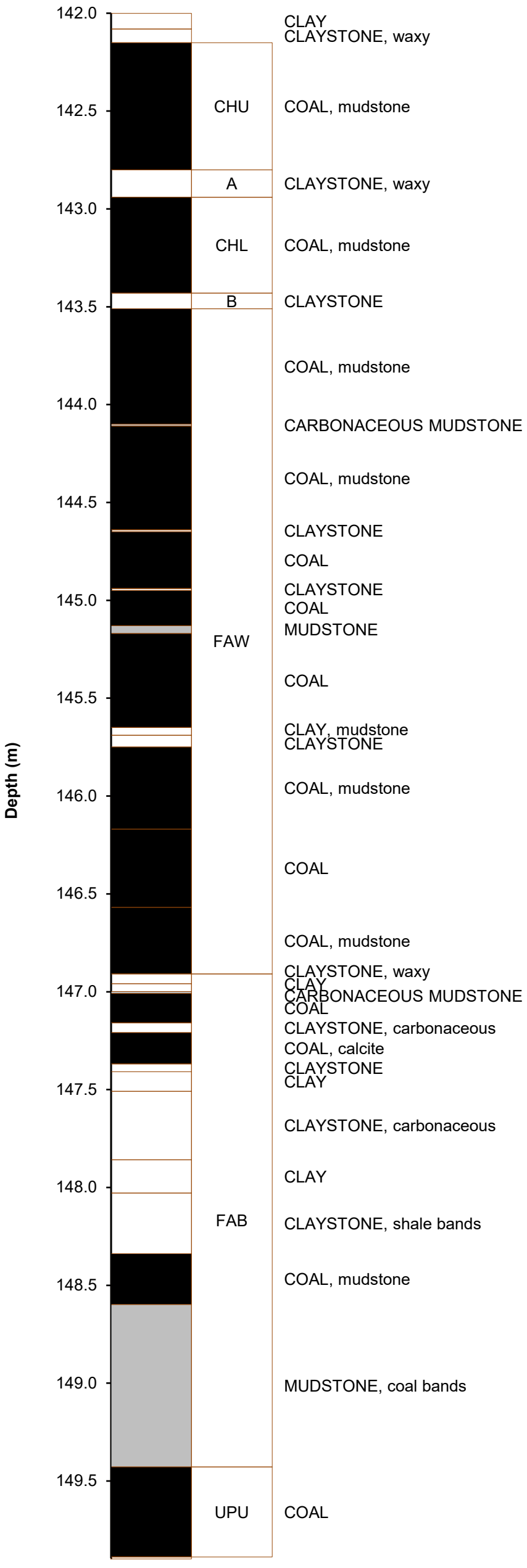
Key:

- Proposed Northen Mining Area Extension
- FAS Tickness Contours (m)
- EER32 - Borehole
- Delta Coal Lease Holding
- SSD-5465 Existing Consent Boundary
- MP06_0211 Existing Consent Boundary
- Existing Mine Workings (Fassifern Seam)
- Proposed Mine Workings (SSD-5465)

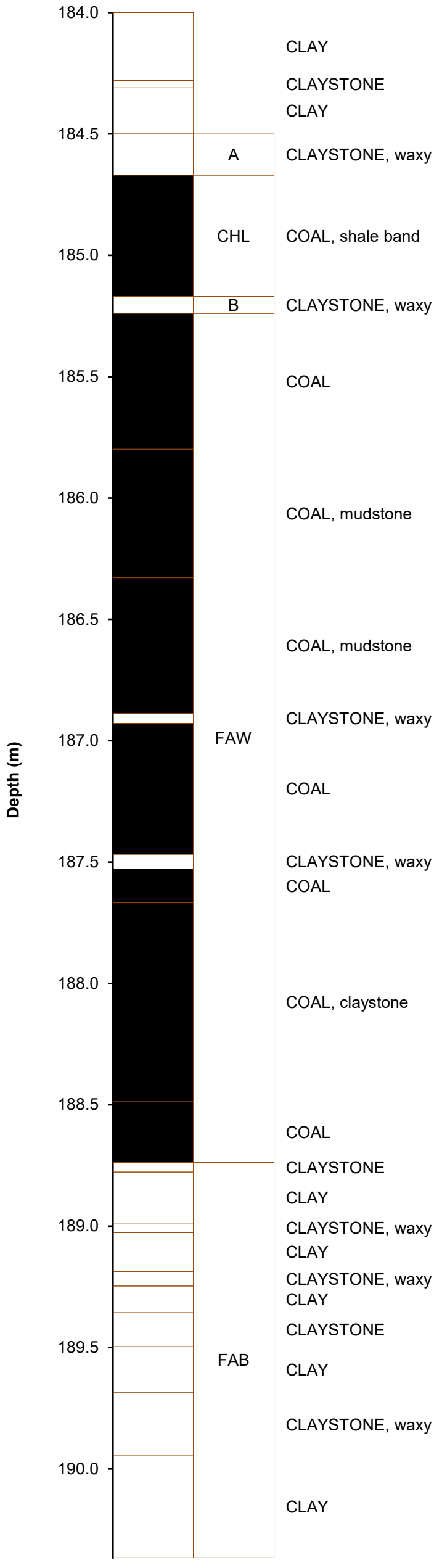
Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Mine Plan Showing Thickness Contours of FAS Seam and Location of Boreholes Intersecting FAS Seam
Date:	23.03.20		
	STRATA^2	**Ref:**	CHV-016
		Revision No:	0
		Scale:	NTS
		Figure No:	3



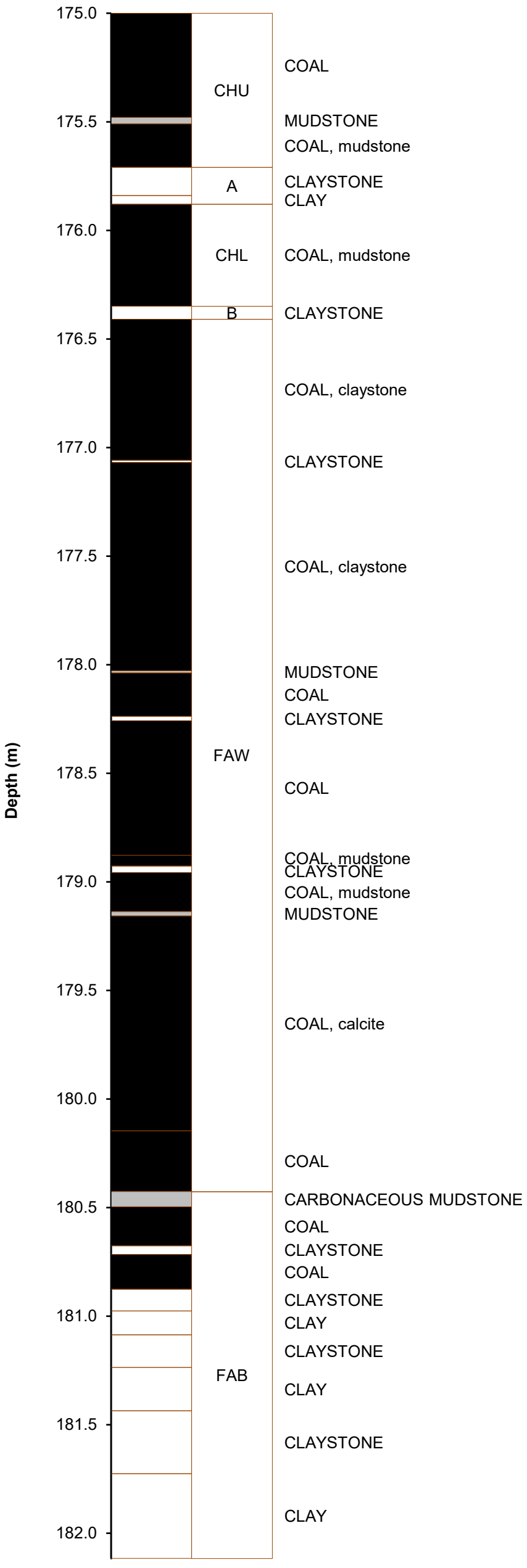
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	EWN7 Lithology Log		
Date:	15.01.19				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	4



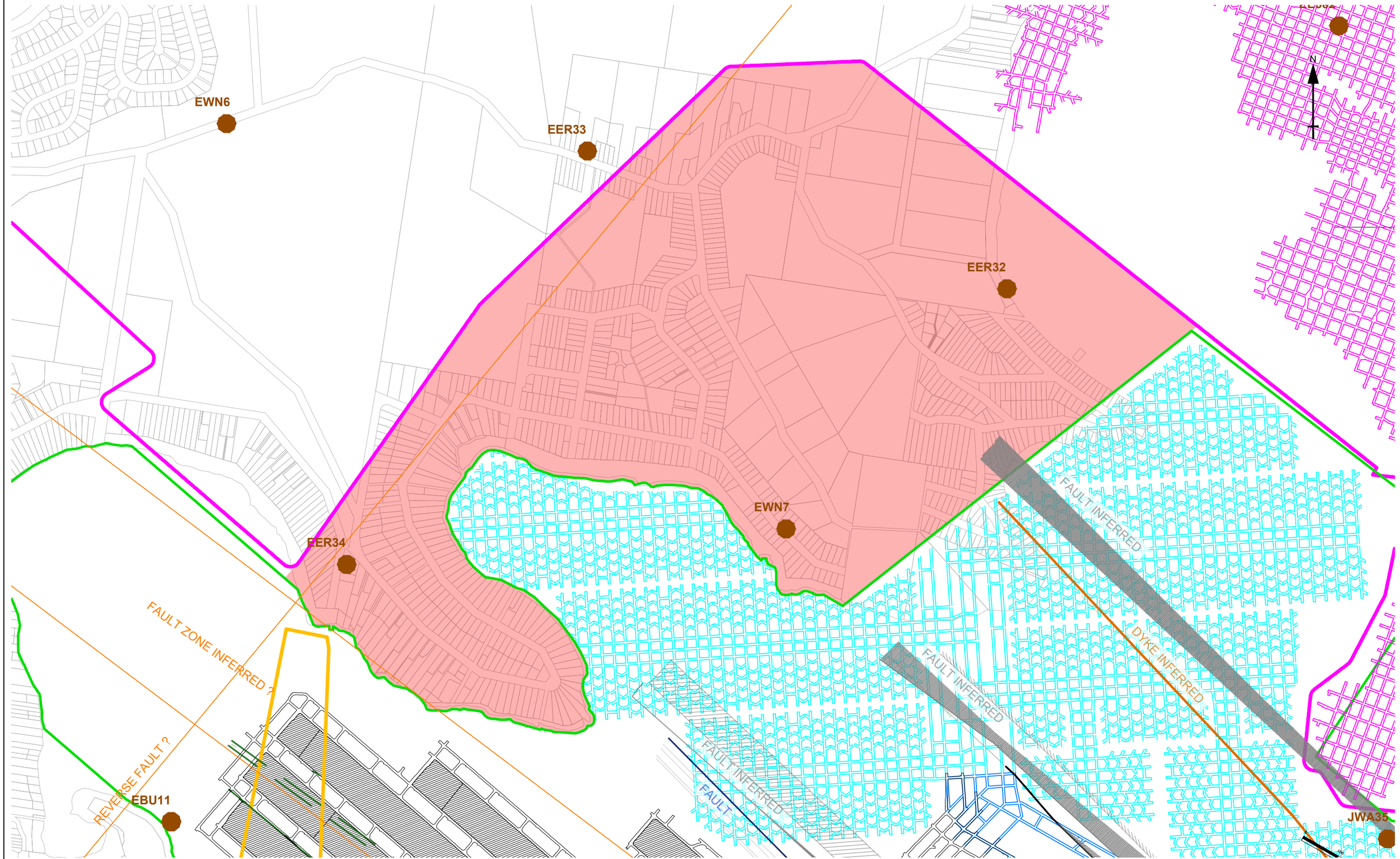
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	Lithology Profile of Fassifern Seam in Borehole EER32		
Date:	13.01.20				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	5



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	Lithology Profile of Fassifern Seam in Borehole EER33		
Date:	15.01.20				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	6



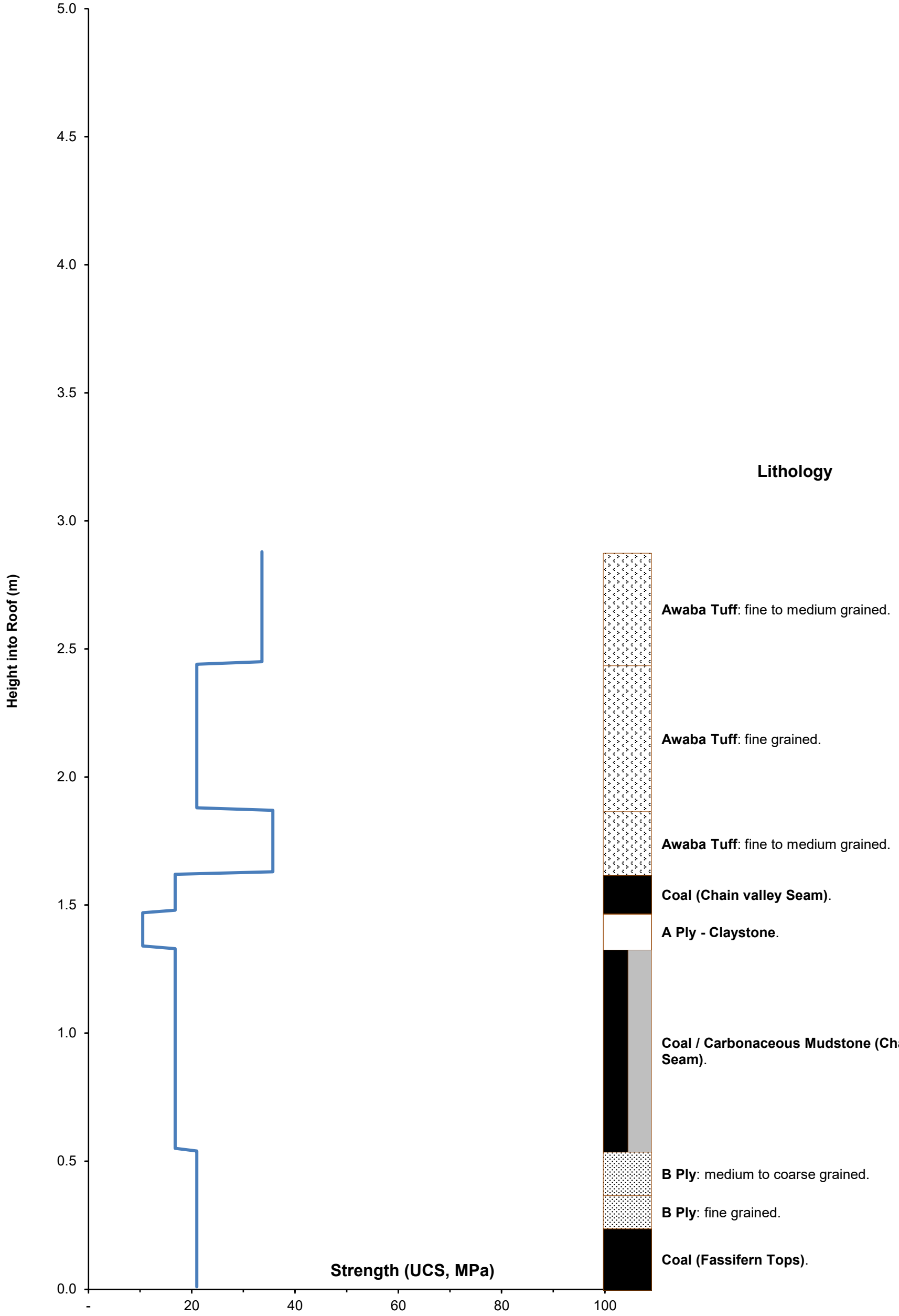
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	Lithology Profile of Fassifern Seam in Borehole EER34		
Date:	15.01.20				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	7



Key:

- Proposed Northen Mining Area Extension
- EER32 - Borehole
- Delta Coal Lease Holding
- SSD-5465 Existing Consent Boundary
- MP06_0211 Existing Consent Boundary
- Existing Mine Workings (Fassifern Seam)
- Proposed Mine Workings (SSD-5465)

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Mine Plan Showing Geological Structure and Location of Boreholes
Date:	23.03.20		
	STRATA^2	**Ref:**	CHV-016
		Revision No:	0
		Scale:	NTS
		Figure No:	8



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	Strength and Lithology Profiles of Fassifern Seam Roof in Borehole A1.90		
Date:	16.01.20				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	9

Figure 10a: Database of Major Horizontal Stress Measured in Australian Collieries

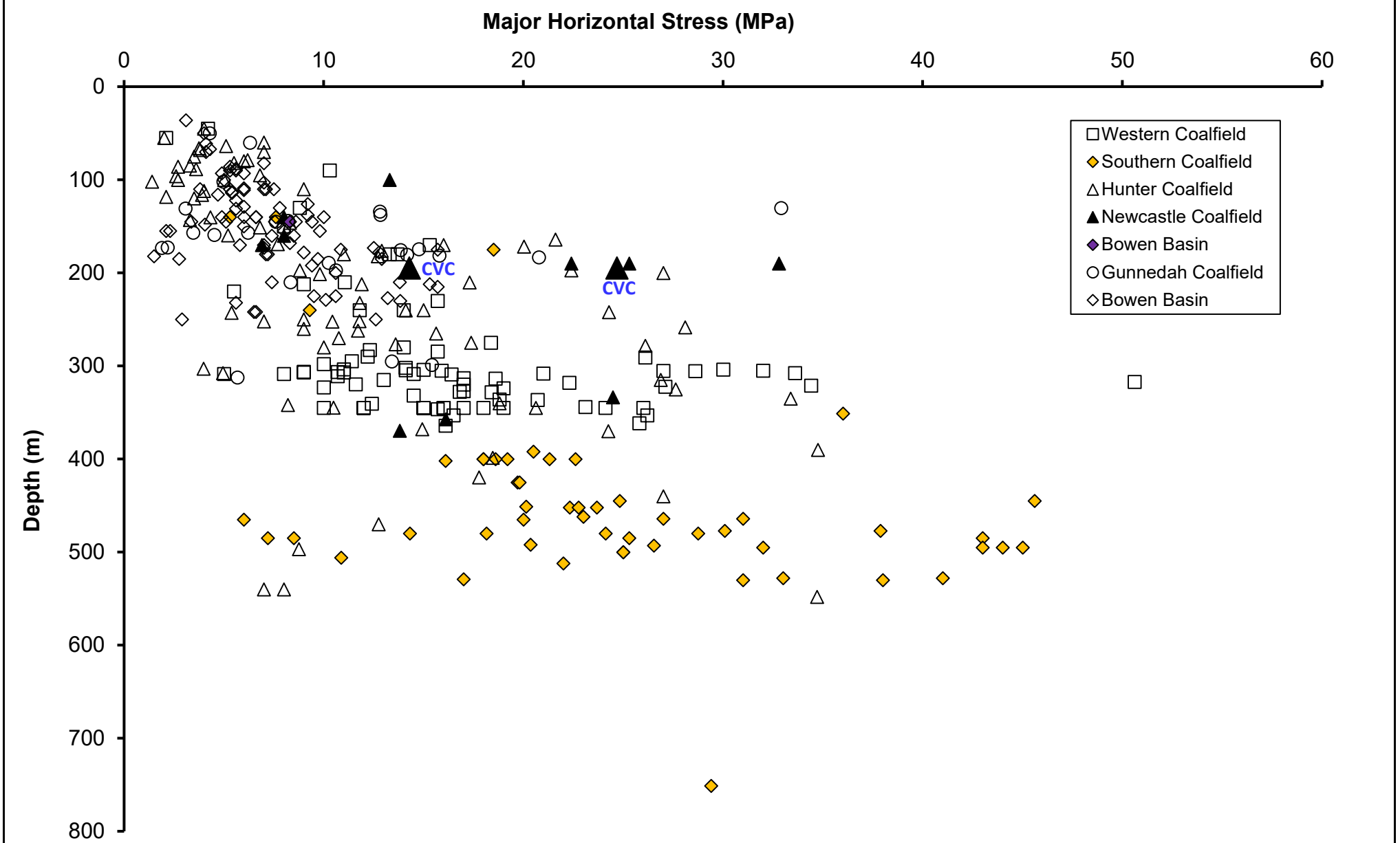
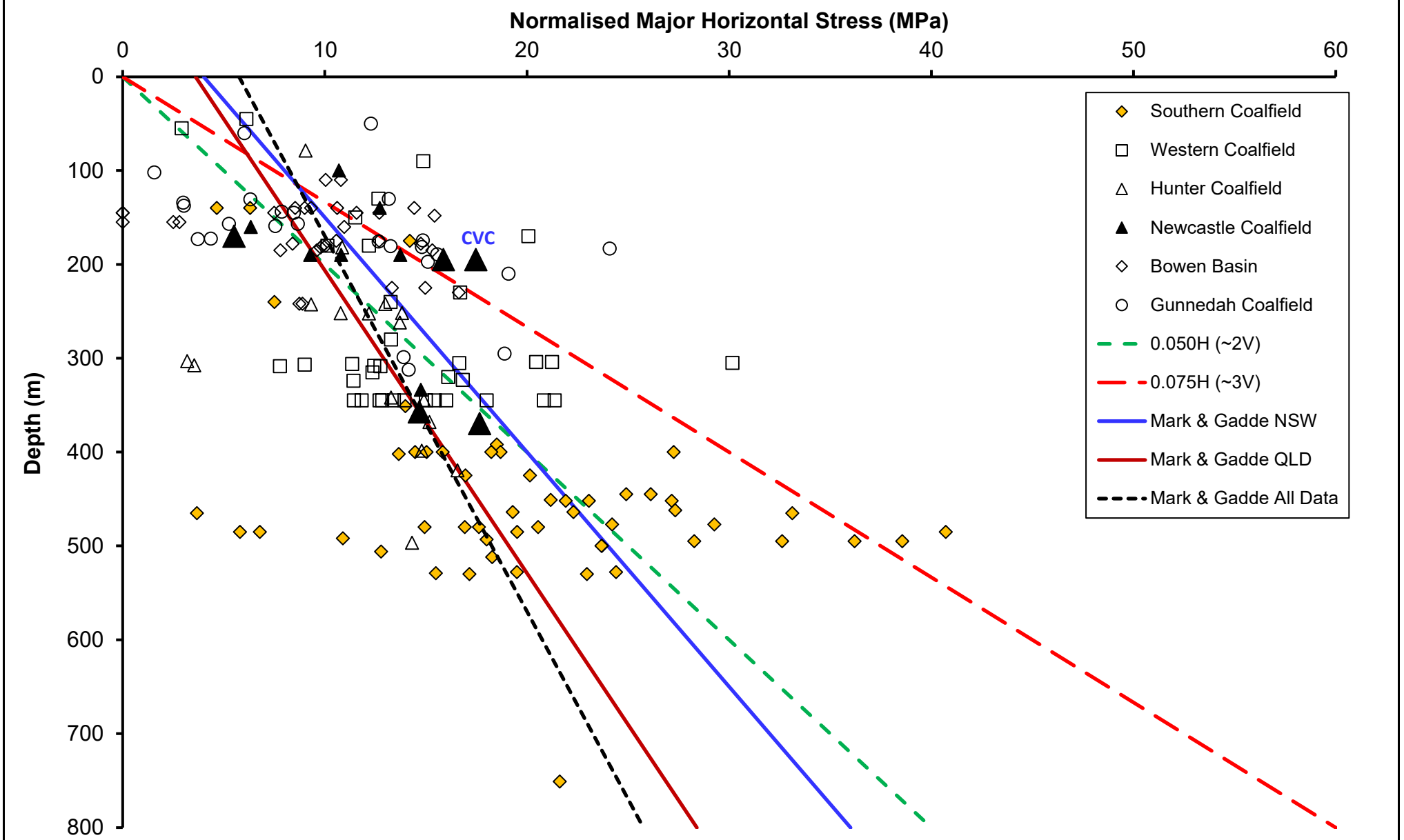
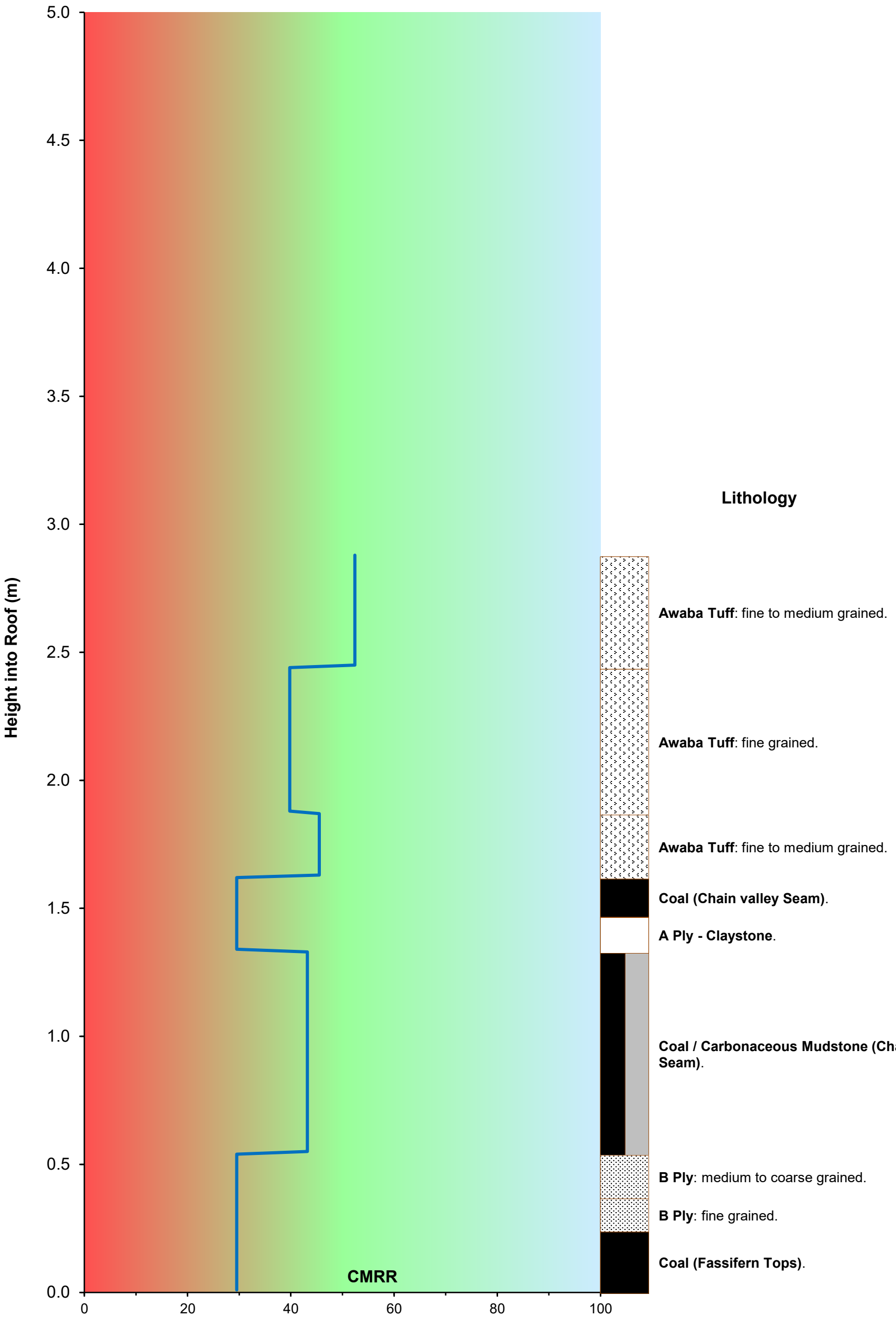


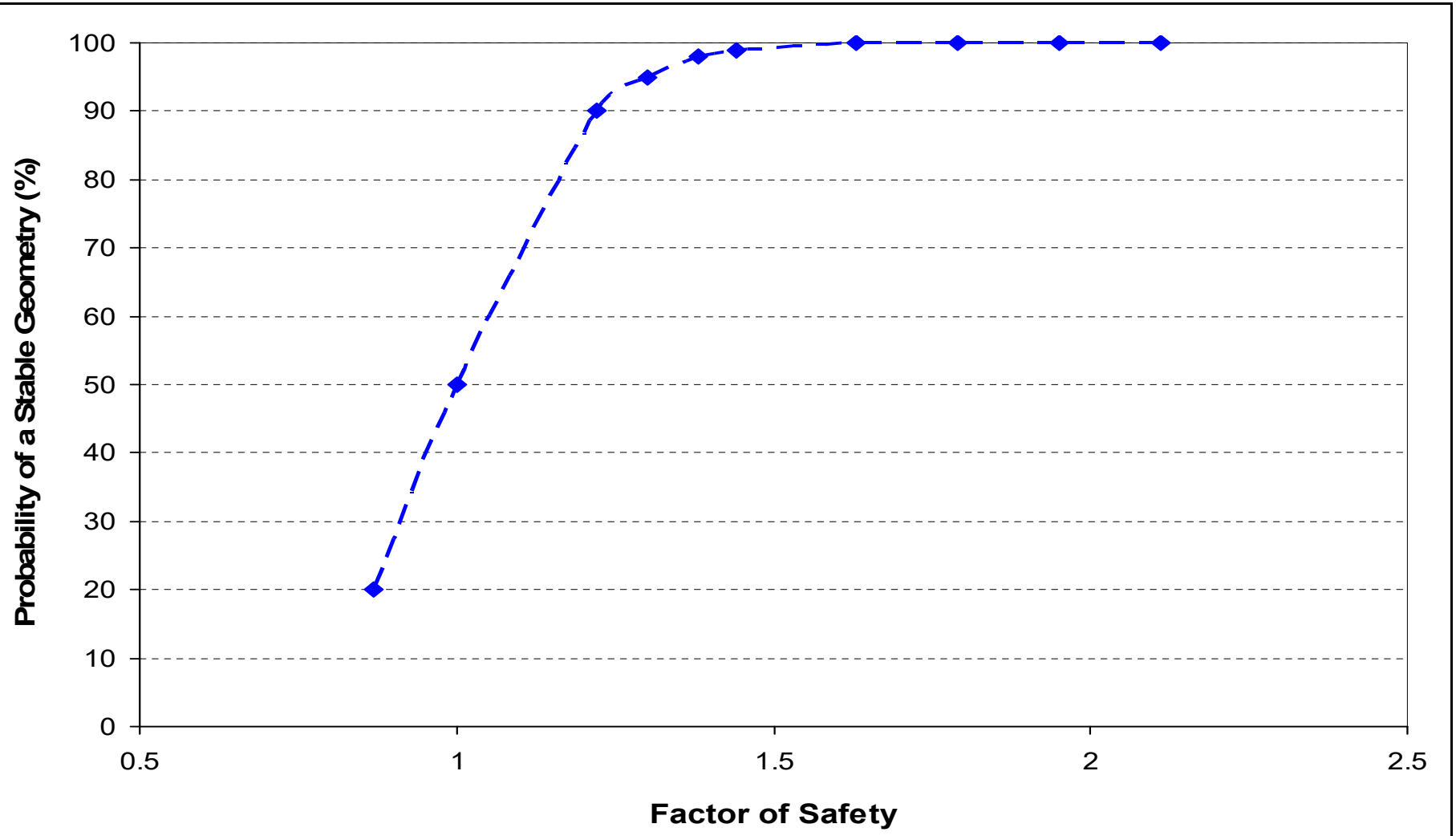
Figure 10b: Normalised Major Horizontal Stress Database



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Australian Major Horizontal Stress Database, with CVC Data Points		
Date:	15.01.2020				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	10a/b

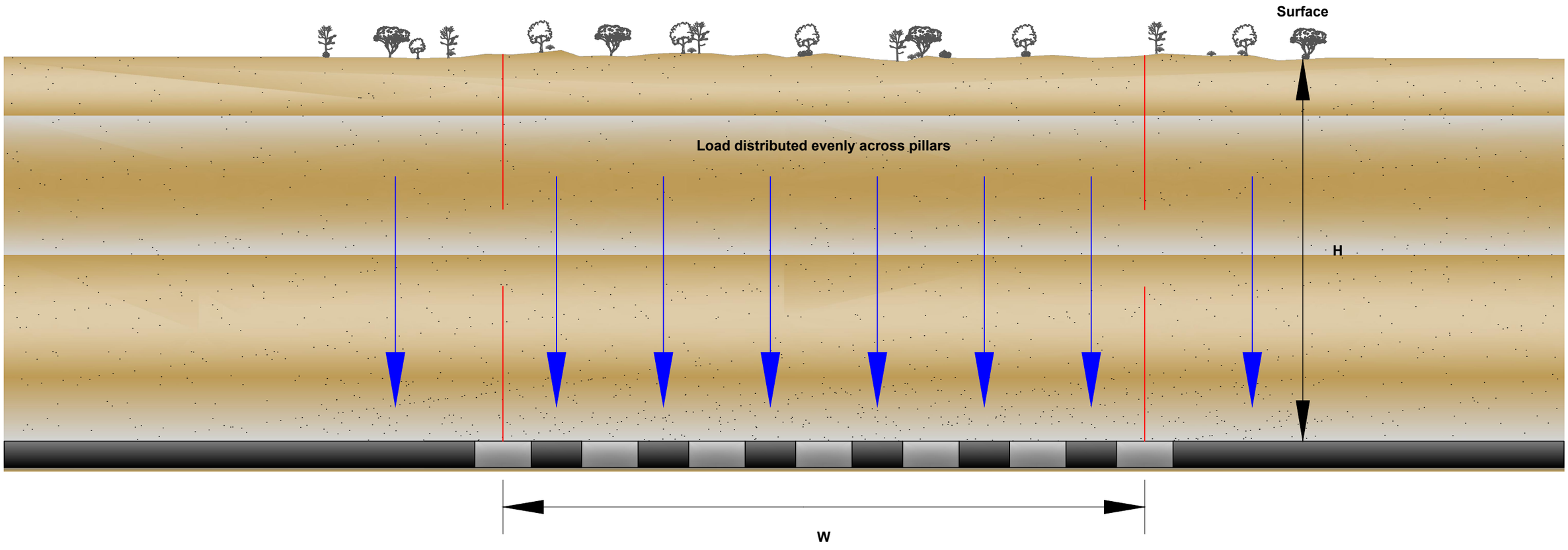


Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de L.	**Title:**	CMRR and Lithology Profiles of Fassifern Seam Roof in Borehole A1.90		
Date:	16.01.20				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	11



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Salamon Factor of Safety versus Probability of Stability		
Date:	15.01.2020				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	12

Tributary Area Loading Concept Appropriate for Use with Panel W/H Ratios of ≥1



Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Schematic Illustration of the Tributary Area Loading Concept during Roadway Development
Date:	15.01.2020		
STRATA²		**Ref:**	CHV-016
		Revision No:	0
		Scale:	NTS
		Figure No:	13

Figure 14a: UCS Test Results on Sandstone Samples (Madden, 1987)

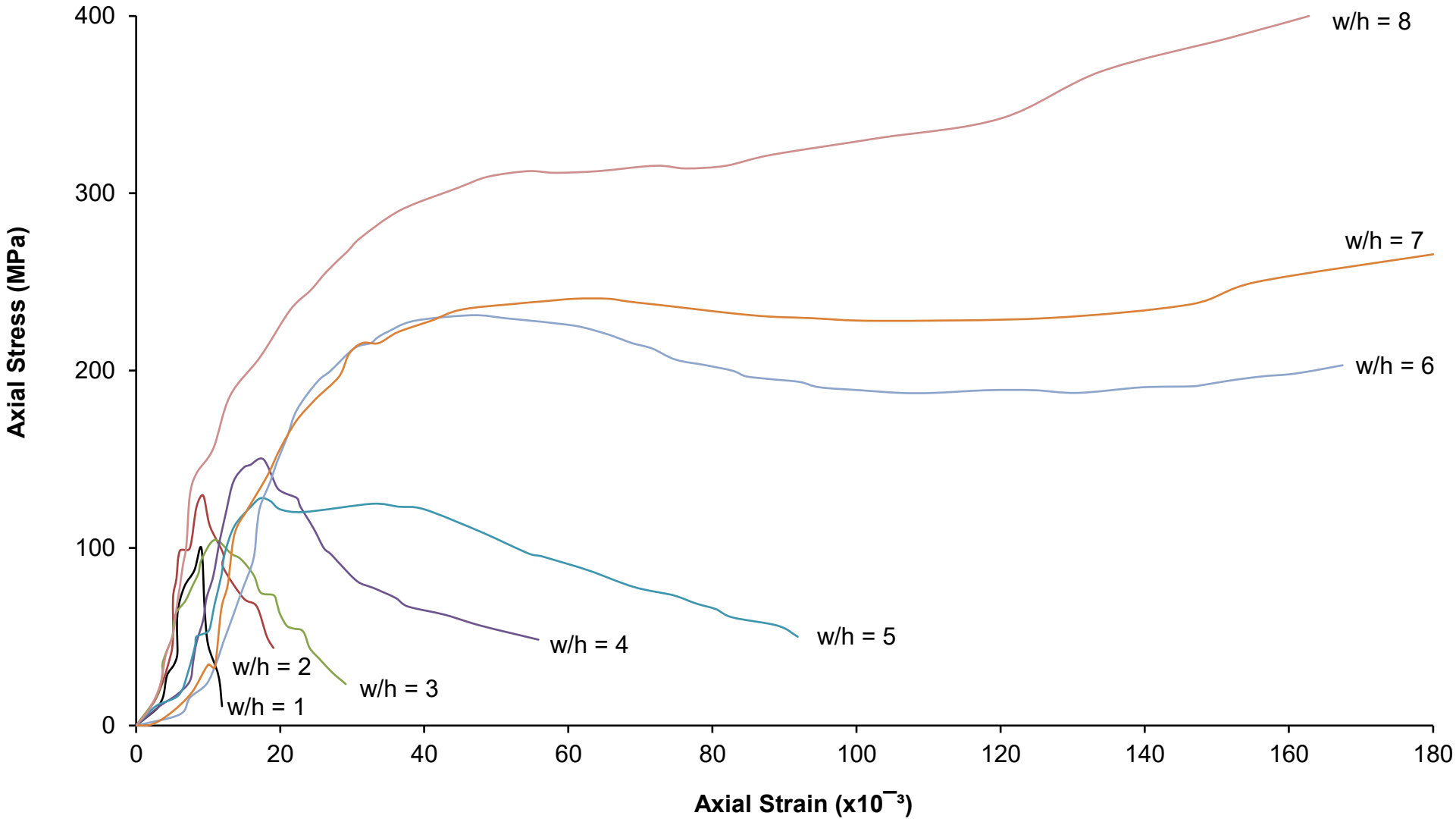
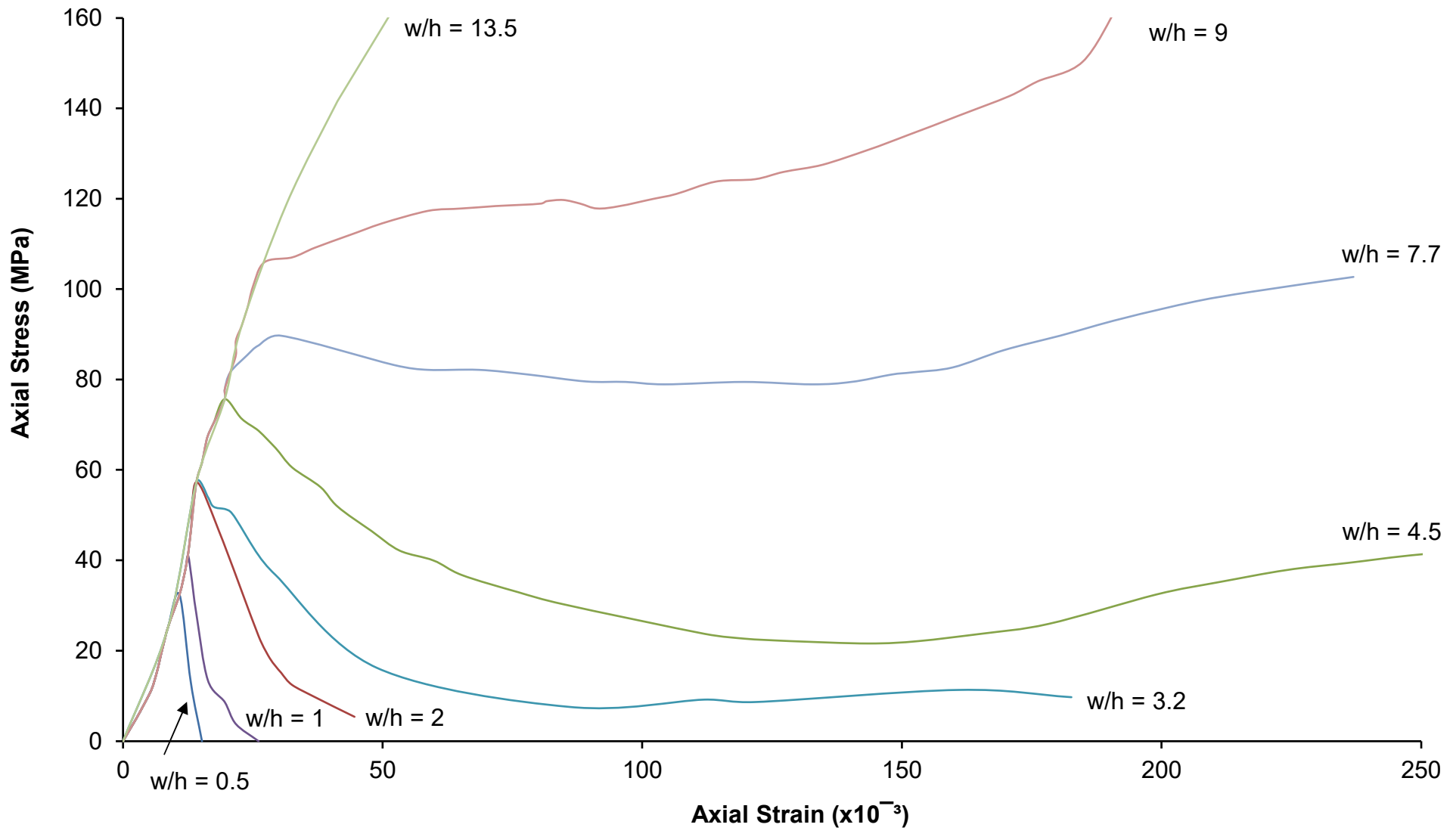
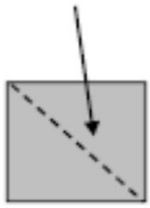


Figure 14b: UCS Test Results on Coal Samples (Das, 1986)



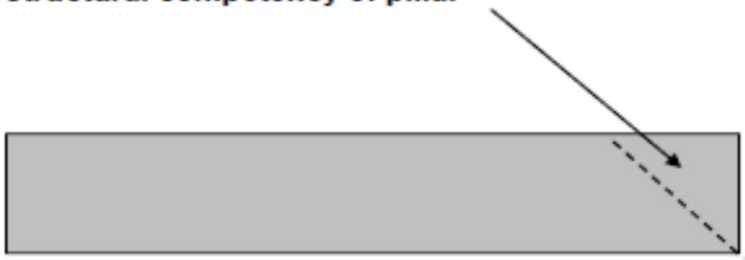
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Effect of Width to Height Ratio on Load - Deformation Characteristics of Rocks		
Date:	15.01.20				
STRATA²		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	14a/b

45° joint impacts significantly
on structural competency of pillar



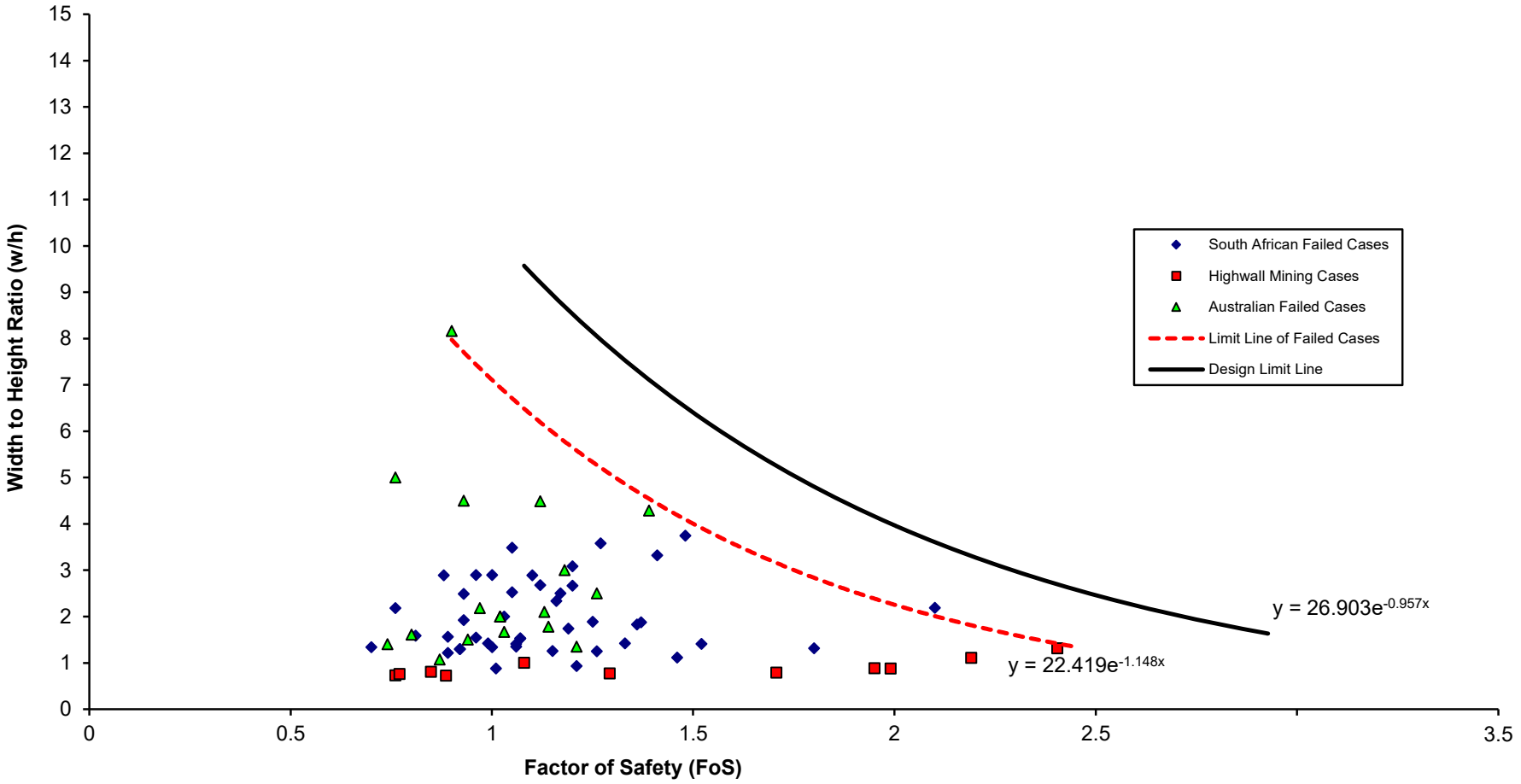
Width to Height Ratio = 1

45° joint has minimal impact on
structural competency of pillar

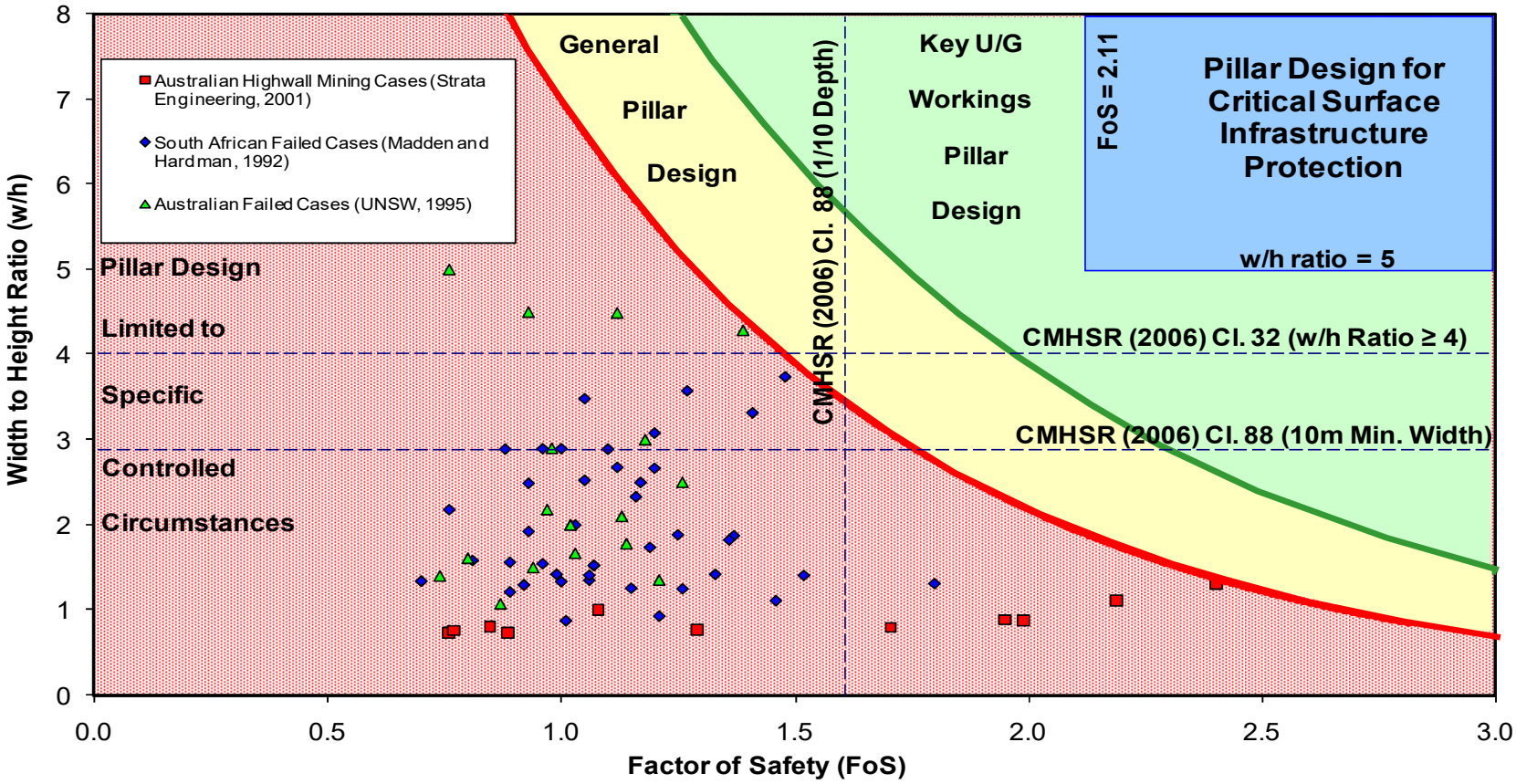


Width to Height Ratio = 5

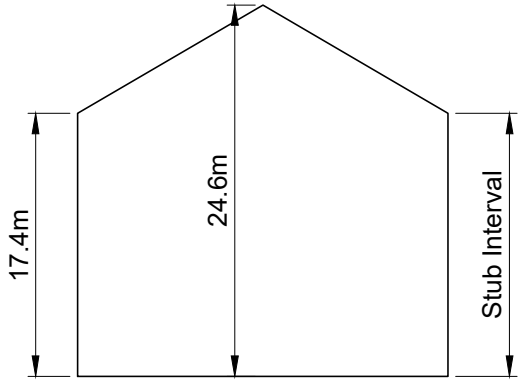
	Engineer: D. Hill	**Client:**	Chain Valley Colliery		
	Drawn: D. Hill	**Title:**	Increasing Pillar Width to Height Reduces the Impact of Unfavourably Orientated Structure		
	Date: 15.01.2020				
	STRATA²	**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	15

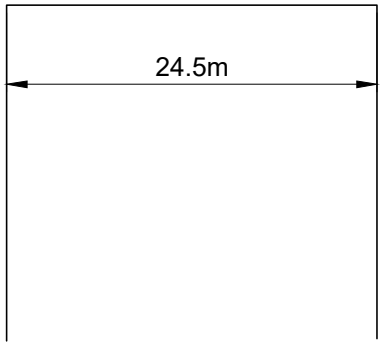


Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Failed Pillar Database		
Date:	15.01.2019				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	N/A	**Figure No:**	16



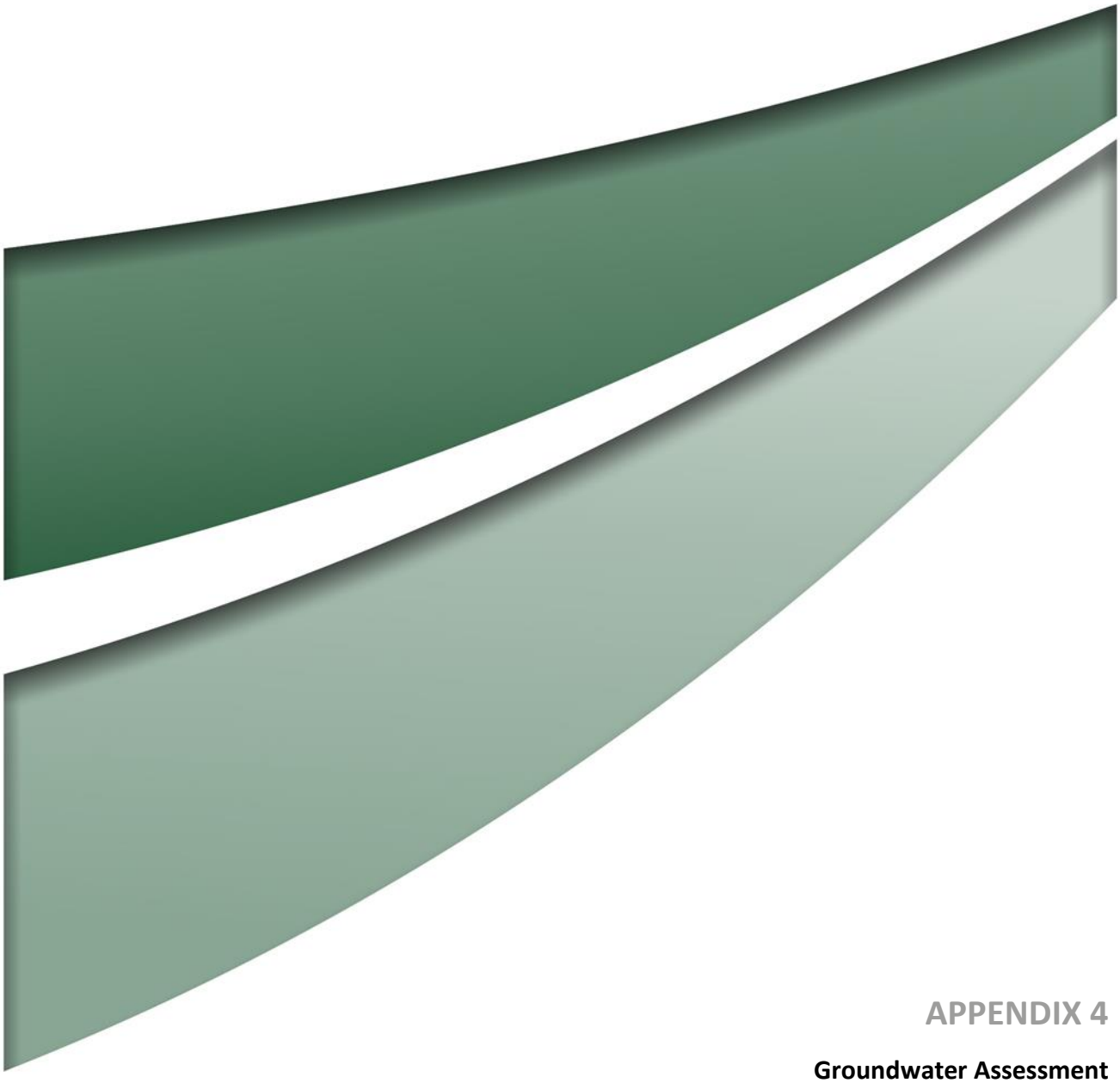
Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	D. Hill	**Title:**	Failed Pillar Database plus Design Zones
Date:	15.01.2020		
STRATA^2		**Ref:**	CHV-016
		Scale:	N/A
		Revision No:	0
		Figure No:	17





Average Pillar Width
= (17.4+24.6) / 2
= 21m

Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	I. Saliamon	**Title:**	Example of Configuration of "Dog-Kennel" Pillar (Plan Dimensions)		
Date:	15.01.2020				
STRATA^2		**Ref:**	CHV-016	**Revision No:**	0
		Scale:	NTS	**Figure No:**	18



APPENDIX 4

Groundwater Assessment

Delta Coal

Chain Valley Colliery Modification 4

Groundwater Assessment

September 2020

Table of contents

1. Introduction....1
   - 1.1 Project background....1
   - 1.2 Project Application Area....1
   - 1.3 Proposed and approved project conditions....4
   - 1.4 Objectives of the groundwater impact assessment....6
   - 1.5 Active and historical mine operations....6
   - 1.6 Limitations....7
2. Legislation and policy....8
   - 2.1 Legislation....8
   - 2.2 Policy....9
3. Site description....11
   - 3.1 Climate....11
   - 3.2 Topography....13
   - 3.3 Hydrology....13
   - 3.4 Geology....13
   - 3.5 Hydrogeology and groundwater sources....16
   - 3.6 Groundwater use....17
   - 3.7 Groundwater dependent ecosystems....18
4. Groundwater monitoring and conceptual model....22
   - 4.1 Groundwater management overview....22
   - 4.2 Monitoring program details....22
   - 4.3 Baseline monitoring results....22
   - 4.4 Conceptual hydrogeological model....23
5. Impact assessment methodology....25
   - 5.1 Numerical groundwater model....25
   - 5.2 Impact assessment criteria....39
6. Impact assessment....40
   - 6.1 Impact prediction....40
   - 6.2 Impact assessment....46
7. Mitigation, management and monitoring....48
   - 7.1 Monitoring....48
   - 7.2 Reporting and reviewing....48
8. Summary....49
9. References....50

Table index

Table 1-1 Comparison between Modification 3 and proposed Modification 4 4
Table 3-1 Stratigraphic sequence - CVC 14
Table 3-2 Registered bores 17
Table 5-1 Model layers 27
Table 5-2 Material property ranges 34
Table 5-3 Mandalong Mine groundwater monitoring network 35
Table 5-4 Steady-state calibration model flow budget 36
Table 5-5 Calibrated model parameters 38

Figure index

Figure 1-1 Site locality 2
Figure 1-2 Proposed boundary modification 3
Figure 3-1 Average climate data (-33.15 N, 151.55 E) 11
Figure 3-2 Historical annual rainfall record (-33.15 N, 151.55 E) 12
Figure 3-3 Cumulative rainfall departure curve 13
Figure 3-4 Surface geology map 15
Figure 3-5 Registered bore search 20
Figure 3-6 Groundwater dependent ecosystems 21
Figure 4-1 Conceptual cross section 24
Figure 5-1 Groundwater model domain 26
Figure 5-2 Model grid for Layers 1 and 9 27
Figure 5-3 Model layering 29
Figure 5-4 Boundary conditions in Layer 1 31
Figure 5-5 Drain cells in Wallarah, Great Northern and Fassifern Seams 32
Figure 5-6 Steady state groundwater head (m) – fractured and porous rock 36
Figure 5-7 Scatterplot of observed and modelled groundwater heads 37
Figure 6-1 Predicted groundwater inflows to CVC 40
Figure 6-2 Uncertainty analysis of groundwater inflows to CVC 41
Figure 6-3 Predicted drawdown in Munmorah Conglomerate (Layer 2) 42
Figure 6-4 Predicted drawdown in Wallarah Seam (Layer 3) 43
Figure 6-5 Predicted drawdown in Great Northern Seam (Layer 6) 44
Figure 6-6 Predicted drawdown in Fassifern Seam (Layer 9) 45

Glossary

Alluvial	Deposition from running waters.
Aquifer	A groundwater bearing formation sufficiently permeable to transmit and yield groundwater.
Australian Height Datum	A common national surface level datum approximately corresponding to mean sea level.
Bord and pillar	A mining system whereby coal is extracted leaving 'pillars' of untouched coal to support the strata above.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site.
Cumulative Rainfall Departure	Monthly accumulation of the difference between the observed monthly rainfall and long term average monthly rainfall.
Dewatering	The removal or pumping of water from an above or below ground storage, including the mine water within the water collection system of mine workings. Water removed from mine workings is regarded as dewatering unless the workings are flooded and at equilibrium with the surrounding strata (in which case the removal is considered groundwater extraction).
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Drawdown	A reduction in piezometric head within an aquifer.
Ephemeral	Stream that is usually dry, but may contain water for rare and irregular periods, usually after significant rain.
Fracture	Cracks within the strata that develop naturally or as a result of underground works.
Goaf	That part of a mine from which the mineral has been partially or wholly removed, including the waste left in the workings.
Groundwater	Subsurface water that occurs in soils and geological formations.
Groundwater extraction	For the purposes of this assessment, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Headings	A roadway driven in to the coal seam for access to underground operations by personnel and machinery.

Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks.
Hydrograph	A graph which shows how a water level (either surface or underground) at any particular location changes with time.
Hydrology	The study of rainfall and surface water runoff processes.
Infiltration	The downward movement of water into soil and rock. It is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Interseam	The strata between coal seams.
Licensed Discharge Point	A location where a licensed operation discharges water to the environment in accordance with conditions stipulated within the site Environment Protection Licence.
Longwall	Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. The longwall mining method is supported by roadway development, mined using a continuous miner unit.
Outcrop	Where the bedrock is exposed at the ground surface.
Overburden	The strata between the recoverable topsoil and the upper coal seam.
Permian Age	The youngest geological period of the Palaeozoic era, covering a span between approximately 290 and 250 million years.
Roadway	Underground tunnel constructed to enable access to working face.
Run of Mine	Raw coal production (unprocessed).
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Strata	Geological layers below the ground surface.
Structure	The combination or spatial arrangement of primary soil particles (clay, silt, sand, gravel) into aggregates such as peds or clods, and their stability to deformation.
Subsidence	Mining-induced movements and deformations at the ground surface where (i) the vertical downward surface movements are greater than 20 mm, or (ii) the potential impacts on major surface infrastructure, structures or natural features may be significant, notwithstanding that the vertical downward surface movements are less than 20 mm.
Surface Water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Tailings	Fine reject material produced as a result of the coal processing.
Vertical Subsidence	Vertical downward movements of the ground surface caused by underground coal mining.

1. Introduction

GHD Pty Ltd (GHD) was commissioned by Great Southern Energy Pty Ltd (trading as Delta Coal, hereafter Delta Coal) to prepare a Groundwater Impact Assessment (GIA) for a proposed modification to State Significant Development (SSD) 5465 at Chain Valley Colliery (CVC). This GIA forms part of a Statement of Environmental Effects (SEE) to support the modification application (Modification 4 to SSD-5465).

1.1 Project background

CVC is an underground coal mine on the southern end of Lake Macquarie, located approximately 60 kilometres south of Newcastle. The site locality is shown in Figure 1-1. Mining commenced at CVC in 1962. Delta Coal took over as owner and operator of CVC and the adjoining Mannering Colliery (MC) on 1 April 2019.

The current CVC development consent boundary covers an area of approximately 1,425 hectares (ha), which straddles the boundary of the Lake Macquarie and Central Coast local government areas (LGAs). Within this, the underground mining area is approximately 1,413 ha and is located within the Fassifern Seam, predominantly beneath Lake Macquarie between the suburbs of Summerland Point and Morisset East. Completed workings at CVC existing within the Wallarah and Great Northern Seams.

CVC currently operates under consent SSD-5465, as modified, which was originally granted on 23 December 2013 by the then Minister for Planning and Infrastructure under Part 4, Division 4.1 of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act).

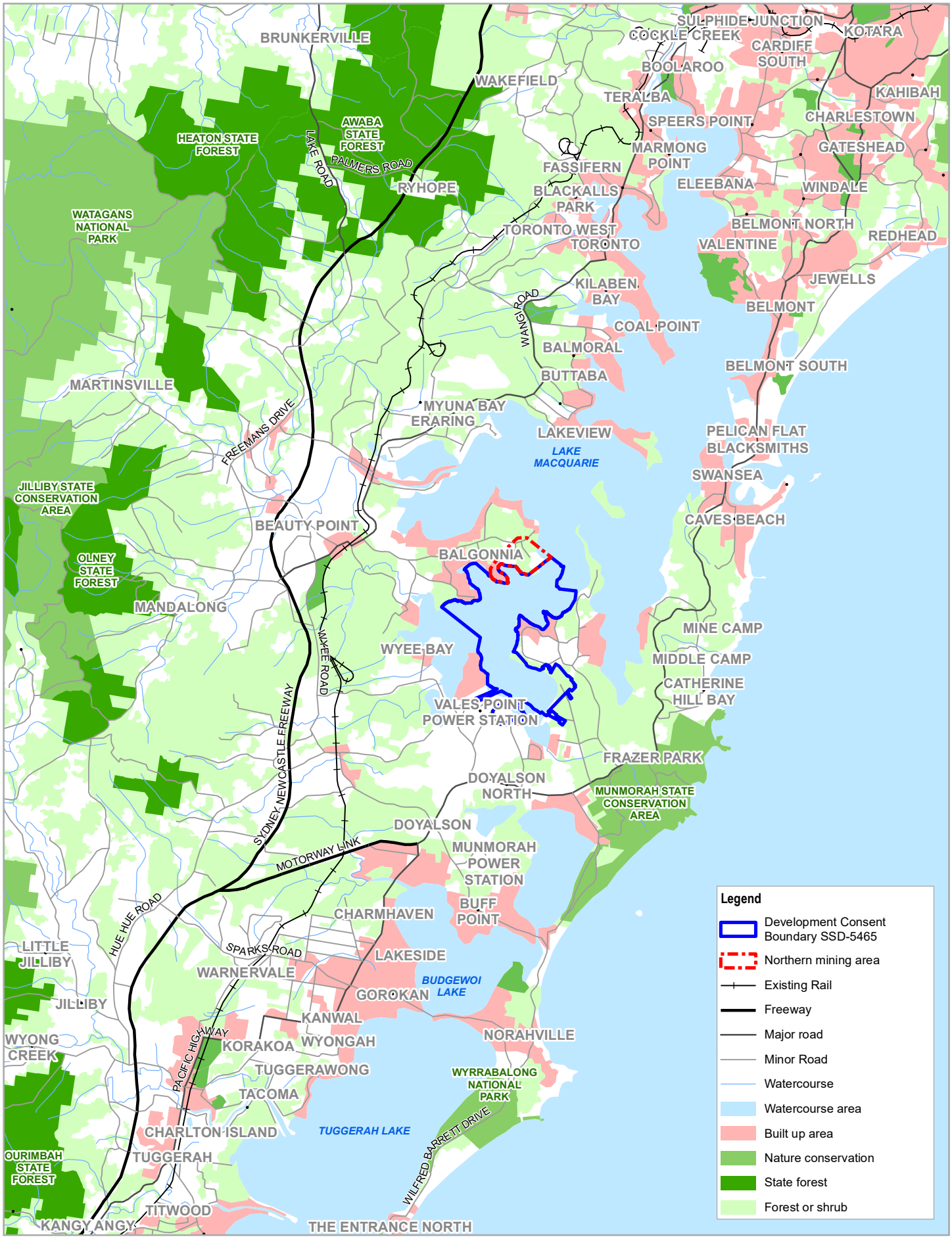
Delta Coal is seeking to further modify SSD-5465 under Section 4.55(2) of the EP&A Act, to allow an increase in the approved underground mining area at CVC (Modification 4).

1.2 Project Application Area

Delta Coal is seeking to modify SSD-5465 to extend CVC's mining operations into an area of the Fassifern Seam that currently forms part of the Myuna Colliery, located to the north of CVC.

The proposed extension area is located immediately to the north of the CVC consent boundary and is referred to as the Northern Mining Area. Delta Coal has recently acquired parts of the Myuna lease holdings which are currently approved to be mined under the Myuna Consent. This includes the Northern Mining Area, where mining generating less than 20 mm surface subsidence is approved in the Fassifern, Great Northern and Wallarah Seams under the Myuna Consent.

The Project Application Area, which encompasses the existing CVC consent boundary and the Northern Mining Area, is shown in Figure 1-2.



Paper Size ISO A4

0 1 2 3 4

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

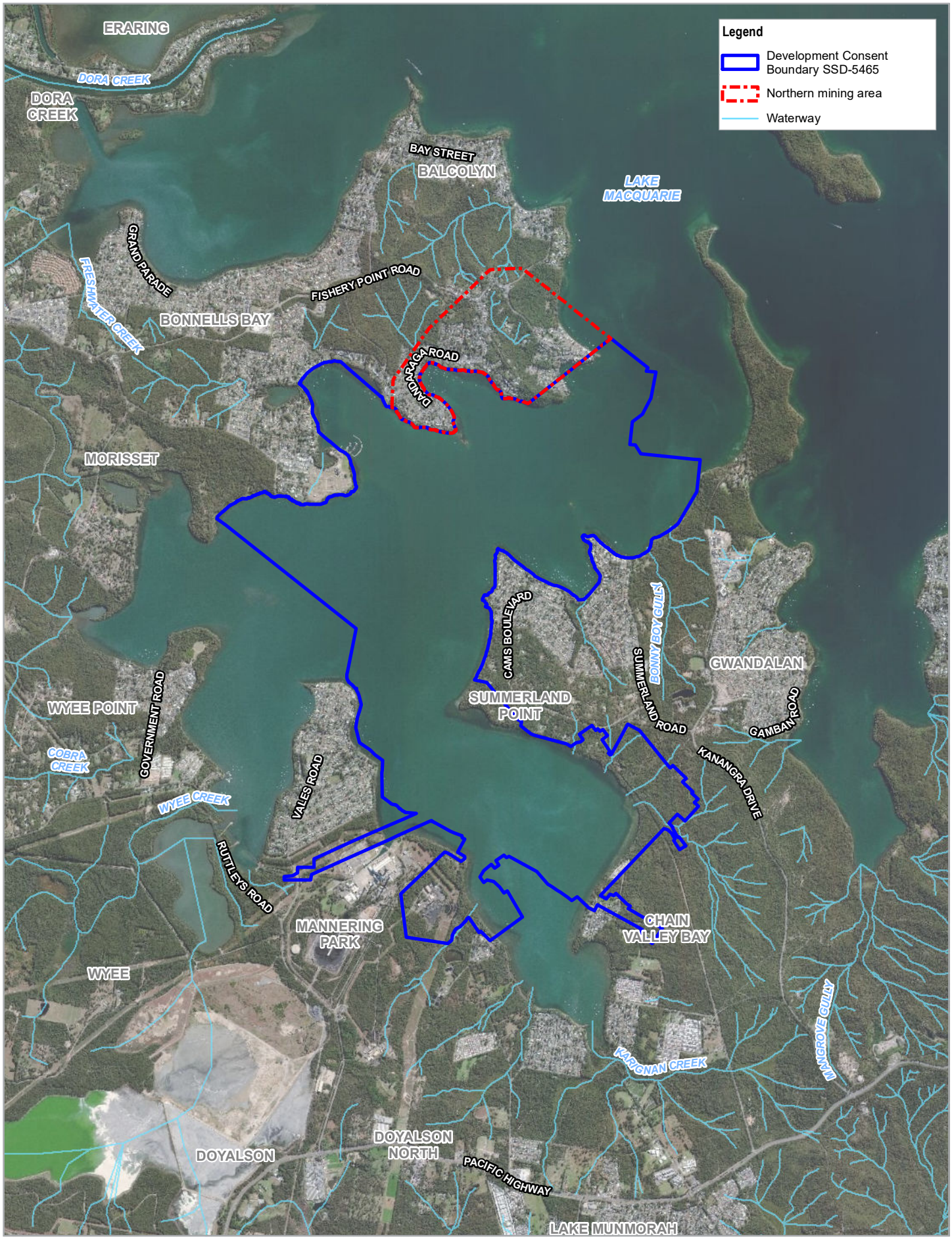
Site locality

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 1-1

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_001_Locality_0.mxd
Print date: 03 Jun 2020 - 08:26

Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006 . Created by: fmackay



Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometers

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

N

GHD

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

Proposed boundary modification

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 1-2

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_002_ProjectBoundaryModification_0.mxd
Print date: 03 Jun 2020 - 08:27

Data source: LPI: DTDB, 2017; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay

1.3 Proposed and approved project conditions

Delta Coal is seeking approval to access the Northern Mining Area from the CVC underground workings rather than from Myuna Colliery, and to transfer coal mined from the Northern Mining Area to the surface via the CVC underground workings. The proposed modification would allow for mains development from the existing CVC underground workings to progress into the Northern Mining Area to access the approved coal reserves.

It is noted that Myuna Colliery has approval to mine this area using bord and pillar mining methods under Project Approval 10_0080.

No other changes to the approved mining method, subsidence impacts, production and coal handling rates, coal transport or surface facilities are proposed as part of the modification.

Alternative mine plans and alternative mining methods have not been considered for the Proposed Modification. Delta Coal is committed to undertaking mining within the Northern Mining Area in a manner that maintains the approved impacts within the Myuna Consent.

A comparison between CVC operations currently being assessed under Modification 3 and the Proposed Modification 4 operations is shown in Table 1-1.

Table 1-1 Comparison between Modification 3 and proposed Modification 4

Key project component	Modification 3 Operations	Proposed Modification 4
Life of Mine	Approved operations to 31 December 2027	No change
ROM Coal Extraction	Up to 2.1 Mtpa of ROM coal	No change
Mining methods	Underground mining undertaken using continuous miner (bord and pillar and pillar extraction) and miniwall mining methods	No change
Development Area	As shown in Figure 2.1 of the Modification 3 SEE (EMM 2019b)	Development consent boundary and Schedule of Lands amended to incorporate the Northern Mining Area
Underground Mining Areas	As shown in Figure 2.1 of the Modification 3 SEE (EMM 2019b)	To incorporate approved mining in the Northern Extension Area
Surface Infrastructure	Utilisation of existing surface infrastructure, including but not limited to: • Personnel-and-material drifts, Run of Mine (ROM) coal conveyor drift. • Upcast and downcast ventilation shaft and fans. • Coal handling facilities for breaking, crushing, sizing and storing product coal. • Administration and workshop facilities.	No change

Key project component	Modification 3 Operations	Proposed Modification 4
	• Water management infrastructure. • Asset Protection Zones (APZs) around some items of surface infrastructure	
Coal Processing	Screening and crushing of ROM coal at CVC	No change
Coal Transport	CVC is approved to transport: • A maximum of 660,000 tonnes of product coal per annum on public roads to Port Waratah Coal Services (PWCS) for export • A maximum of 180,000 tonnes of product coal per annum on public roads to domestic customers (other than Vales Point Power Station (VPPS)) • Product coal to VPPS via truck on private roads only • Up to 2.1 Mtpa to MC (MP06_0311) via the underground linkage for subsequent delivery to VPPS Note: restrictions on both the hours and frequency of dispatch for coal laden trucks also apply.	No change
Water demand and supply	160 megalitres (ML) per annum in water use, drawn from Wyong Shire Council's water supply mains.	No change
Coal reject management	No coal rejects are generated	No change
Hours of operation	Mining operations are approved 24 hours per day, 7 days a week	No change
Mine access	Existing road access from Construction Road, off Ruttleys Road	No change
Environmental Performance Measures	Less than 20 mm subsidence within the High Water Mark Subsidence Barrier (HWMSB) and within seagrass beds. Performance measures as set out in Condition 2 of schedule 4 of SSD-5465.	No change
Rehabilitation	Decommissioning of surface facilities and final rehabilitation following mine closure	No change
Employee Numbers	Employment of approximately 220 full time equivalent personnel in total (including approximately 40 full time equivalent contractors)	No change

Note: 1. Modification 3 to SSD 5465 is currently under assessment by DPIE

1.4 Objectives of the groundwater impact assessment

The key objective of the GIA is to determine the potential incremental impacts of the proposed modification on the groundwater environment. The GIA has been supported by the development of a groundwater model that predicts changes in groundwater flow and groundwater levels attributable to the proposed modification (refer Section 5.1).

The proposed modification does not require assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.5 Active and historical mine operations

Mining at CVC commenced in 1962 with the extraction of coal from both the Wallarah and Great Northern Seams. Mining within these seams occurred to the south-east of the Project Application Area and is completed at this stage, although the workings remain dewatered.

Current mining at CVC occurs in the lower Fassifern Seam only. Bord and pillar mining commenced in the Fassifern Seam in 2006 and miniwall extraction (up to 97 m wide) commenced in 2011. Secondary extraction only occurs under Lake Macquarie (Zone B mining area). Less than 20 mm subsidence is approved within the HWMSB zone.

Other active and historical mining operations exist in close proximity to the Project Application Area. Key operations are detailed in this section.

1.5.1 Mannering Colliery

Formerly the Wyee State Mine, mining operations at MC commenced in 1960 and have included bord and pillar and longwall mining methods in the Great Northern and Fassifern Seams. The site is located to the immediate south-west of CVC. Due to the close proximity of MC to the Project Application Area, the MC mine workings have been included in the groundwater model.

1.5.2 Myuna Colliery

Myuna Colliery is an underground coal mine owned and operated by Centennial Myuna Pty Limited, a subsidiary of Centennial. Mining at Myuna Colliery is undertaken in accordance with Project Approval 10_0080.

The Myuna consent area abuts the northern boundary of the Project Application Area. Mining operations commenced at Myuna in 1982 and have occurred within the Wallarah, Great Northern and Fassifern Seams. Due to the close proximity of Myuna to the Project Application Area, the Myuna mine workings have been included in the groundwater model and recorded groundwater inflows to the Myuna underground workings have been used in model calibration.

1.5.3 Mandalong Mine

Mandalong Mine is an underground coal mine located to the west of MC and is owned and operated by Centennial Mandalong Pty Limited (Centennial Mandalong), a subsidiary of Centennial.

Mining within the Great Northern Seam commenced at Cooranbong Colliery to the north-west of the Project Application Area in 1980 and was completed in 2004. Longwall mining commenced at Mandalong Mine to the south of Cooranbong Colliery in 2005 within the West Wallarah Seam (combined Wallarah and Great Northern Seams) and is ongoing.

The Cooranbong Colliery and Mandalong Mine workings have been included in the groundwater model to simulate dewatering of the Great Northern Seam up gradient of CVC. In addition, groundwater level monitoring data for Mandalong Mine have been used in model calibration.

1.5.4 Wallarah Colliery and Moonee Colliery

The former Wallarah and Moonee Collieries are located to the south-east of the Project Application Area. Mining within the Great Northern Seam occurred at Wallarah Colliery between 1958 and 2000 while mining at Moonee Colliery was carried out in the Wallarah and Great Northern Seams between the 1940s and 2002 (GeoTerra, 2013). Since these mining areas are no longer dewatered it has been assumed for the purposes of this assessment that groundwater levels have recovered in these areas and they have not been included in the groundwater model.

1.6 Limitations

This report has been prepared for Delta Coal and may on be used and relied upon by Delta Coal for the purpose agreed between GHD and Delta Coal as set out in Section 1.5 of this report.

GHD otherwise disclaims responsibility to any person other than Delta Coal arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Delta Coal and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Legislation and policy

The following section provides a brief overview of the legislation and policies relevant to this GIA.

2.1 Legislation

2.1.1 Environmental Planning and Assessment Act 1979

The EP&A Act is the core legislation relating to planning and development activities in NSW and provides the statutory framework under which development proposals are assessed. The EP&A Act aims to encourage the proper management, development and conservation of resources, environmental protection and ecologically sustainable development.

The GIA forms part of a SEE to support the application to further modify SSD-5465 under Section 4.55(2) of the EP&A Act.

2.1.2 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. It provides a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses, as well as providing for protection of catchment conditions.

Fresh water sources throughout NSW are managed via Water Sharing Plans (WSPs) under the WM Act. Provisions within WSPs provide water to support the ecological processes and environmental needs of groundwater dependent ecosystems (GDEs) and waterways. WSPs also regulate how the water available for extraction is shared between the environment, basic landholder rights, town water supplies and commercial uses. Key rules within the WSPs specify when licence holders can access water and how water can be traded. Under the WM Act a Water Access Licence (WAL) is required to extract or interfere with groundwater in areas where a WSP is in place.

The WSP for the Hunter Unregulated and Alluvial Water Sources commenced in August 2009 and regulates the interception and extraction of surface water and alluvial groundwater within the defined WSP area. The alluvium within the Project Application Area is located within the South Lake Macquarie Water Source managed under this WSP. Therefore, the interference and extraction of alluvial groundwater throughout the Project Application Area would normally require a WAL under the WM Act.

The WSP for the North Coast Fractured and Porous Rock Groundwater Sources commenced in July 2016. The porous and fractured groundwater sources within the Project Application Area are covered by the Sydney Basin North Coast Groundwater Source, which is defined under this WSP.

Section 4.41 of the EP&A Act removes the need for a number of approvals under the WM Act when development consent has been granted for a SSD. These are a water use approval under Section 89 of the Act, a water management work approval under section 90 of the Act and an activity approval (other than an aquifer interference approval) under section 91 of the Act.

2.2 Policy

2.2.1 NSW State Groundwater Policy

The objective of the NSW State Groundwater Policy Framework Document (NSW Government 1997) is to manage the State's groundwater resources so that they can sustain their environmental, social and economic uses. The policy has three component parts:

- NSW Groundwater Quantity Protection Policy
- NSW Groundwater Quality Protection Policy
- NSW Groundwater Dependent Ecosystems Policy

NSW Groundwater Quantity Protection Policy

The principles of this policy include:

- Maintain total groundwater use within the sustainable yield of the aquifer from which it is withdrawn.
- Groundwater extraction shall be managed to prevent unacceptable local impacts.
- All groundwater extraction for water supply is to be licensed. Transfers of licensed entitlements may be allowed depending on the physical constraints of the groundwater system.

NSW Groundwater Quality Protection Policy

The objective of this policy is the ecologically sustainable management of the State's groundwater resources to:

- Slow and halt, or reverse any degradation in groundwater resources.
- Direct potentially polluting activities to the most appropriate local geological setting so as to minimise the risk to groundwater.
- Establish a methodology for reviewing new developments with respect to their potential impact on water resources that will provide protection to the resource commensurate with both the threat that the development poses and the value of the resource.
- Establish triggers for the use of more advanced groundwater protection tools such as groundwater vulnerability maps or groundwater protection zones.

NSW Groundwater Dependent Ecosystems Policy

This policy was designed to protect ecosystems that rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems are maintained or restored for the benefit of present and future generations.

2.2.2 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) outlines the water licensing requirements under the Water Act 1912 and WM Act. A water licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity (such as dewatering) even where that water is not being used consumptively as part of the activity's operation.

Under the WM Act, a water licence gives its holder a share of the total entitlement available for extraction from the groundwater source. The WAL must hold sufficient share component and water allocation to account for the take of water from the relevant water source at all times. Sufficient access licences must be held to account for all water taken from a groundwater or

surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased.

The NSW AIP requires that potential impacts on groundwater sources, including their users and GDEs, be assessed against minimal impact considerations, outlined in Table 1 of the Policy. If the predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered acceptable.

The Level 1 minimal impact considerations for less productive groundwater sources are relevant to the groundwater sources at CVC 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.

3. Site description

The existing geological, hydrogeological and surface water environment within the Project Application Area is outlined in this section.

3.1 Climate

Climate data were obtained as SILO Patched Point Data from the Science Division of the Queensland Government's Department of Environment and Science. SILO Patched Point Data is based on historical data from a particular Bureau of Meteorology station with missing data "patched in" by interpolating with data from nearby stations.

SILO data were obtained for the grid point located at -33.15 N, 151.55 E, which is located within the Project Application Area. Average monthly climate data for this point is shown in Figure 3-1. Evaporation varies seasonally, with higher values recorded in summer compared to winter. Average monthly rainfall exceeds evaporation between March and July.

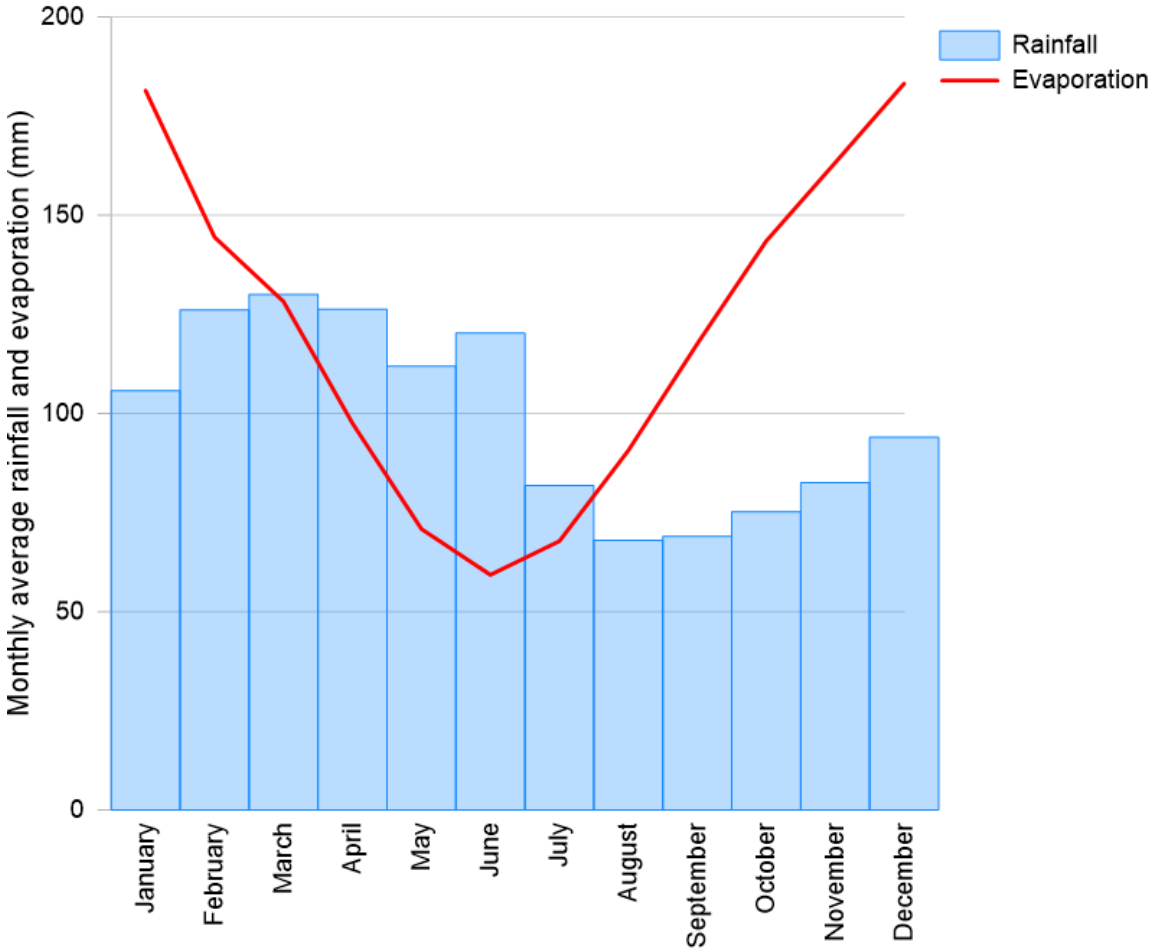


Figure 3-1 Average climate data (-33.15 N, 151.55 E)

Historical annual SILO point rainfall data between 1900 and 2019 is shown in Figure 3-2. Annual rainfall statistics associated with this data are summarised below:

- Minimum rainfall – 605 mm in 1944
- Median rainfall – 1,156 mm
- Average rainfall – 1,189 mm
- Maximum rainfall – 2,037 mm in 1950

Annual rainfall was below the annual average in recent years (from 2016 – 2019).

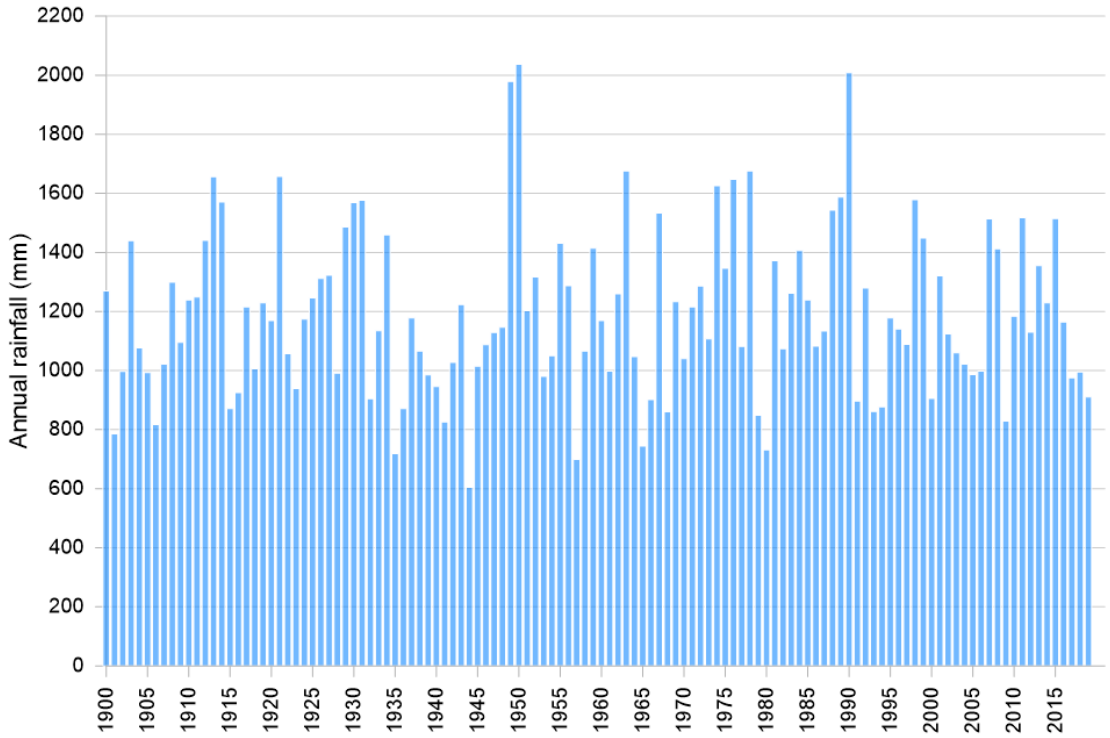


Figure 3-2 Historical annual rainfall record (-33.15 N, 151.55 E)

The SILO dataset was used to generate a Cumulative Rainfall Departure (CRD) curve. CRD is the monthly accumulation of the difference between the observed monthly rainfall and the long term average monthly rainfall. Any increase in the CRD reflects above average rainfall while a decrease in CRD reflects below average rainfall. The CRD curve only deviates from zero due to atypical (above and below average) rainfall. The CRD over the period 1900 to 2019 is shown in Figure 3-3.

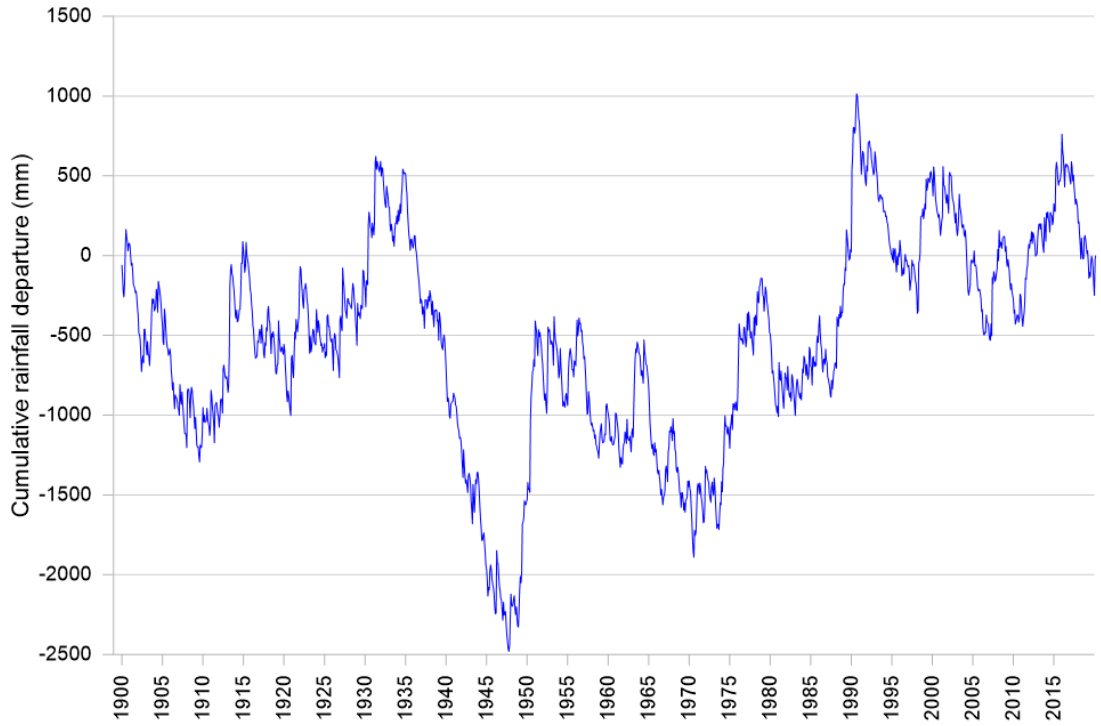


Figure 3-3 Cumulative rainfall departure curve

3.2 Topography

The topography of the Project Application Area is generally low lying due to its proximity to Lake Macquarie. Local relief within the Northern Mining Area ranges from approximately 0 to 30 m AHD. The elevation rises to the west of the Project Application Area to over 400 m AHD.

3.3 Hydrology

The Project Application Area is located within the catchment area of south Lake Macquarie to the south of the Dora Creek catchment. The main creek systems in the vicinity of the Project Application Area include Wyee Creek, Cobra Creek and Pourmalong Creek to the west, Karignan Creek to the south, Bonny Boy Gully and Tiembula Creek to the east and Postmistress Creek to the north (within the Northern Extension Area). A number of unnamed tributaries also exist in the vicinity of the Project Application Area. Watercourse locations are shown in Figure 1-2.

A number of estuarine lakes exist to the south of the Project Application Area, including Lake Munmorah and Budgewoi Lake.

There are no data regarding creek water levels and flow in the vicinity of the Project Application Area. In general, creeks are ephemeral and water gaining upstream of the tidal zone. This includes creeks within the Northern Mining Area. Within the tidal zone there is permanent water in creeks including Wyee Creek and Pourmalong Creek.

3.4 Geology

The Project Application Area is located within the Newcastle Coalfield within the northern portion of the Sydney Basin. The stratigraphy of the region is summarised in Table 3-1 and consists predominantly of Triassic and Permian strata.

Triassic rocks of the Narrabeen Group outcrop in the vicinity of the Project Application Area, including the Northern Mining Area, as shown in Figure 3-4. The Narrabeen Group (labelled as Rn in Figure 3-4) comprises variable sequences of interbedded claystones, siltstones and fine

to coarse grained sandstones. It includes the Munmorah Conglomerate, which is a low permeability sandstone-dominated formation (Centennial Mandalong, 2019).

Quaternary alluvial deposits overlay the bedrock in some areas, with the approximate location of alluvium labelled as Qa in Figure 3-4. The main alluvial deposits in the vicinity of the Project Application Area occur to the west and are associated with Wyee Creek and Pourmalong Creek. There are no known alluvial deposits within the Northern Mining Area.

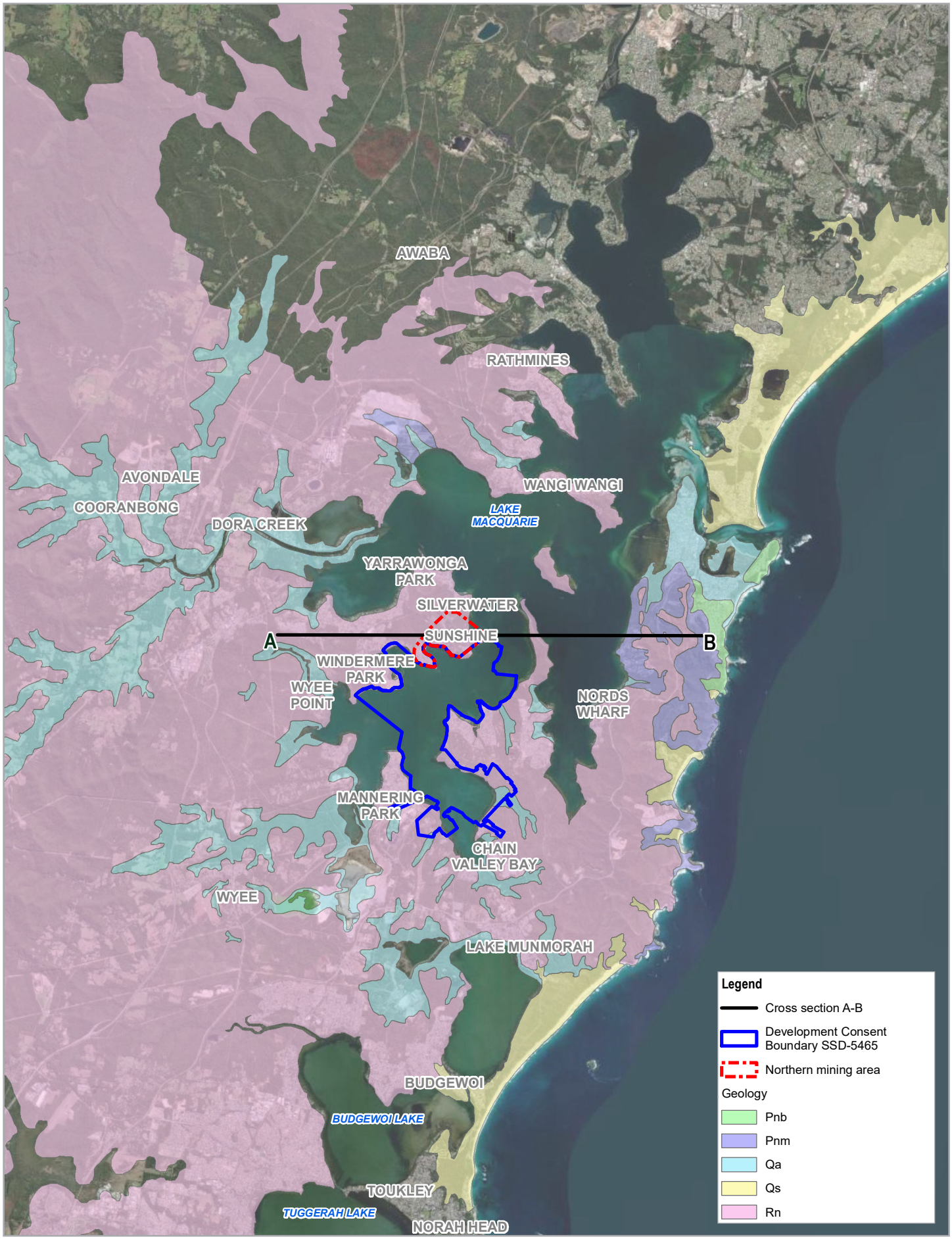
The thickness of the sediment beneath Lake Macquarie ranges from 6 to 20 m (GeoTerra, 2013).

Table 3-1 Stratigraphic sequence - CVC

Age	Group	Subgroup	Unit
Quaternary		Terrestrial and lacustrine marine alluvium	
Triassic	Narrabeen	Clifton	Munmorah Conglomerate
			Dooralong Shale
Permian	Newcastle Coal Measures	Moon Island Beach Formation	Vales Point Seam
			Karignan Conglomerate
			Wallarah Seam
			Mannering Park Tuff
			Teralba Conglomerate
			Great Northern Seam
			Karingal Conglomerate
		Awaba Tuff	
		Boolaroo	Fassifern Seam

The Triassic rocks are underlain by the Permian Newcastle Coal Measures, which subcrop to the east of the Project Application Area as well as to the north-west. The strata of the Newcastle Coal Measures gently dip to the south / south-west at one to two degrees.

The target seams at CVC, from shallowest to deepest, are the Wallarah Seam, Great Northern Seam and Fassifern Seam. The depth of cover above the Fassifern Seam within the Project Application Area ranges from approximately 150 to 230 m (GeoTerra, 2015) with the depth of cover in the Northern Mining Area being approximately 160 m. The Munmorah Conglomerate extends to a depth of 120 m within the CVC area and consists of mainly quartz-lithic sandstone interbedded with pebble conglomerate (GeoTerra, 2013).



Paper Size ISO A4

0 1 2 3 4

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

Surface geology map

FIGURE 3-4

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_003_Geology_0.mxd
Print date: 04 Jun 2020 - 19:31

Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; DPI: Geology, 2010; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: smacdonald

The Fassifern Seam is underlain by Warners Bay Tuff in some areas, as well as deeper sandstone, conglomerate and siltstone units of the Newcastle Coal Measures and various coal seams.

3.4.1 Structure and intrusions

The dominant geological feature that intersects the Project Application Area is the north-south trending Macquarie Syncline. It results in folding of the strata within the Newcastle Coal Measures, including the target seams at CVC. The pattern of folding of the Permian strata in the vicinity of CVC is shown in Figure 4-1.

Mapped and inferred geological structures in the Project Application Area also include faults and dykes, which are north-west to south-east trending and have been intersected by the existing Fassifern Seam workings (GeoTerra, 2015). These geological features have been incorporated into the numerical groundwater model only through their observed effect on layer geometry.

There are no known geological structures within the Northern Mining Area that are likely to become a conduit to groundwater flow and provide a hydraulic connection between the proposed mine workings and upper aquifers.

3.5 Hydrogeology and 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 Aquifer Interference Policy, as yields are generally less than 5 L/s and/or the total dissolved solids (TDS) concentration is typically greater than 1500 mg/L (due to the close proximity to Lake Macquarie). A general overview of groundwater sources is provided in this section.

3.5.1 Alluvium

The alluvium within and in the vicinity of the Project Application Area forms an unconfined shallow aquifer. The groundwater flow direction within the alluvium generally reflects the topography with flow towards Lake Macquarie. GeoTerra (2013) suggested that the alluvium would be thin within the Project Application Area with limited aerial extent, and therefore have no significant water storage or transmitting ability. Alluvial groundwater would be expected to provide baseflow to the ephemeral creeks outlined in Section 3.3.

The alluvial water sources within the Project Application Area are covered under the Water Sharing Plan (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. Sediments within Lake Macquarie are not managed under a WSP. These sediments act as a marine aquifer with aquifer pressures dominated by the water level within Lake Macquarie (GeoTerra 2013).

3.5.2 Fractured and porous rock

The porous and fractured rock groundwater sources underlying the Project Application Area generally occur within weathered rock (Triassic) and coal seams (Permian). They are managed under the North Coast Fractured and Porous Rock Groundwater Sources WSP. The piezometric head within the Permian coal seams tends 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 to the north-west of the Project Application Area. Groundwater tends to flow laterally along sedimentary layers since the vertical hydraulic conductivity is usually at least one order of magnitude lower than the horizontal hydraulic conductivity due to the interbedding of low permeability strata. 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 (Pacific Power International, 1997).

Active and historical underground coal mining at CVC and other sites is likely to have caused some depressurisation of fractured and porous rock groundwater sources in the vicinity of the Project Application Area. Groundwater Exploration Services (GES, 2012) developed a groundwater model for CVC to predict the potential impacts on the groundwater and surface water systems due to the proposed Fassifern Seam miniwall extraction activities. Model predictions indicate that there is likely to be existing depressurisation of Triassic strata as well as of the target coal seams within the Northern Mining Area.

3.6 Groundwater use

A search of the Australian Groundwater Explorer (BOM 2019a) and Water NSW (2020) identified 25 registered bores within an approximate five kilometre radius of the Northern Mining Area. Of the registered bores, the majority (21) were registered as test and monitoring bores. Four bores were registered for water supply, including stock watering and domestic supply. No registered bores were identified within the Northern Mining Area. Several shallow test bores were identified within approximately 1 km to the south-west of the Northern Mining Area.

Bore details are provided in Table 3-2. A map of bore locations is shown in Figure 3-5. Additional registered bores beyond a radius of 5 km from the Northern Mining Area are also shown on this map.

Table 3-2 Registered bores

Bore ID	Purpose	Easting	Northing	Depth	Yield	SWL1	Lithology
GW024575	General use	365969	6332788	15.2	0.01	4.5	Clay, sandstone, conglomerate
GW034560	Domestic	364130	6330883	18.3		5.5	Clay, sand
GW034600	Domestic	367678	6332873	60.9	0.06	5.7	Clay, sandstone, conglomerate, shale
GW080830	Test bore	363757	6330850				
GW201977	Monitoring	363730	6331388	7.1		6	Sandy, gravelly clay
GW201978	Monitoring	363712	6331391	7.1		6	Sandy clay, clayey sand
GW201979	Monitoring	363704	6331405	7.2		6	Clay, sandy clay
GW202027	Test bore	363829	6334141	3.7		0.8	

Bore ID	Purpose	Easting	Northing	Depth	Yield	SWL1	Lithology
GW202028	Test bore	363872	6334034	5.5		1.6	
GW202098	Test bore	363829	6334141	4		0.8	
GW202246	Test bore	363834	6334174	3.5		1.2	
GW202247	Test bore	363899	6333964	5		3.6	
GW202248	Test bore	363918	6333881	5			
GW202372	Test bore	363834	6334174	4		1.2	
GW202833	Monitoring	363568	6330876	6		2	Clay, sandy silt, silty clay
GW202834	Monitoring	363563	6330861	6.5		2.5	Silty sandy clay
GW202839	Monitoring	363574	6330883	7.2		2.5	Clay, conglomerate
GW202840	Monitoring	363573	6330859	5		2	Clay, silty sand
GW203160	Monitoring	364359	6329885	2.8		0.609	Sandy clay, sandy gravel
GW203161	Monitoring	364448	6329941	14		1.548	Conglomerate
GW203162	Monitoring	364433	6329983	12		2.642	Conglomerate
GW203163	Monitoring	364392	6330065	6		2.43	Clay, sandy clay
GW203164	Monitoring	364370	6330145	7.5		2.582	Clayey sand
GW203165	Monitoring	364461	6330010	11.5		1.243	Sandstone
GW203987	Stock, domestic	363530	6334261.8	36	0.06	7	Sandstone

Notes: 1. SWL – Standing Water Level

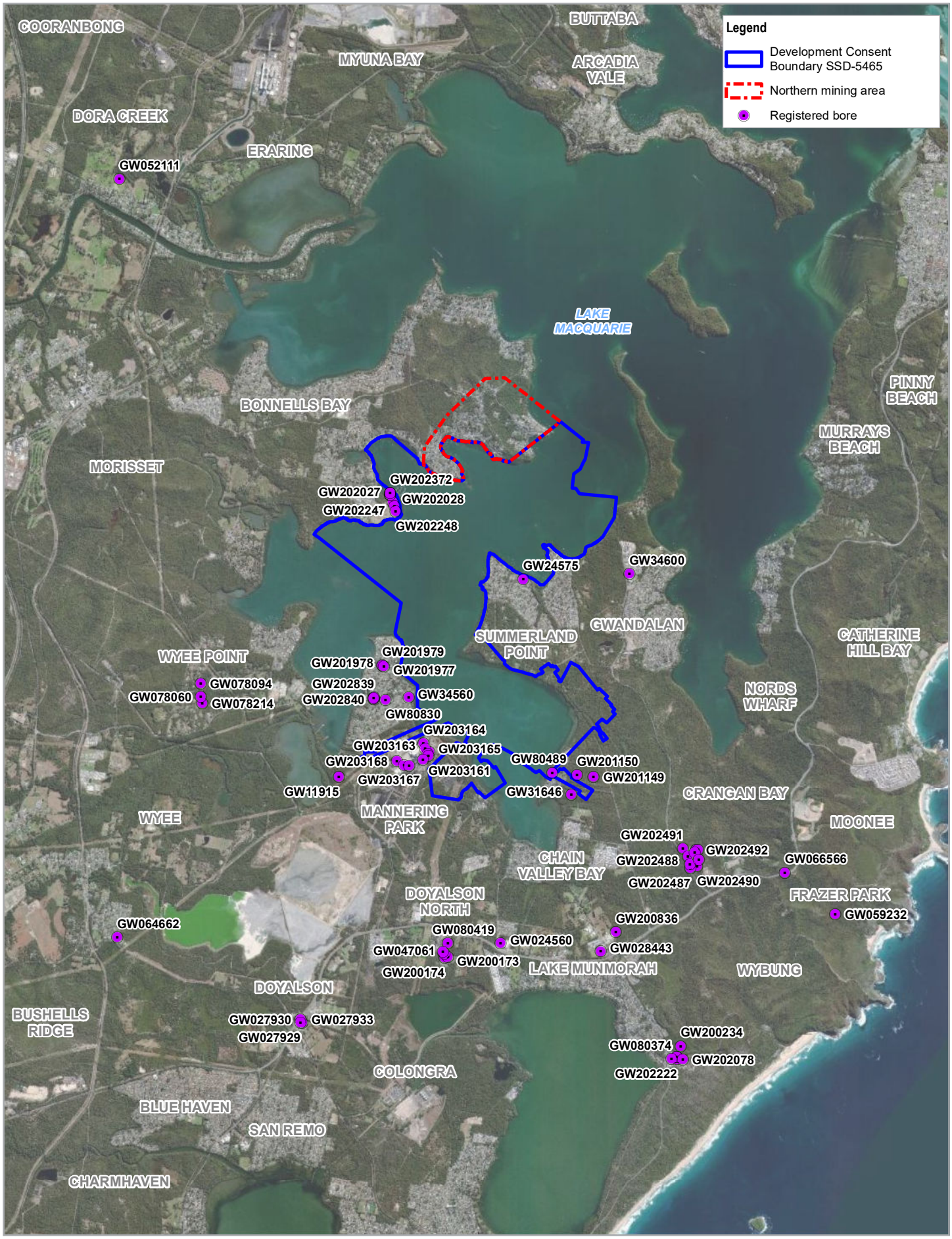
The maximum depth of the registered bores is 61 m, with most of the bores installed to a depth of less than 20 m. Reported groundwater yields are less than 1 L/s. Depths to groundwater are generally shallow (less than 7 m). Overall, the search of the registered bore databases suggest that groundwater use in the vicinity of the Project Application Area is limited.

3.7 Groundwater dependent ecosystems

A search of the Groundwater Dependent Ecosystems Atlas (BOM 2019b) was undertaken to identify GDEs near CVC. No high priority GDEs, listed in the relevant WSPs, were identified in the Project Application Area.

A map of terrestrial and aquatic GDEs in the vicinity of the Project Application Area, classified as either high, moderate or low potential GDEs, is shown in Figure 3-6. Lake Macquarie is

identified as a moderate potential aquatic GDE. High, moderate and low potential terrestrial GDEs were identified within the Northern Mining Area. The high potential terrestrial GDE appears to be associated with Postmistress Creek.



Paper Size ISO A4

0 0.55 1.1 1.65 2.2

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

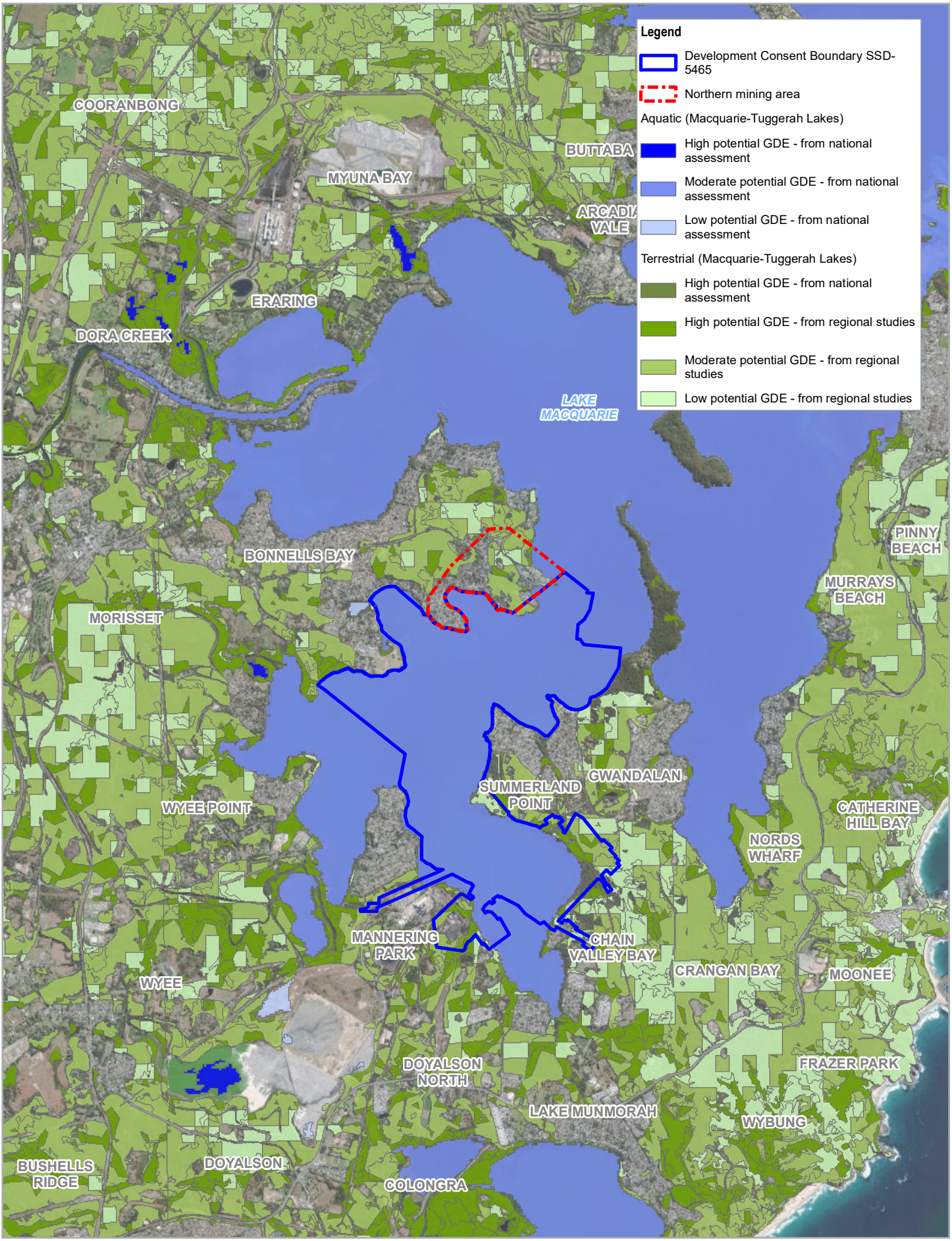
Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

Registered Bore Search

FIGURE 3-5

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_004_BoreSearch_0.mxd
Print date: 03 Jun 2020 - 08:27

Data source: LPI: DTDB, 2017; BOM: Registered Borse, 2019; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
Created by: fmackay



Paper Size ISO A4

0 0.55 1.1 1.65 2.2

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

Groundwater dependent ecosystems

FIGURE 3-6

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_005_GDEs_0.mxd
Print date: 03 Jun 2020 - 08:27

Data source: LPI: DTDB, 2017; BOM: GDEs, 2019; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay

4. Groundwater monitoring and conceptual model

4.1 Groundwater management overview

4.1.1 Existing groundwater management plan

Groundwater at CVC is managed in accordance with the Chain Valley Colliery Groundwater Management Plan (GeoTerra, 2019). The Groundwater Management Plan outlines groundwater level, quality and quantity monitoring requirements. It also identifies trigger levels and the actions and responses that should be adopted in the case that these triggers are exceeded.

4.1.2 Existing licences

The former owner of CVC (LakeCoal) was granted a groundwater licence in March 2013 under the Water Act 1912 (20BL173107) to extract up to 4,443 ML in any 12 month period from the underground workings. This licence has been converted to Works Approval 20MW065025 and Water Access Licence (WAL) 41508 for the annual extraction of 4,443 ML from the Sydney Basin North Coast Groundwater Source.

4.2 Monitoring program details

The Groundwater Management Plan identifies a number of private bores for inclusion in the groundwater level and quality monitoring program. Monitoring of these bores is required at least once before and once after mining of the relevant miniwall is completed. At this point in time, Delta has not been able to gain access to a suitable private bore for monitoring.

Daily metering of total underground mine water input and output is undertaken. Underground water quality sampling is also undertaken on occasion.

4.3 Baseline monitoring results

4.3.1 Groundwater inflow

Total mine dewatering over the period 2009 to 2018 (including all three seams) ranged from a maximum of approximately 2,500 ML/year in 2012 to a minimum of approximately 1,900 ML/year in 2018. Taking into account the potable water input, the average groundwater make for 2018 was estimated to be 5 ML/day (GeoTerra, 2019). The GES (2012) groundwater model predicts that groundwater inflows at CVC will peak at 10.5 ML/day.

In comparison, total groundwater inflow to Myuna (including all three seams) ranged between 4 and 5 ML/day between 2014 and 2018 (GHD, 2019).

Groundwater inflow data are not available for MC.

4.3.2 Groundwater quality

Groundwater monitored within the CVC underground workings indicates that groundwater inflow is brackish to saline in subsided areas of the Great Northern Seam workings (11,800 – 28,200 mg/L) with a pH between 7.30 and 7.76 (GeoTerra, 2019). Seepage from a dyke at the northern end of the current Fassifern Seam workings was reported to have brackish salinity (2,390 mg/L) and a pH of 8.63. (GeoTerra, 2019). The lower salinity groundwater inflow to the Fassifern Seam indicates the absence of hydraulic connection between Lake Macquarie and the Fassifern Seam.

4.4 Conceptual hydrogeological model

Based on the hydrogeological environment detailed in Section 3 and available monitoring data outlined in Section 4, a conceptual hydrogeological model has been developed to form the basis of the numerical groundwater model.

Key features of the conceptual hydrogeological model of the Project Application Area and wider region is shown schematically in Figure 4-1. The conceptual model has been developed to identify the key hydrogeological processes and their interactions. It includes surface water and groundwater systems, flow paths, recharge and discharge processes and the interaction between each component.

Inputs to the groundwater system throughout the model domain include rainfall recharge to alluvium and weathered rock, and leakage from Lake Macquarie and permanent streams as shown in Figure 4-1. While leakage from Lake Macquarie is ongoing, recharge across terrestrial areas is expected to occur only after major rainfall events. Rainfall recharge also varies according to the permeability of the surface strata. Permanent streams only occur in the lower reaches within the tidal zone, as outlined in Section 3.3.

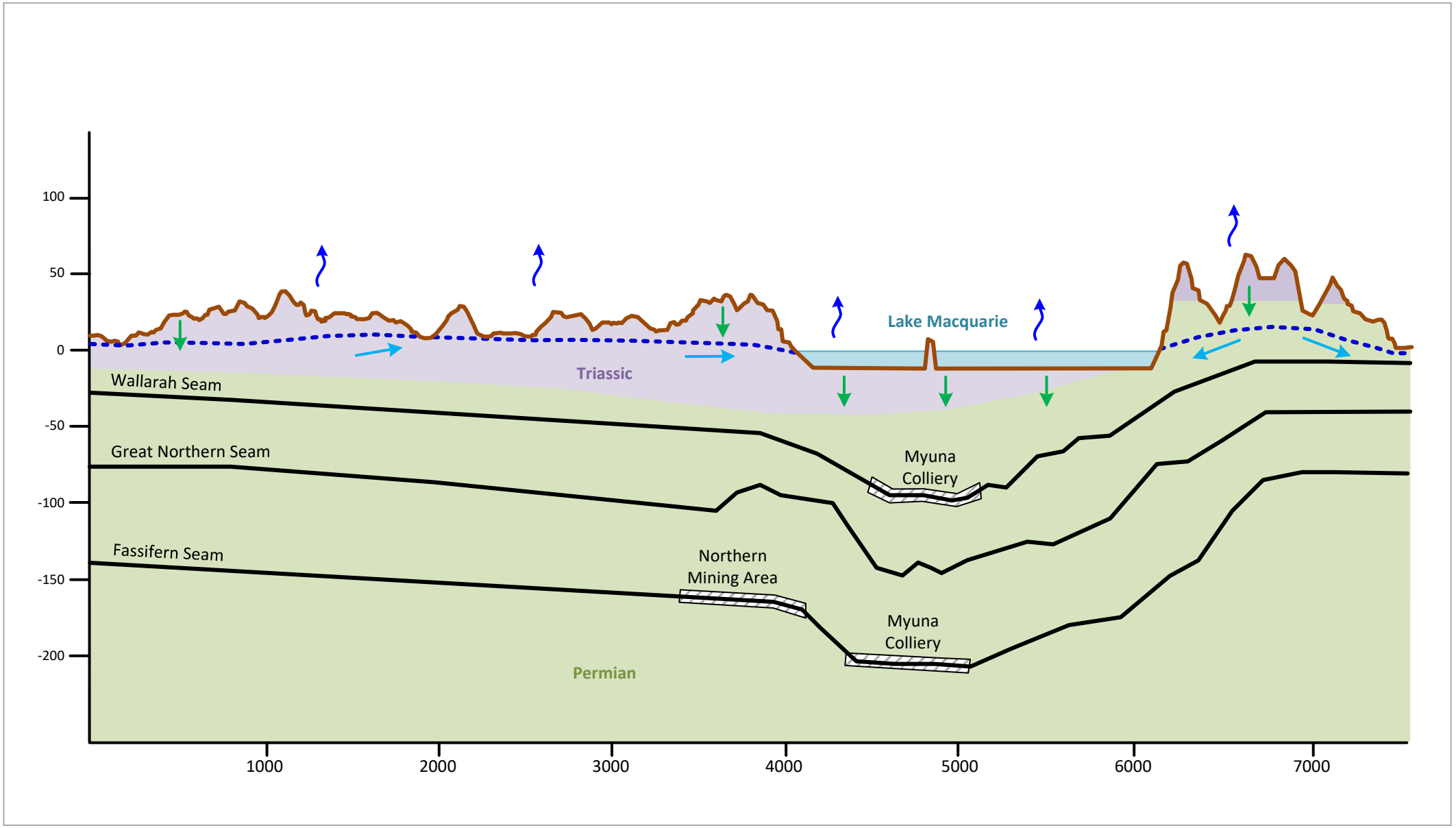
The main outputs from the groundwater system include evapotranspiration, baseflow to water gaining streams, outflow to Lake Macquarie and inflow to mine workings, as shown in Figure 4-1. Evapotranspiration varies across the model domain according to the extent of vegetation. The majority of streams within the model domain, including all within the Northern Mining Area, are considered to be water gaining and as such will receive baseflow from groundwater when the groundwater level rises to the bed elevation.

Alluvial groundwater flow generally reflects topography and discharges to connected surface waterways or infiltrates to the regional porous and fractured rock groundwater system. Alluvial groundwater levels often respond to rainfall. Groundwater within the porous and fractured rock system generally flows east from areas of seam subcrop to the west and north of the Project Application Area towards Lake Macquarie. Lateral flow dominates over vertical flow through the strata unless mining creates a hydraulic gradient towards the mine workings.

Bord and pillar mining results in complete depressurisation of the coal seam only. Secondary extraction, including miniwall mining, results in the zone of complete groundwater depressurisation extending above the coal seam into the overburden strata. The height of complete depressurisation adopted in the groundwater model has been derived using typical empirical equations such as Tammetta (2012).

Potential impacts to groundwater from mining at CVC are as follows:

- Groundwater inflows into mine workings from the porous and fractured rock groundwater source. It is considered that there is a low risk of loss of alluvial groundwater into underlying strata (and mine workings).
- Groundwater drawdown at water supply works within the porous and fractured rock groundwater source. Drawdown within alluvial bores is considered to be less risk.
- Groundwater drawdown within alluvium and shallow groundwater sources that support GDEs.
- Reduction or loss in groundwater baseflow to ephemeral streams within the Northern Mining Area.



Recharge / leakage

Approximate water table

Groundwater flow / baseflow

Evapotranspiration

Delta Coal
Chain Valley Colliery
Modification 4 Groundwater Assessment

Conceptual cross-section

Project No. 12519253
Revision No. A
Date 04/06/2020

FIGURE 4-1

Created by: SMacDonald

G:\22\12519253\Tech\Visio\12519253-VIS-CVC_Groundwater Flow_Conceptual.vsdx
Print date: 04/06/2020 11:58

5. Impact assessment methodology

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

5.1 Numerical groundwater model

The groundwater modelling described in this report has been undertaken in a staged manner consistent with the recommendations of the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). A hydrogeological conceptualisation is presented in Section 4.4, based on the review and analysis of available information, which forms the basis for the subsequent model design and construction. The model has been calibrated to available data, to ensure that the choice of parameter values are sensible and consistent with the current hydrogeological knowledge of the site.

Although an independent third party review of the groundwater model has not been completed at this stage, consultation has been carried out with Dr Noel Merrick (HydroAlgorithmics) to discuss the modelling approach.

A formal hydrogeological risk assessment to determine the approach to uncertainty analysis has not been undertaken because the proposed modification is considered to be a low risk project in terms of groundwater impact. The low risk of impact to groundwater sources from the proposed mining in the Northern Mining Area is based on the following:

- First workings only with subsidence less than 20 mm.
- No groundwater users or high priority GDEs within the Northern Mining Area.
- The Northern Mining Area is currently approved to be mined under the Myuna Consent and the proposed modification application changes the point of access to the coal resource but not the nature of approved mining or the scale of the resource approved to be extracted from this area.

A numerical groundwater model is a mathematical representation of a complex natural environment where parameters and processes can only be inferred from a finite number of measurements. Simplifications and assumptions are necessary in modelling. Efforts have been made to provide clarity on the data used to support the modelling and associated limitations. Findings presented in this report should be considered in this context.

5.1.1 Model construction

Software selection

MODFLOW-USG (MF-USG) has been selected as the most appropriate groundwater modelling software. MF-USG is an unstructured grid version of the industry standard MODFLOW code developed and maintained by the United States Geological Survey (Panday et al 2013). Advantages of MF-USG include flexible meshing for efficient refinement of model cells in the area of interest and robust handling of saturation and desaturation of model cells for tracking the location of the water table.

The input data files for the MF-USG model have been prepared using the graphical user interface GMS Version 10.4.

Model domain

The groundwater model domain is shown in Figure 5-1. The red boundary shows the initial model frame and the yellow boundary shows the groundwater model domain that was ultimately used to build the model. The domain defines the extent of the numerical groundwater model and should be large enough to capture key stresses on the groundwater system and their area of influence, both in the context of past and future activities.

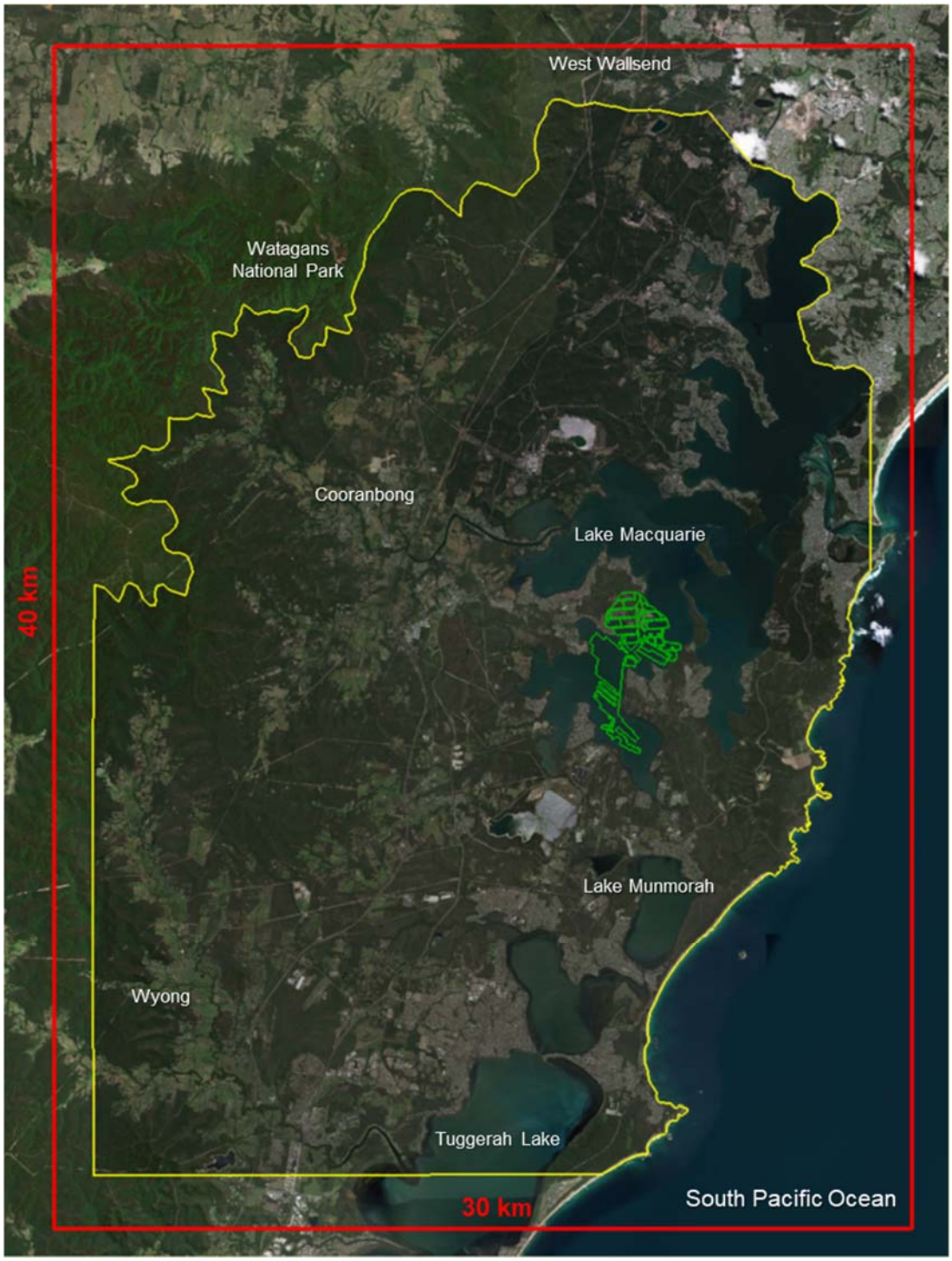


Figure 5-1 Groundwater model domain

The northern boundary of the model domain follows the outcrop of the Fassifern Seam while the north-western boundary follows the topographic ridgeline. The south western and southern boundaries are of sufficient extent to include the Dora Creek and south Lake Macquarie catchment boundaries, lakes to the south of the Project Application Area that may influence the

system, as well as the mining area at Mandalong Mine. The eastern boundary follows the coastline.

Model grid

The MF-USG grid (Layers 1 and 9) is shown in Figure 5-2. The grid is a layered quadtree mesh with cell refinement in the footprint of existing and proposed workings within the Wallarah, Great Northern and Fassifern Seams, in the fracture zones overlying areas of secondary extraction, along key waterways and along model edges. The grid for Layer 1 shows the grid refinement around waterways while the grid for Layer 9 shows the grid refinement around workings in the Fassifern Seam.

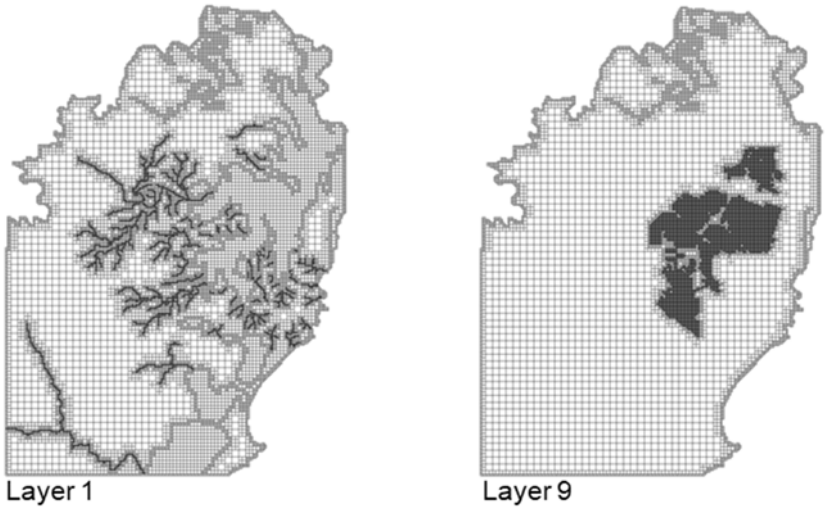


Figure 5-2 Model grid for Layers 1 and 9

The maximum cell size is 600 m x 600 m, with refinements as follows:

- 80 m x 80 m along watercourses in Layer 1, within the footprint of mine workings in Layers 3, 6 and 9 and within fracture zones overlying areas of secondary extraction.
- 150 m x 150 m along the model boundary (all Layers), along the ocean boundary (Layers 1 and 2) and along the boundary of lakes (Layer 1).
- 300 m x 300 m within lake areas.

Overall there are a total of 160,930 model cells.

Model layers

There are ten layers within the groundwater model. These layers are detailed in Table 5-1 and shown in Figure 5-3.

Table 5-1 Model layers

Model layer	Unit	Typical layer thickness (m)
1	Lake and river bed sediments and weathered Triassic conglomerate	10
2	Munmorah Conglomerate	100 - 150
3	Wallarah Seam	0.7 - 2

Model layer	Unit	Typical layer thickness (m)
4	Mannering Park Tuff	~10
5	Teralba Conglomerate	
6	Great Northern Seam	2 - 3
7	Karingal Conglomerate	20 - 60
8	Awaba Tuff	
9	Fassifern Seam	6 – 6.5
10	Shale, Sandstone and Conglomerate	50

The ground surface, corresponding to the top of model Layer 1, has been assigned using a Digital Elevation Model (DEM). Due to limited data, the depth of alluvium, lake sediment and weathered conglomerate (Layer 1) was assigned as 10 m.

The elevations of model layers are based primarily on available coal seam elevation contours. Beyond the extent of available coal seam contour data, the elevation of the coal seams were interpolated from the surface elevation at the outcrop of the coal seams to the edge of the seam elevation contours. Each layer is continuous throughout the model domain, reducing to a minimum thickness of 0.5 m where they pinch out.

5.1.2 Boundary conditions

Boundary conditions were applied according to the following:

- General Head Boundary (GHB) conditions were applied to the ocean boundaries in Layer 1 and Layer 2.
- No flow boundary conditions were applied along the majority of the northern, western and southern boundaries in all layers. These boundaries apply where the boundary is parallel to the expected groundwater flow direction, in locations commensurate with groundwater divides (e.g. seam outcrop) and along the base of the model.
- Rivers cells were assigned in Layer 1 to permanent watercourses including lakes and major rivers up to their tidal limits.
- Recharge was assigned to the highest active cells and varied temporally (during transient calibration) based on a fraction of measured rainfall.
- Evapotranspiration (ET) was assigned to Layer 1 using the EVT package. Groundwater is extracted by ET only where the water table lies above the prescribed ET extinction depth (e.g. along natural topographic low points such as creek lines).
- Drain cells were applied to ephemeral creeks in Layer 1. Mine workings in the Wallarah, Great Northern and Fassifern Seams were represented using drain cells. The stacked drain approach was used to represent the zone of complete depressurisation above areas of secondary extraction.

The set-up of the boundary conditions is further discussed in the following sections. The locations of drain cells (green), river cells (blue) and GHBs (brown) in Layer 1 are shown in Figure 5-4. The location of drain cells representing mine workings in Layers 3, 6 and 9 is shown in Figure 5-5.

Pumping from landholder bores is not simulated in the model as there are a limited number of landholder bores in the vicinity of the Project Application Area and potential pumping from these bores are assumed to have negligible effect on model flow budgets.

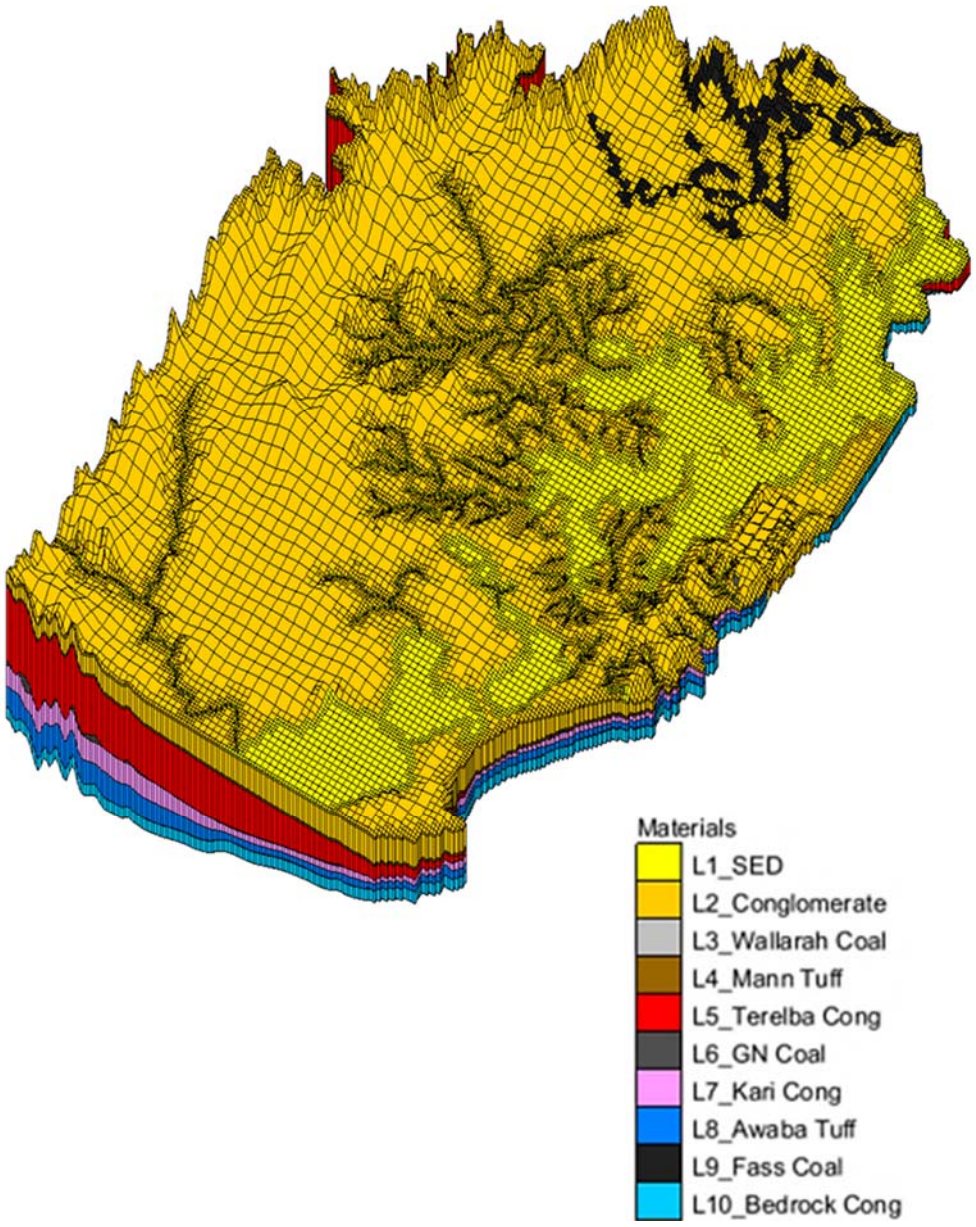


Figure 5-3 Model layering

General head

GHBs have been assigned at an elevation of 0 m AHD along the ocean boundary of the model in Layers 1 and 2. Conductance values for the GHB were assigned to not restrict flow across the boundary.

No flow

The Fassifern Seam outcrops along the northern boundary of the model and therefore no flow boundary conditions were applied along this boundary. The majority of the western boundary of the model coincides with topographic ridgelines and catchment boundaries. These areas have

been assumed to form a groundwater flow divide and therefore no flow boundaries were applied to these boundaries. A no flow boundary was applied along the southern boundary of the model since this boundary is parallel to the expected regional groundwater flow direction.

Rivers

River (RIV) cells were applied to lakes and permanent creeks (Dora Creek, Pourmalong Creek and Wyee Creek) in Layer 1. The river stage elevation was based on topographic data for permanent creeks and was set at 0 m AHD for lakes. The river bed elevation was set equal to the river stage elevation for permanent creeks. This application of RIV cells allowed baseflow but did not allow leakage from the watercourse to the aquifer. The lake bed elevation was set at – 10 m AHD.

The conductance of RIV cells along permanent creeks ranged from approximately 1 and 100 m^2/day. The conductance of RIV cells within the lakes was high with a value up to approximately 90,000 m^2/day.

Recharge

Recharge was assigned to the highest active cells and varied temporally based on measured monthly rainfall data during the transient calibration. Recharge was calculated as a percentage of the monthly rainfall.

Recharge is conceptually higher along higher permeability alluvium areas than in areas where the weathered rock outcrops. Therefore recharge zones have been assigned to account for different surface geology across the model domain. The percentage of rainfall available for recharge was varied depending on the outcropping geology.

Evapotranspiration

The ET surface elevation was set to the top of model Layer 1 and the ET extinction depth was assigned as 1 m across the layer. An ET rate of 0.0022 m/year was applied. ET was not applied to waterbodies including Lake Macquarie.

Drains

Drain cells were used for several purposes in the model. Drains were applied along ephemeral creeks in Layer 1 within the model domain to make them water gaining only. The drain elevation was set at ground level and conductance ranged between 1 and 100 m^2/day.

Drain cells were also utilised to simulate historical mining and proposed mining at CVC (Wallarah, Great Northern and Fassifern Seams), MC (Great Northern and Fassifern Seams), Myuna (Wallarah, Great Northern and Fassifern Seams) and Cooranbong/Mandalong (Great Northern / West Wallarah Seams). Drain cell elevation was assigned to 0.1 m above the base of each coal seam layer. Drains were activated for each mine based on available commencement and completion information outlined in Section 1.5. It was assumed that all workings remain dewatered until the end of 2027, the current approved life of mining at CVC (refer Table 1-1). Drain cells were assigned a conductance of approximately 5500 m^2/day, which was sufficiently high to ensure that drained cells were completely desaturated.

To simulate depressurisation of groundwater sources above the Fassifern Seam due to miniwall mining at CVC, a stacked drain approach was adopted. Drain cells were activated to a height of up to 90 m above miniwalls in Layer 9, which is an approximation of the height of complete depressurisation above the miniwalls. This is based on the Tammetta (2012) approximation, reported by Strata2 (2019). These drain cells were also assigned a conductance of 5500 m^2/day and were progressively activated in accordance with the miniwall mining schedule at CVC. Note

that it was not necessary to apply stacked drains above the proposed workings in the Northern Mining Area since bord and pillar mining is proposed in this area.

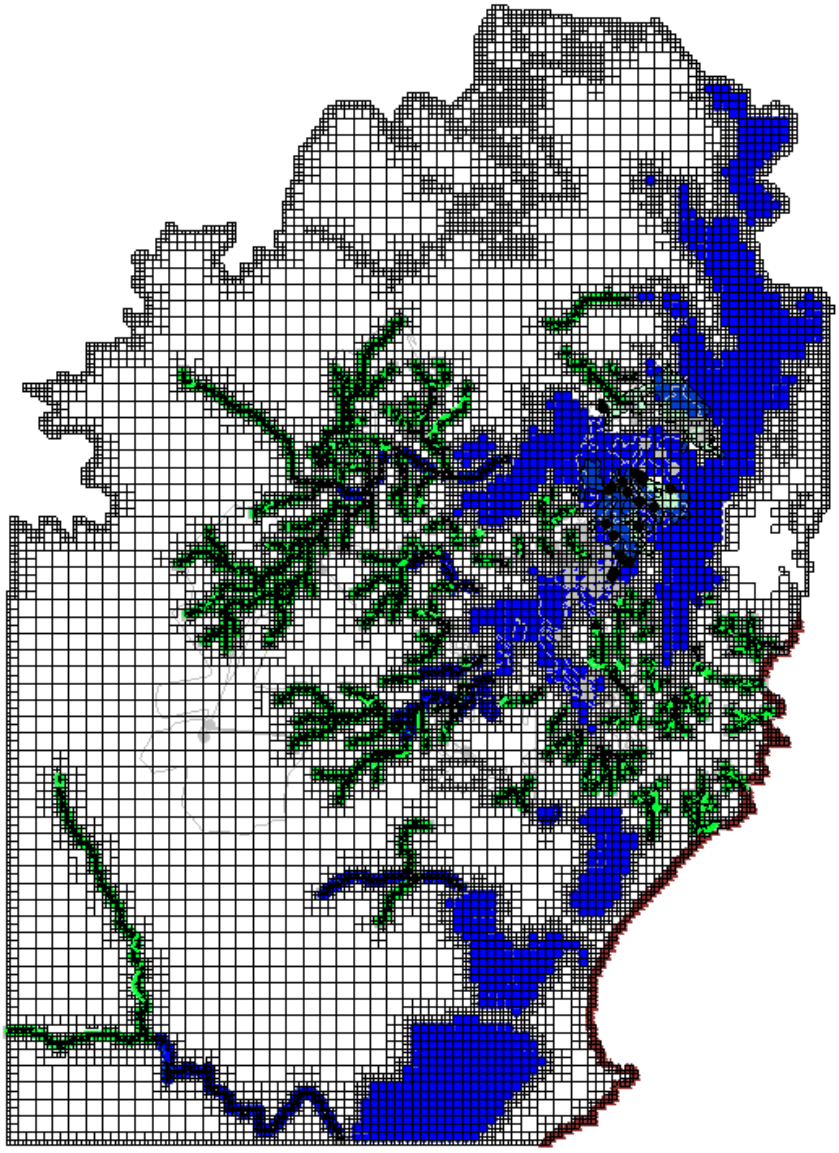


Figure 5-4 Boundary conditions in Layer 1

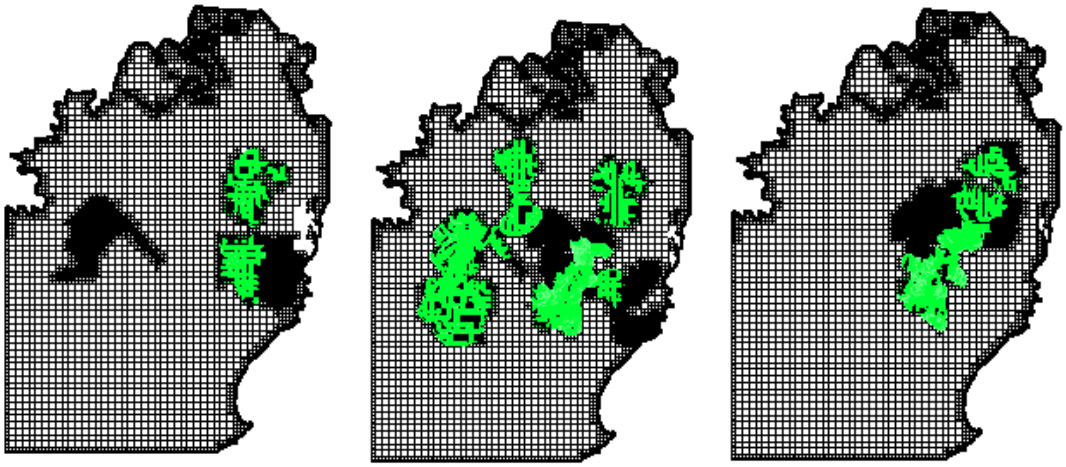


Figure 5-5 Drain cells in Wallarah, Great Northern and Fassifern Seams

5.1.3 Material properties

A range of material properties for each hydrogeological unit within the model was compiled from previous hydrogeological assessments and modelling reports within the Newcastle Coalfield (GeoTerra, 2013; GES, 2012; GHD, 2019; EMM, 2019). Parameter ranges are shown in Table 5-2. Parameter ranges were also reviewed by Dr Noel Merrick.

5.1.4 Model calibration

Approach

Model calibration involves changing the value of model parameters within bounds until the model outputs fit historical measurements, such that the model can be accepted as a reasonable representation of the physical system of interest (Barnett et al. 2012).

A two stage process was adopted, which involved running the steady state model first, to obtain a sensible set of initial heads and groundwater flow contours, followed by the transient model to simulate temporal variations in groundwater levels.

In total the transient model has 91 annual stress periods, from January 1960 to December 2050. Each stress period is divided into 12 time steps. The calibration period was between 1997 and 2019.

Since groundwater level monitoring data is limited in the vicinity of the Project Application Area, it was necessary to use monitoring data for Mandalong Mine, located to the west of CVC, for transient calibration. A groundwater monitoring program has progressively been established at Mandalong since 1997 and includes monitoring bores installed in alluvial and fractured and porous rock groundwater sources. Monitoring bores used in model calibration are listed in Table 5-3.

In addition to calibration of modelled groundwater levels to observed data at Mandalong Mine, modelled groundwater inflows into CVC and Myuna Colliery were compared to recorded data.

Calibration was undertaken by manually changing material properties and recharge within the ranges specified in Table 5-2 over a number of model runs.

Calibration results

A contour plot of the modelled steady state groundwater heads within the fractured and porous rock groundwater source is shown in Figure 5-6. Groundwater flow is shown towards the south-

east as expected, and groundwater heads are in the expected range. It is therefore considered that the steady state model run provides suitable initial heads for the transient model.

The steady state flow budget is shown in Table 5-4. The water balance error is low at 0.06%, well below the target of 1%.

Figure 5-7 presents a scatter plot of observed and modelled heads for the calibrated transient model. Only the observed heads (and corresponding modelled heads) for the last data point of each monitoring bore in Table 5-3 are shown so that the points for each bores are clearly seen on the plot. The root mean squared (RMS) error is 3.45 m and the SRMS is 8.6%, within the 10% target typically adopted for modelling projects.

Based on the calibrated transient model, the total average groundwater inflow to CVC mine workings in 2018 is predicted to be 5.1 ML/day, which closely matches the recorded value of 5 ML/day (refer Section 4.3.1). The predicted total average groundwater inflow to Myuna Colliery mine workings in 2018 is 5.8 ML/day, also closely matching the recorded inflow.

Calibrated material properties are summarised in Table 5-5.

Table 5-2 Material property ranges

Unit	Model layer	Horizontal hydraulic conductivity (m/day)		Vertical anisotropy (-)		Specific yield (-)		Specific storage (m-1)	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Alluvium / sediments	1	1	10	10	20	0.05	0.2	0.00000023	0.000013
Weathered rock	1	0.01	2	10	20	0.05	0.1	0.00000023	0.000013
Munmorah Conglomerate	2	0.00001	0.01	10	20	NA	NA	0.00000023	0.000013
Wallarah Seam	3	0.0001	0.01	10	20	NA	NA	0.00000023	0.000013
Mannering Park Tuff	4	0.000001	0.004	10	20	NA	NA	0.00000023	0.000013
Teralba Conglomerate	5	0.00001	0.01	10	20	NA	NA	0.00000023	0.000013
Great Northern seam	6	0.0001	0.01	10	20	NA	NA	0.00000023	0.000013
Karingal Conglomerate	7	0.00001	0.01	10	20	NA	NA	0.00000023	0.000013
Awaba Tuff	8	0.000001	0.004	10	20	NA	NA	0.00000023	0.000013
Fassifern seam	9	0.0001	0.01	10	20	NA	NA	0.00000023	0.000013
Basement rock	10	0.00001	0.01	10	20	NA	NA	0.00000023	0.000013

Note: NA denotes parameters not changed during model calibration.

Table 5-3 Mandalong Mine groundwater monitoring network

Bore	Monitoring period reviewed	Strata
BH01	2004 – July 2019	Alluvium
BH02	2005 – October 2016	Alluvium
BH03	2005 – July 2019	Alluvium
BH04	2004 – July 2019	Alluvium
BH05	2004 – July 2019	Alluvium
BH06	2004 – October 2016	Alluvium
BH07	2004 – October 2016	Alluvium
BH08	2004 – October 2016	Alluvium
BH09	2004 – July 2019	Alluvium
BH10	2004 – July 2019	Alluvium
BH11	2004 – July 2019	Alluvium
BH12	2004 – July 2019	Alluvium
BH13	2004 – July 2019	Alluvium
BH14	2004 – July 2019	Alluvium
BH17A	2005 – October 2016	Alluvium
BH20A	2004 – July 2016	Alluvium
BH21A	2004 – October 2016	Alluvium
BH22A	2005 – October 2016	Alluvium
BH23B	2005 – October 2016	Alluvium
BH24A	April 2010 – July 2013	Alluvium
BH25A	April 2010 – July 2019	Narrabeen Sandstone
BH25B	July 2010 – July 2012	Narrabeen Sandstone
BH26A	October 2011 – July 2019	Alluvium
BH26B	October 2011 – October 2016	Narrabeen Sandstone
MSGW01	July 2011 – July 2019	Mannering Creek alluvium
MSGW04A	October 2011 – July 2019	Morans Creek alluvium

Table 5-4 Steady-state calibration model flow budget

Component	Flow (m3/day)
Inflow	
General head boundary (ocean)	-
Leakage from lakes	5,146
Recharge	75,799
Total	80,945
Outflow	
General head boundary (ocean)	1,743
Outflow to rivers and lakes	38,843
Outflow to ephemeral creeks	36,946
Evapotranspiration	3,362
Total	80,894

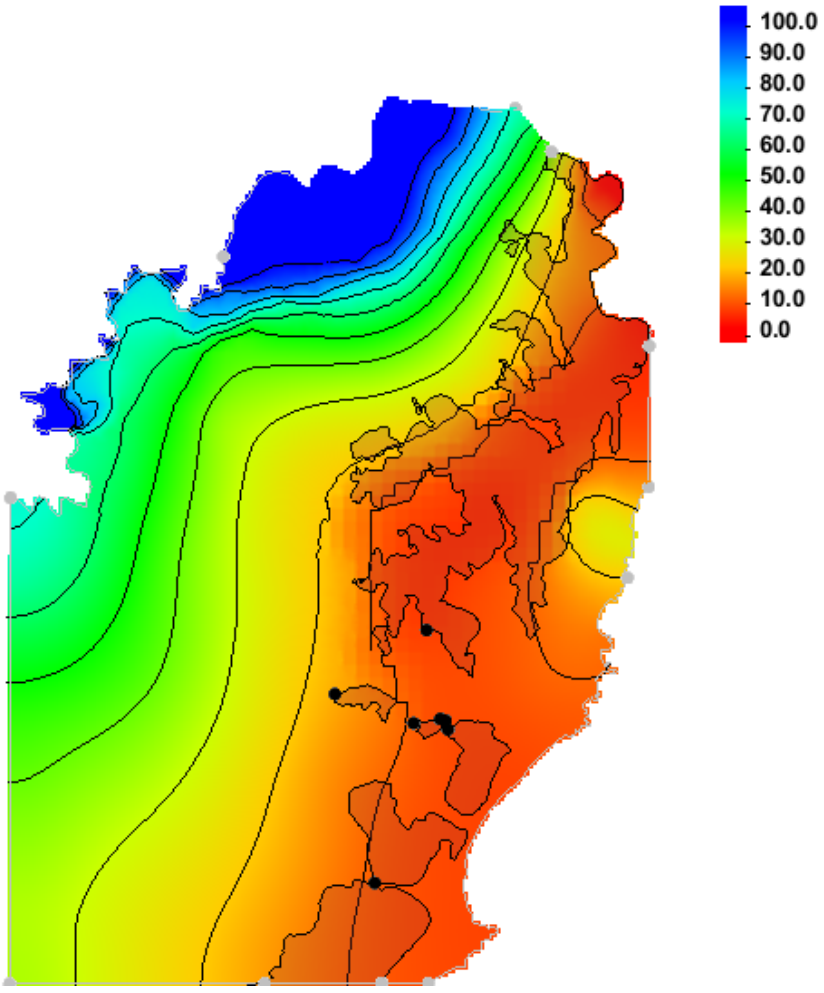


Figure 5-6 Steady state groundwater head (m) – fractured and porous rock

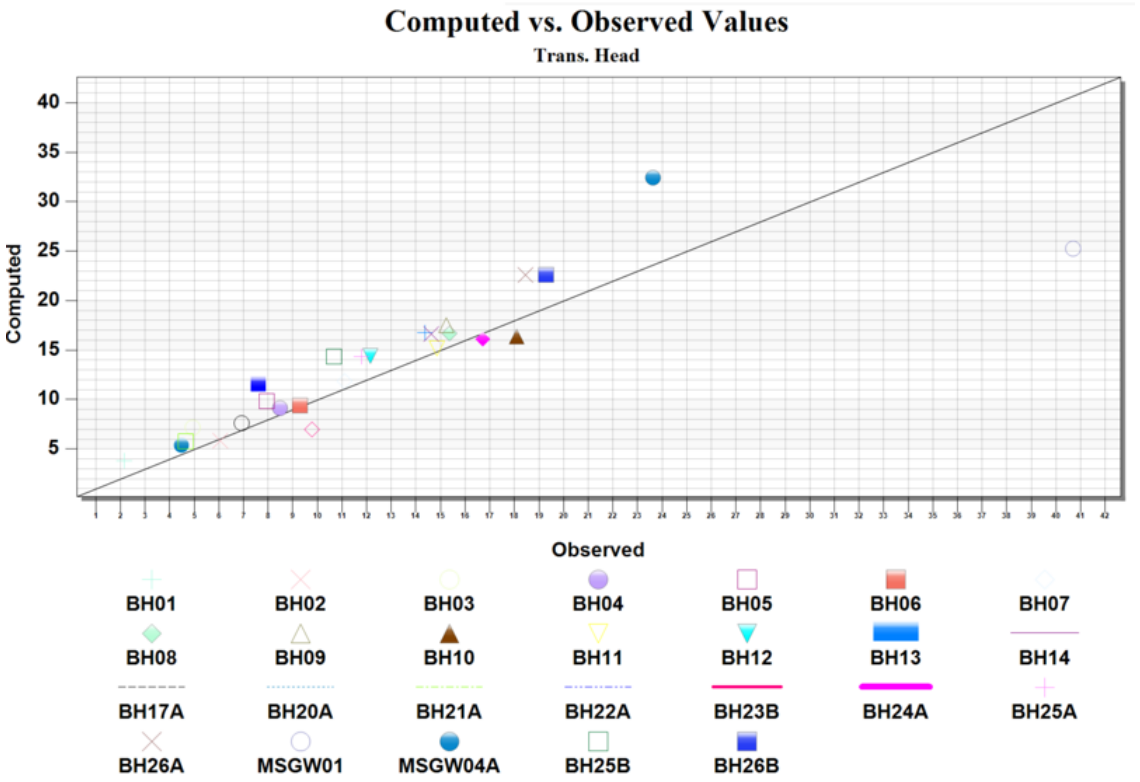


Figure 5-7 Scatterplot of observed and modelled groundwater heads

5.1.5 Impact prediction

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

- Groundwater inflows into the proposed workings within the Northern Mining Area.
- Incremental groundwater drawdown due to mining within the Northern Mining Area, including drawdown at private bores and GDEs.
- Reduction in baseflow to surface watercourses attributable to mining within the Northern Mining Area.

Model scenarios

The model was run to the end of year 2050. Three scenarios have been modelled:

- No mining (or null) condition. Under this condition, no drain cells representing mine workings are turned on. The model runs between 1960 and 2050 with all other boundary conditions active.
- Approved conditions. Under this condition, all historical and approved (future) mine workings at CVC, MC, Myuna Colliery and Mandalong Mine are simulated by progressively turning on drain cells in accordance with historical and approved mining schedules for each site. Although Myuna Colliery currently has approval to mine within the Northern Mining Area, it has been conservatively assumed under the approved scenario that no mining takes place in this area.
- Proposed conditions. This scenario includes approved conditions as well as the proposed bord and pillar mining within the Northern Mining Area by CVC.

For each scenario, the predictive model used constant recharge rates, assigned based on the percentage of long-term average rainfall.

Table 5-5 Calibrated model parameters

Unit	Model layer	Horizontal hydraulic conductivity (m/day)	Vertical anisotropy (-)	Specific yield (-)	Specific storage (m-1)	Recharge (%)
Alluvium / sediments	1	5	10	0.1	0.0000013	2
Weathered rock	1	2	10	0.01	0.0000013	2
Munmorah Conglomerate	2	0.0025	10	NA	0.0000013	
Wallarah Seam	3	0.002	10	NA	0.0000013	
Mannering Park Tuff	4	0.0001	10	NA	0.0000013	
Teralba Conglomerate	5	0.001	10	NA	0.0000013	
Great Northern seam	6	0.002	10	NA	0.0000013	
Karingal Conglomerate	7	0.001	10	NA	0.0000013	
Awaba Tuff	8	0.001	10	NA	0.0000013	
Fassifern seam	9	0.002	10	NA	0.0000013	
Basement rock	10	0.001	10	NA	0.0000013	

Uncertainty analysis

An uncertainty analysis has been undertaken as part of the groundwater modelling process to gain an understanding of the range of modelled groundwater inflows to mine workings under different plausible sets of material properties. The uncertainty analysis undertaken is commensurate with the level of complexity of the project and the existing hydrogeological environment and the approach has been agreed with Dr Noel Merrick. It is important to note that the uncertainty analysis undertaken pertains to the model input parameters and outcomes of scenarios investigated, and not the numerical model itself.

5.2 Impact assessment criteria

The NSW AIP requires that potential impacts on the groundwater sources, including their users and GDEs, be assessed against minimal impact considerations, outlined in Table 1 of the Policy. 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 this groundwater impact assessment and are outlined in Section 2.2.2. Predicted impacts to groundwater, based on the numerical groundwater model, have been assessed in accordance with this criteria.

6. Impact assessment

Model predictive results are presented and assessed in this section.

6.1 Impact prediction

6.1.1 Groundwater inflows

Total groundwater inflows to CVC mine workings under approved and proposed conditions are shown in Figure 6-1. Predicted inflows for each year are an average from the 12 time steps for each annual stress period.

As shown in Figure 6-1, bord and pillar mining in the Northern Mining Area is predicted to increase groundwater inflows at CVC by up to 0.4 ML/day in years 2023 and 2024 (compared to approved conditions). Total groundwater inflow to CVC during the period of mining within the Northern Mining Area is predicted to peak at 4.5 ML/day in 2023 (1,643 ML/year). This is less than the current recorded inflow. Overall, groundwater inflows are predicted to trend downwards up to the end of mining in 2027 under both approved and proposed conditions. Inflows are predicted to remain well below the current groundwater licence allocation held by CVC of 4,443 ML/year.

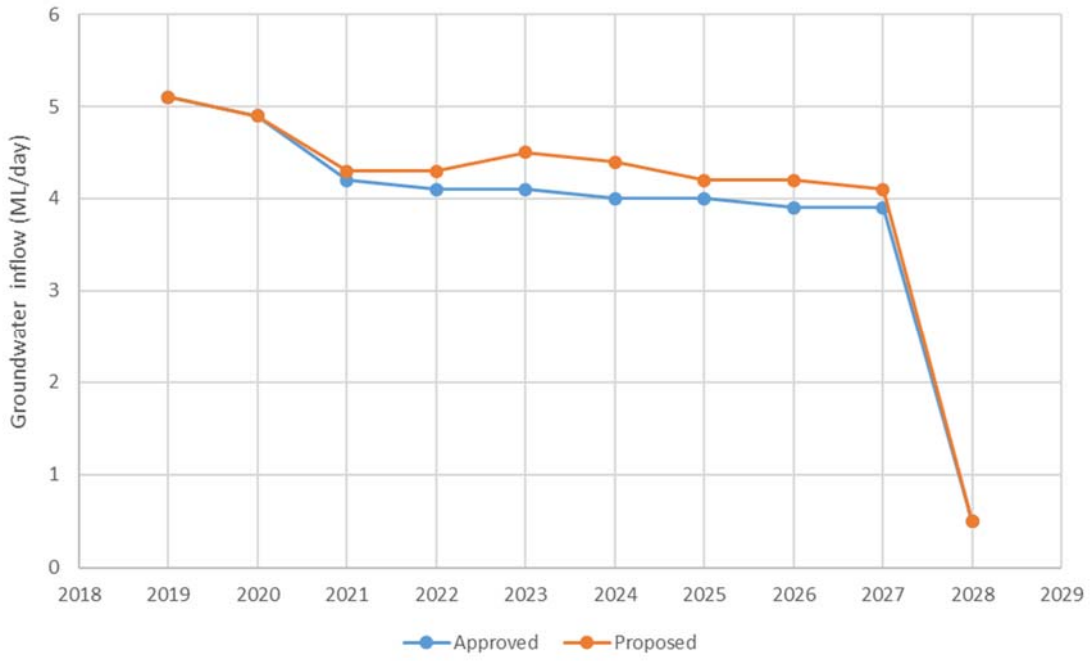


Figure 6-1 Predicted groundwater inflows to CVC

Uncertainty analysis was undertaken to verify the prediction that groundwater inflows are unlikely to reach the current licence allocation of 4,443ML/year under the proposed modification. Two additional model runs were undertaken for the proposed scenario. Both involved increasing horizontal hydraulic conductivities and specific storage as follows:

- Uncertainty analysis run 1 (UR1) – increase the horizontal hydraulic conductivity of the Munmorah Conglomerate (Layer 2) and basement rock (Layer 10) by up to two orders of magnitude, increase the horizontal hydraulic conductivity of the coal seams by four times, and increase the specific storage of all model layers by one order of magnitude so that these values are at their respective maximums from Table 5-2.

- Uncertainty analysis run 2 (UR2) – same as UR1, except the horizontal hydraulic conductivity of the Munmorah Conglomerate was returned to the calibrated value.

Predicted groundwater inflows for UR1 and UR2 are compared to predicted inflows for the calibrated (best fit) model in Figure 6-2. Even under the very high hydraulic conductivity and storage values adopted in UR1 and UR2, the approved peak inflow of 10.5 ML/day and current licence allocation of 4,443 ML/year are not predicted to be reached. For UR1, peak groundwater inflow is predicted to be 9.2 ML/day during mining in the Northern Mining Area. The uncertainty analysis runs also predict only a very small increase in groundwater inflow in years 2023 and 2024 as mining moves into the Northern Mining Area.

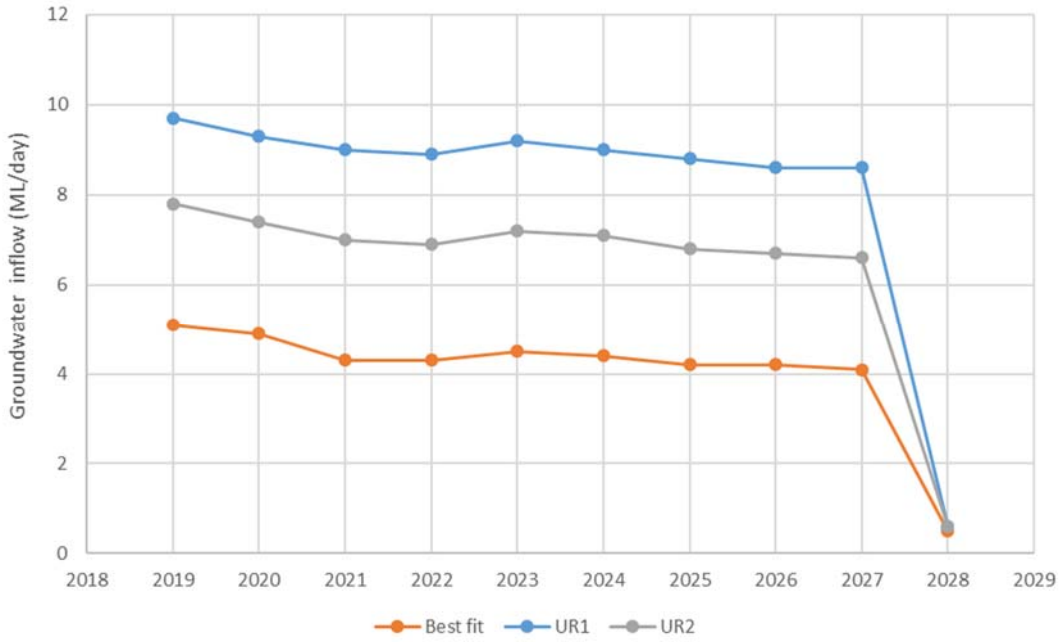


Figure 6-2 Uncertainty analysis of groundwater inflows to CVC

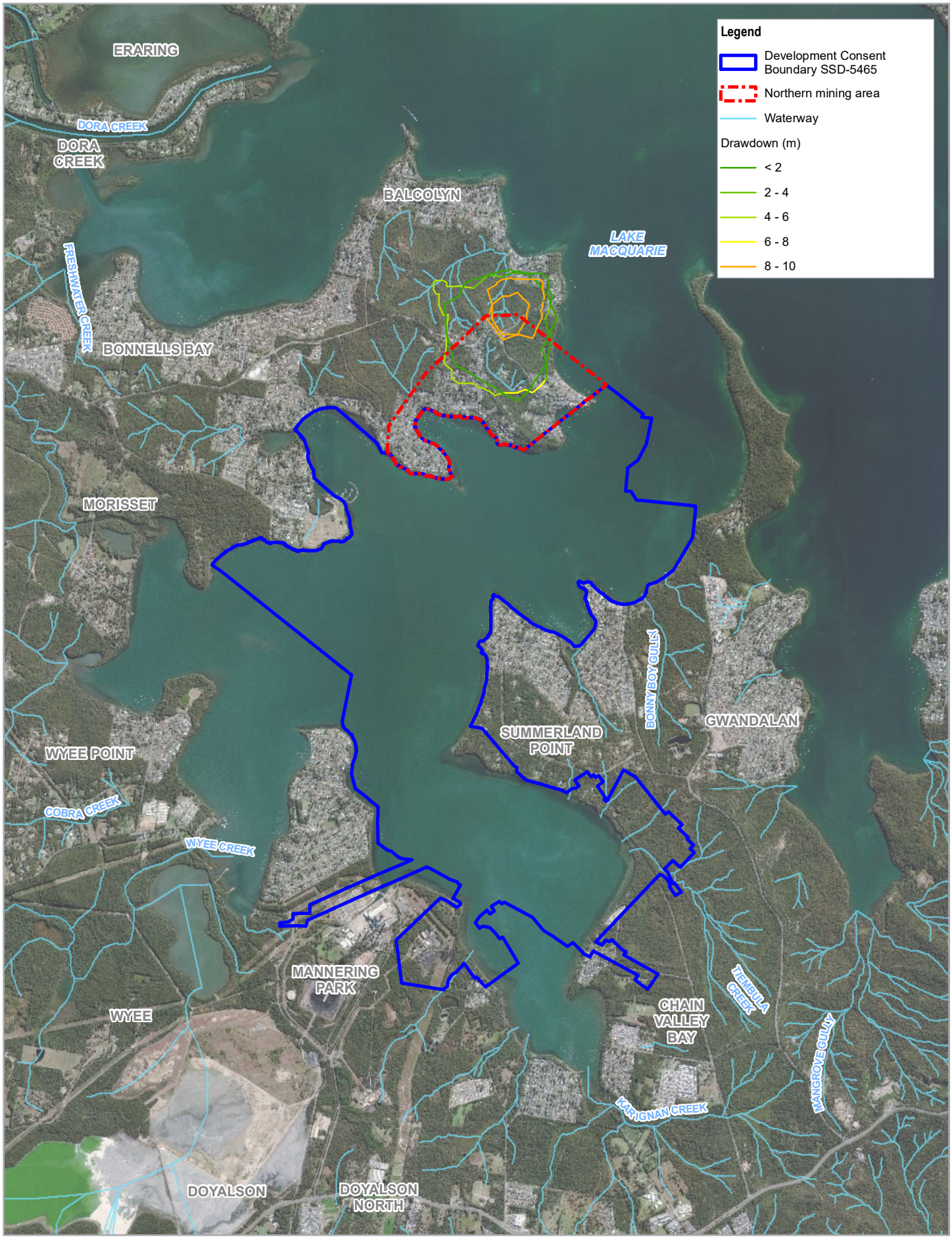
6.1.2 Groundwater drawdown

Incremental groundwater drawdown contours attributable to the proposed modification have been generated for the Munmorah Conglomerate (Figure 6-3), Wallarah Seam (Figure 6-4), Great Northern Seam (Figure 6-5) and Fassifern Seam (Figure 6-6).

No drawdown in the water table is predicted due to mining in the Northern Mining Area. In addition, the groundwater model does not predict that there is existing water table drawdown in this area.

As shown in Figure 6-3 to Figure 6-6, drawdown in fractured and porous rock groundwater sources is predicted to occur as a result of the proposed modification, particularly in the Permian strata. Incremental drawdown of up to 10 m is predicted to occur in the Munmorah Conglomerate, while drawdown of over 100 m is predicted to occur within Permian strata overlaying the Fassifern Seam. However, no drawdown is predicted to occur at existing private bores in the vicinity of the Project Application Area.

As noted previously, these model predictions are considered to be conservative relative to currently approved mining operations as the calculation of incremental impact does not allow for the approved mining of the Northern Mining Area by Myuna. If the proposed modification is not approved and the area is instead mined as part of the Myuna operations, similar levels of drawdown would be anticipated.



Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

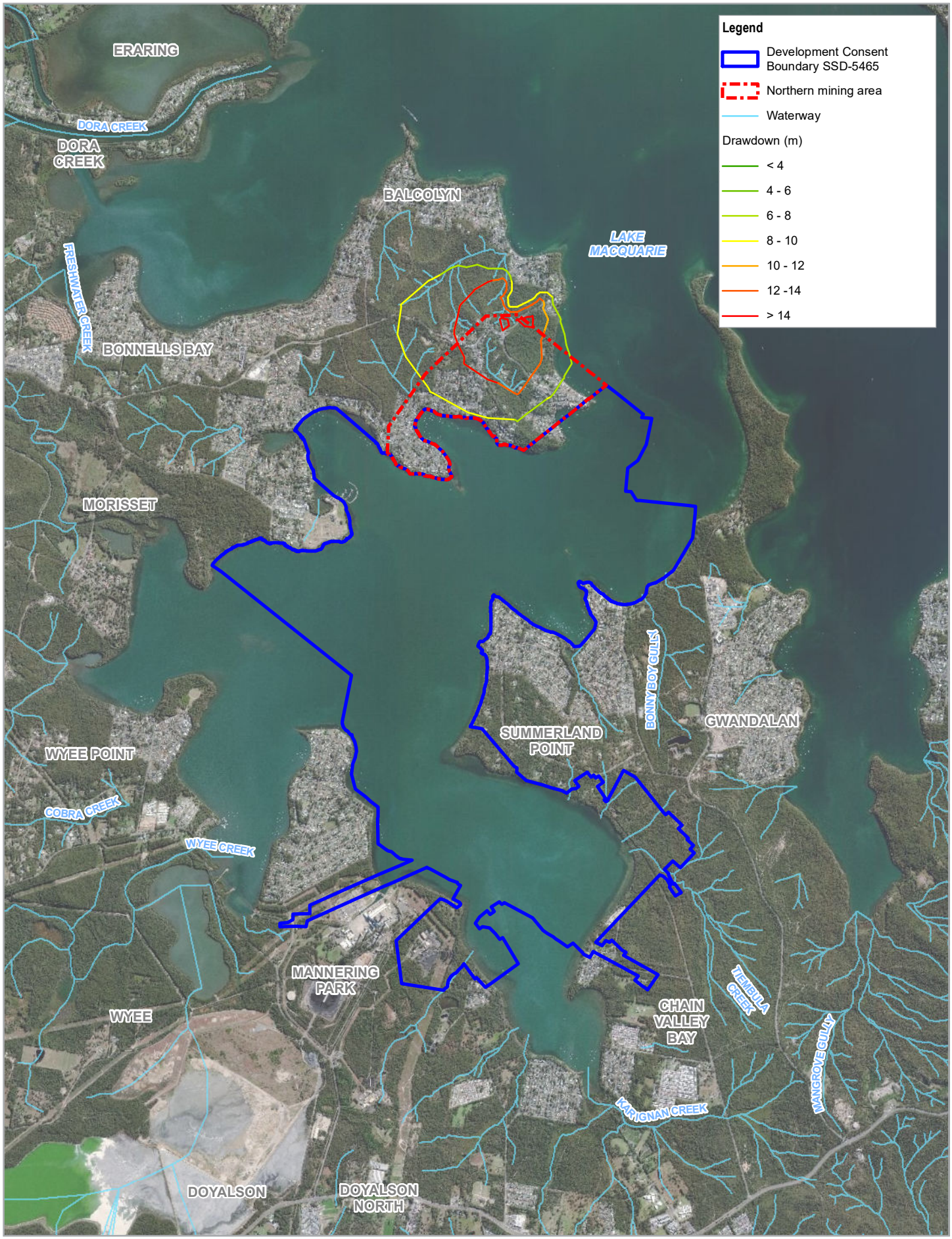
Incremental groundwater drawdown in Munmorah Conglomerate (Layer 2)

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 6-3

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_006_Contours_Munmorah_0.mxd
Print date: 03 Jun 2020 - 08:27

Data source: LPI: DTDB, 2017; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay



Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

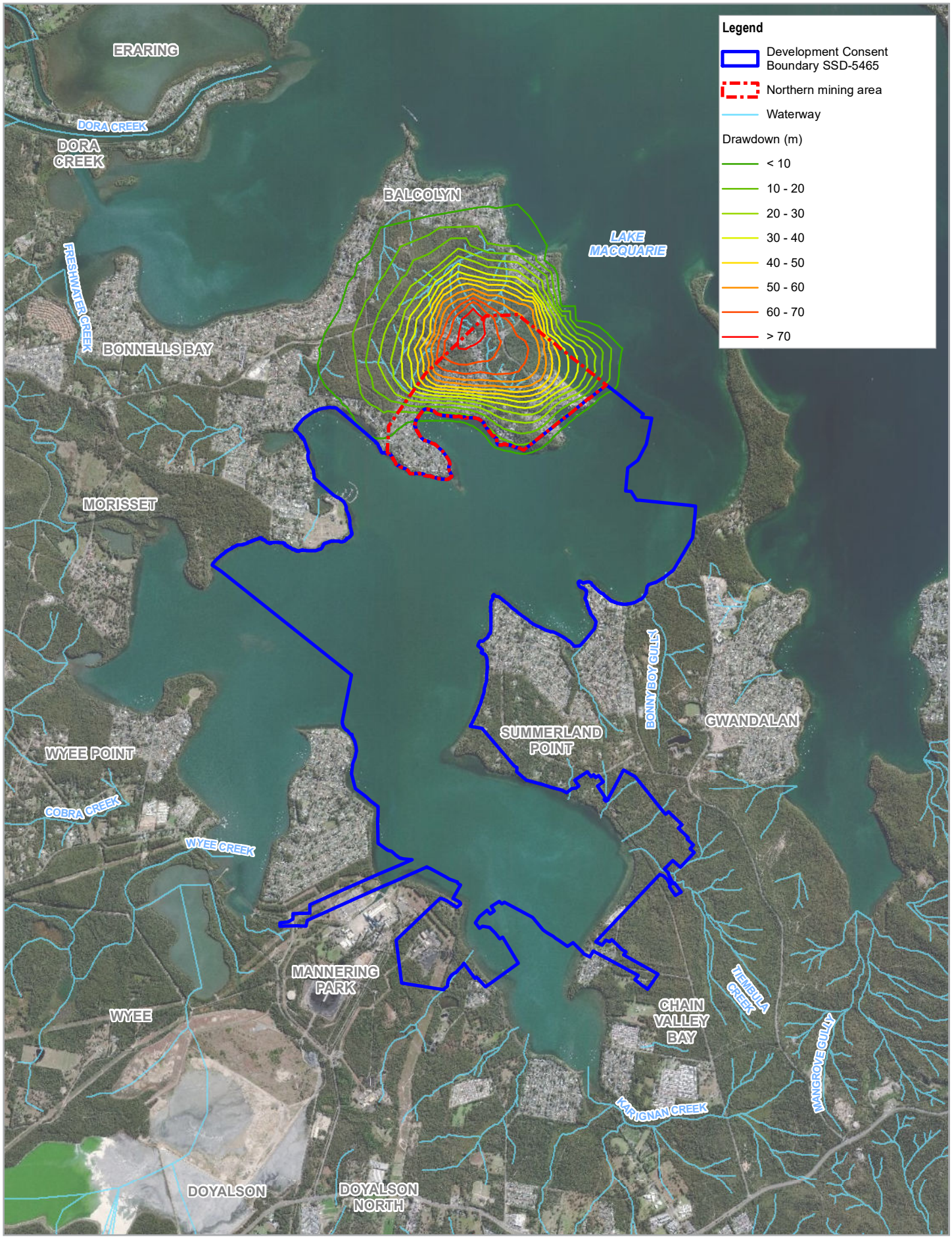
Incremental groundwater drawdown in Wallarah Seam (Layer 3)

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 6-4

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_007_Contours_Wallarah_0.mxd
Print date: 03 Jun 2020 - 08:27

Data source: LPI: DTDB, 2017; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay



Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometers

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

N

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

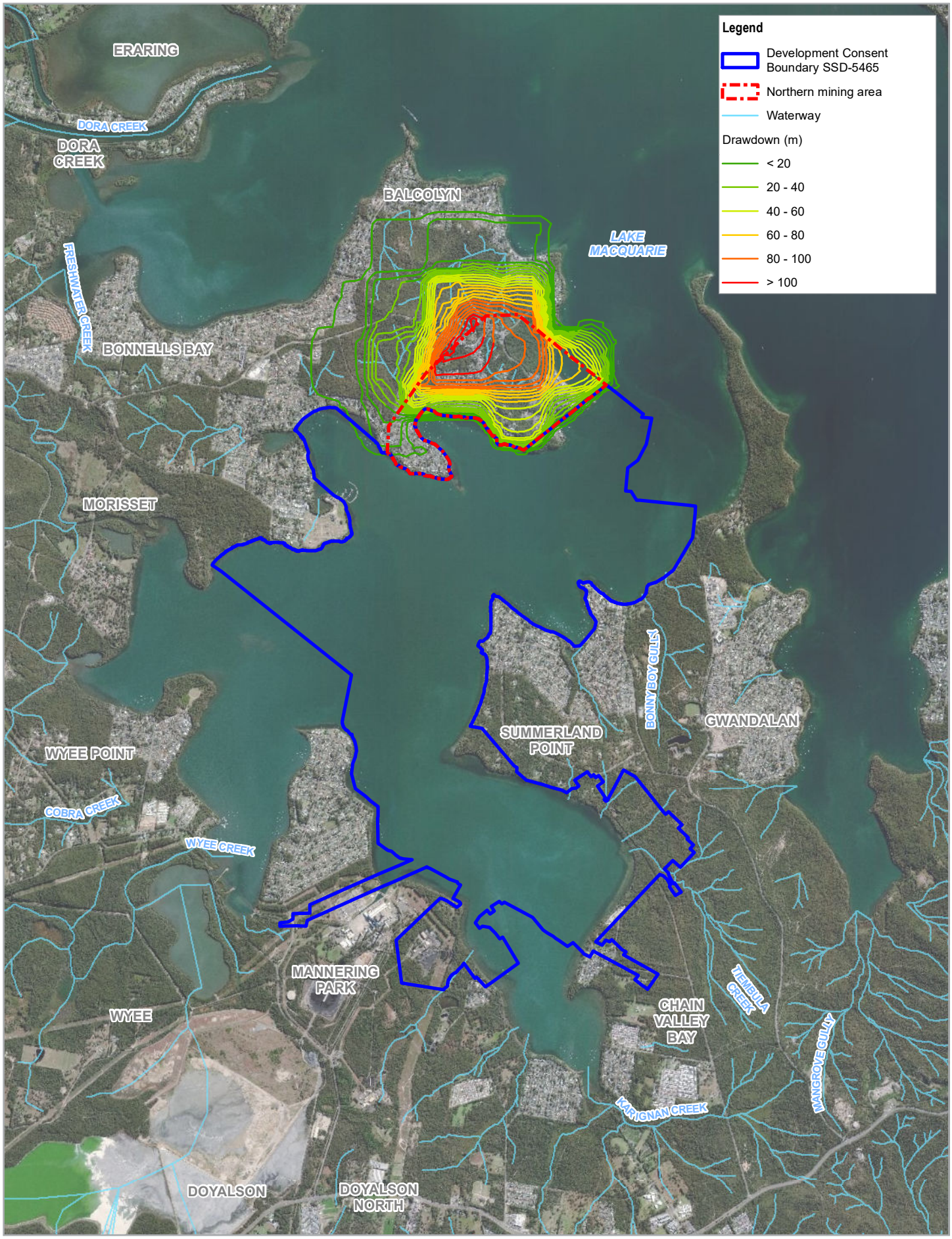
Incremental groundwater drawdown in Great Northern Seam (Layer 6)

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 6-5

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_008_Contours_GNS_0.mxd
Print date: 03 Jun 2020 - 08:28

Data source: LPI: DTDB, 2017; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay



Paper Size ISO A4

0 0.35 0.7 1.05 1.4

Kilometers

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

N

GHD

Delta Coal
Chain Valley Colliery
Modification 4
Groundwater Assessment

Incremental groundwater drawdown in Fassifern Seam (Layer 9)

Project No. **12519253**
Revision No. **0**
Date **03 Jun 2020**

FIGURE 6-6

G:\22\12519253\GIS\Maps\Deliverables\12519253_GA_009_Contours_Fassifern_0.mxd
Print date: 03 Jun 2020 - 08:28

Data source: LPI: DTDB, 2017;Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: fmackay

6.1.1 Baseflow

A reduction in baseflow to ephemeral creeks within the Northern Mining Area, including Postmistress Creek, is not predicted to occur.

6.2 Impact assessment

The assessment of potential impacts on groundwater receptors is detailed in this section. Again, it is noted that Myuna Colliery has approval to mine this area using bord and pillar mining methods under Project Approval 10_0080 and this impact assessment conservatively assumes that there is no mining by Myuna Colliery within the Northern Mining Area.

6.2.1 Alluvial groundwater sources

There is no mapped alluvium within the Northern Mining Area. The main alluvial deposits in the vicinity of the Project Application Area occur to the east and are associated with Wyee Creek and Pourmalong Creek.

Water table

No drawdown of alluvial groundwater or the water table is predicted as a result of mining in the Northern Mining Area. It follows that there will be no impact on baseflow to ephemeral creeks or GDEs. This includes the high potential terrestrial GDE within the Northern Mining Area. Further it is not predicted that there will be drawdown at the shallow private bores located to the west of the Northern Mining Area (refer Figure 3-5).

Based on the above assessment, the predicted impacts to alluvial groundwater are less than the Level 1 minimal impact considerations for ‘Water Table’ under the NSW AIP and are therefore considered to be acceptable. Since alluvial groundwater sources are unconfined, the criterion for ‘Water Pressure’ does not apply.

Groundwater quality

There is no available quality data for shallow groundwater in the vicinity of the Project Application Area. Since groundwater use is limited, it is considered that the existing beneficial use category for alluvial groundwater and shallow groundwater is ‘environmental protection’.

Since there is no drawdown in the water table predicted, it is not expected that there would be a change in shallow groundwater quality attributable to mining in the Northern Mining Area. Hence, the beneficial use category of the alluvial/shallow groundwater is not expected to change and the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

6.2.2 Fractured and porous rock groundwater sources

The Triassic and Permian 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.

Water pressure

Groundwater drawdown attributable to the proposed workings is predicted to be up to 10 m in the Munmorah Conglomerate and over 100 m within Permian strata overlaying the Fassifern Seam. Current groundwater inflow to CVC, resulting in take from the fractured and porous rock groundwater sources, is approximately 5 ML/day. This is predicted to reduce over time based on current mine plans (peaking at 4.5 ML/day during mining within the Northern Mining Area). Mining in the Northern Mining Area is predicted to result in an additional take of up to 0.4 ML/day by CVC from the fractured and porous rock groundwater sources.

No incremental drawdown is predicted to occur at existing private bores in the vicinity of the Project Application Area. Since no drawdown at private bores is predicted to exceed 2 m, the predicted 'Water Pressure' impacts are less than the Level 1 minimal impact considerations under the NSW AIP and are therefore considered to be acceptable.

Groundwater quality

The proposed mining is not predicted to result in additional leakage from Lake Macquarie to the underlying fractured and porous rock groundwater sources. The take of groundwater into the mine workings will be from the existing storage within the fractured and porous rock. As a results it is not predicted that groundwater salinity will increase.

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 therefore the level of impact is less than the Level 1 minimal impact considerations under the NSW AIP.

6.2.3 Groundwater licensing

The existing groundwater licence for CVC permits extraction of up to 4,443 ML from the Sydney Basin North Coast Groundwater Source in any 12 month period from the underground workings. Based on the groundwater model predictions outlined in Section 6.1.1, the existing licence allocation is sufficient to cover the predicted take by CVC associated with the proposed extension of mining into the Northern Mining Area. No take from the Hunter Unregulated and Alluvial Water Sources (South Lake Macquarie Water Source) is predicted to occur as a result of mining in the Northern Mining Area.

The cumulative groundwater take from the fractured and porous rock groundwater source by CVC and Myuna Colliery is not expected to change as a result of the proposed modification. While the modelling indicates that the mining of the Northern Mining Area as part of the CVC operations will increase the take attributable to CVC by up to 0.4 ML/day (approximately 146 ML/year), it should be noted this is take that would otherwise result from mining operations at Myuna Colliery if this area was instead mined as part of those operations (as is currently approved).

7. Mitigation, management and monitoring

All groundwater impacts attributable to the project have been assessed to be less than the Level 1 impact considerations in the NSW AIP. Therefore ongoing measures should focus on monitoring, where possible, to validate groundwater model predictions and provide observation data for future model calibration.

7.1 Monitoring

Groundwater monitoring should continue in accordance with the Groundwater Management Plan (GeoTerra, 2019). No additional groundwater monitoring bores have been identified for inclusion in the monitoring program. It is recommended that Delta Coal continue to pursue agreements with private landholders to monitor suitable private bores.

Daily metering of dewatering volumes from the underground workings should continue in accordance with the Groundwater Management Plan. Where water is stored underground for a period of time and allowed to accumulate, or underground ‘dams’ are dewatered, this should be noted to assist in the calculation of annual groundwater make.

7.2 Reporting and reviewing

The groundwater model will be reviewed and revised if required every two years. The review of the groundwater model will include a comparison of modelling results against groundwater monitoring data and mine dewatering volumes.

The Groundwater Management Plan includes a trigger for the mine dewatering volume. Consideration should be given to revising this trigger level based on the predictions from the groundwater model.

8. Summary

The GIA has considered the potential impacts of the Project on the groundwater environment and groundwater receptors under the proposed conditions. A numerical groundwater model has been developed to quantify groundwater impacts from the proposed extension into the Northern Mining Area.

The key conclusions from this assessment are as follows:

- Groundwater inflows to the CVC mine workings are predicted to reduce over time from those observed in current operations. Bord and pillar mining within the Northern Mining Area is predicted to result in an additional 0.4 ML/day groundwater inflow to CVC (compared to approved conditions). The existing groundwater licence for CVC is sufficient to cover the take from the Sydney Basin North Coast Groundwater Source associated with the proposed extension of mining into the Northern Mining Area.
- Cumulative take from the Sydney Basin North Coast Groundwater Source is expected to remain unchanged as a result of the proposed modification as similar volumes of take would occur if this area was mined by Myuna Colliery under its consent, rather than as part of the CVC operations.
- The proposed mining in the Northern Mining Area is not predicted to reduce baseflow to ephemeral creeks or result in drawdown of the water table.
- Proposed mining is not predicted to impact GDEs within the Northern Mining Area, including the high potential terrestrial GDE associated with Postmistress Creek. Further, no high priority GDEs listed in the relevant WSPs occur within the Project Application Area.
- Although some drawdown is predicted within Triassic and Permian strata, it is not predicted that the proposed modification will result in drawdown at any private bore.
- Overall, the level of impact to the water table, water pressure and groundwater quality are considered to be less than the Level 1 minimal impact considerations under the NSW AIP and are therefore considered to be acceptable.

9. References

Barnett, B., Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A., Boronkay, A., (2012). *Australian groundwater modelling guidelines*, Waterlines Report Series No. 82, National Water Commission, Canberra, 191 pp. June.

BOM (2019a). *Australian Groundwater Explorer*, Australian Government Bureau of Meteorology, viewed online 30 September 2019 from http://www.bom.gov.au/water/groundwater/explorer/map.shtml

BOM (2019b). *Groundwater Dependent Ecosystems Atlas,* Australian Government Bureau of Meteorology, viewed online 1 October 2019 from http://www.bom.gov.au/water/groundwater/gde/map.shtml

Centennial Mandalong (2019). *Mandalong Mine Water Management Plan*, Revision 4, August 2019.

EMM (2014). *Chain Valley Colliery Modification 1 – Statement of Environmental Effects Section 96 Modification to SSD-5465.* Report prepared for LakeCoal Pty Limited April 2014.

EMM (2019). *Chain Valley Colliery Modification 3: Groundwater impacts of mining method change.* Memorandum to Delta Coal April 2019.

GeoTerra Pty Ltd (2013). *Chain Valley Colliery Mining Extension 1 Project – Groundwater Assessment*. Report prepared for LakeCoal Pty Limited March 2013.

GeoTerra Pty Ltd (2015). *Chain Valley Colliery Groundwater Assessment – Panel Re-Orientation Project.* Report prepared for LakeCoal Pty Limited May 2015.

GeoTerra Pty Ltd (2019). *Chain Valley Colliery Groundwater Management Plan.*

GES (2012). *A groundwater modelling assessment of the Chain Valley Colliery – Mine Extension 1 Project.* Report prepared for LakeCoal Pty Limited December 2012.

GHD Pty Ltd (2019). *Myuna Colliery: 2018 Annual Groundwater Review*.

Pacific Power International (1997). *Newstan Colliery Life Extension Project Overburden Groundwater Study*.

Panday, S., Langevin, C.D., Niswonger, R.G., Ibaraki, M., Hughes, J. (2013). *MODFLOW–USG Version 1: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using a Control Volume Finite-Difference Formulation*, Chapter 45 of Section A, Groundwater Book 6, Modeling Techniques. Techniques and Methods 6–A45.

Strata2 (2019). *S4 Panel: Geotechnical Environment, Subsidence Estimates and Impacts*.

Tammetta, P. (2012) Estimation of the height of complete groundwater drainage above mined longwall panels, Groundwater NGWA org pp 1-16.

WaterNSW (2020) NSW Water Register, https://realtimedata.waternsw.com.au/, accessed 29 January 2020.

GHD

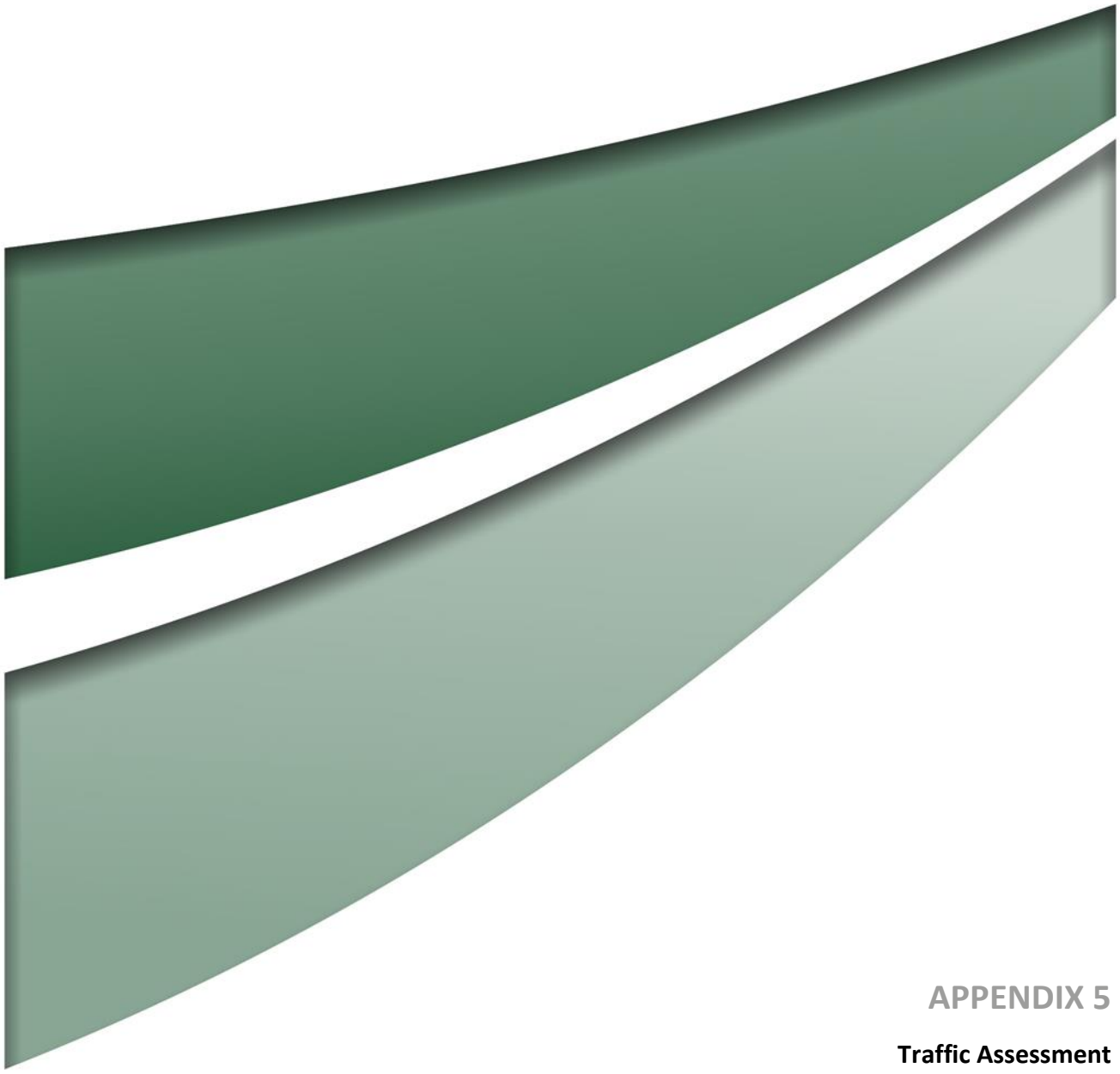
Level 3 GHD Tower 24 Honeysuckle Drive Newcastle NSW 2300
PO BOX 5403 Hunter Region Mail Centre
T: 61 2 4979 9999 F: 61 2 9475 0725 E: ntlmail@ghd.com

12519253-67037/https://projectsportal.ghd.com/sites/pp01_04/cvccontinuedoperatio/ProjectDocs/12519253-REP_CVC Continued Operations Groundwater Assessment.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M Kay / S Askarimarnani	S Gray		S Gray		11/06/20
1	S Askarimarnani	S Gray		S Gray		15/09/20

www.ghd.com



APPENDIX 5

Traffic Assessment

Great Southern Energy Pty Ltd

Chain Valley Colliery and Mannering Colliery

Final Traffic Impact Assessment

August 2020

Table of contents

1. Introduction 1
   - 1.1 Purpose of this report 3
   - 1.2 Study limitations and assumptions 3
   - 1.3 Literature review 4
   - 1.4 Report structure 4
2. Existing conditions 5
   - 2.1 Existing road network characteristics 5
   - 2.2 Crash data 10
   - 2.3 Traffic surveys 11
   - 2.4 Current network operation 12
   - 2.5 Current employment data 16
3. Proposed development 17
   - 3.1 Trip generation 17
   - 3.2 Trip distribution 20
   - 3.3 Future road network changes 21
4. Impact assessment 22
5. Summary and conclusion 26

Table index

Table 2-1 Intersection Level of Service Criteria 12

Table 2-2 Current Intersection Performance 15

Table 2-3 Current Shift Data (mining staff) 16

Table 3-1 Existing and proposed staffing level (per shift) 17

Table 3-2 Trip Generation Data 18

Table 3-3 Staff Residential Locations 20

Table 4-1 Intersection performance (2030): Low growth scenario 23

Table 4-2 Intersection performance (2030): Medium growth scenario 24

Table 4-3 Intersection performance (2030): High growth scenario 25

Figure index

Figure 1-1 Subject site location 1

Figure 1-2 Approved haulage route, CVC to coal terminal 3

Figure 2-1 Ruttleys Road looking south of Construction Road 6

Figure 2-2 Ruttleys Road looking north of Construction Road.....7
Figure 2-3 Construction Road looking south to Ruttleys Road.....8
Figure 2-4 CVC site access looking west to the Construction Road.....8
Figure 2-5 MC access road looking west towards Ruttleys Road.....9
Figure 2-6 Bicycle logo on Ruttleys Road.....10
Figure 2-7 Traffic survey locations.....11
Figure 2-8 Ruttleys Road and Construction Road.....13
Figure 2-9 Construction Road and CVC site access.....14
Figure 2-10 Ruttleys Road and MC access road.....14
Figure 3-1 Trip distribution.....21

Appendices

Appendix A – Traffic Survey Outputs

Appendix B – Peak Hour Traffic Volumes

Appendix C – SIDRA Outputs - Existing

Appendix D – 2030 Traffic Volumes (low, medium and high growth scenarios)

Appendix E – SIDRA Outputs - 2030

1. Introduction

Chain Valley Colliery (CVC) and Mannering Colliery (MC) comprise of an underground coal mine and coal processing site, located approximately 60 km south of Newcastle. The Vales Point Power Station is located approximately 300 m to the north-west of the CVC. CVC operates under State significant development (SSD) consent SSD 5465 (CVC Consent), originally granted in 2013, which has been modified three times.

GHD has been engaged by Great Southern Energy Pty Ltd (trading as Delta Coal) to undertake a Traffic Impact Assessment (TIA) to support a modification to the CVC Consent, that will facilitate a change to staffing levels at CVC and MC.

CVC currently has approval for approximately 220 FTE employees and Mannering Colliery (also managed by Delta Coal) has approval for approximately 170 FTE employees. CVC is currently operating at its employee capacity but this is expected to increase to approximately 330 staff by 2023.

The increase in staffing levels is associated with a change in mining technique, rather than an increase in coal output. As the CVC and MC operations are adjacent to each other and increasingly being managed in an integrated manner, there is a desire for more centralised management of employees.

The locations of the CVC, MC and Vales Power Station are shown in Figure 1-1.

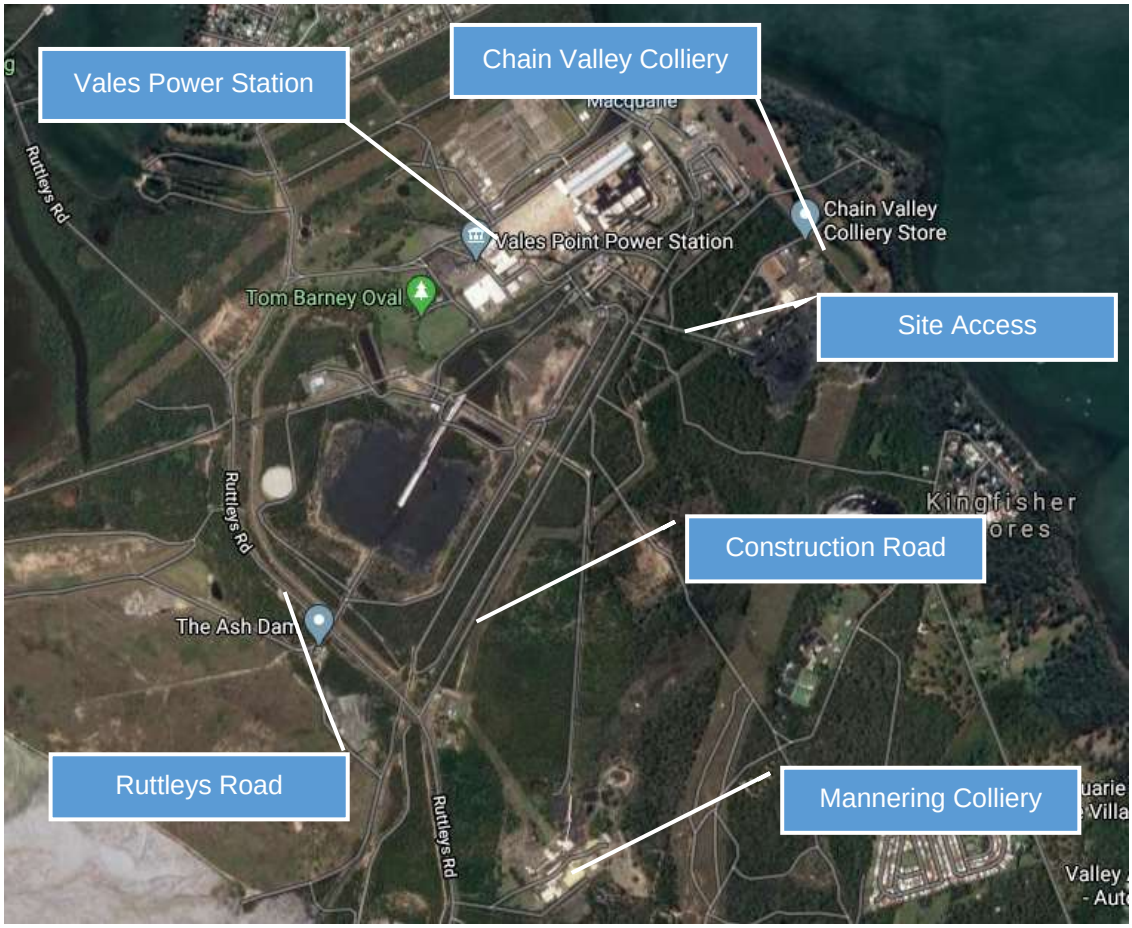


Figure 1-1 Subject site location

Source: Google maps modified by GHD

CVC operates under Development Consent SSD-5465, which permits a maximum rate of 2.1 million tonnes per annum (mtpa) of run-of-mine (ROM) coal in the Fassifern Seam. Mining operations are undertaken 24 hours per day, seven days per week.

An underground conveyor was constructed between the CVC and MC in 2017. Additionally, an overland conveyor transports coal between MC and the adjoining Vales Power Station. Under current arrangements the coal is:

- Transferred from the CVC to the MC via a conveyor for crushing and processing.
- Transferred from the MC to Vales Power Station to for the production of electricity.

Coal from CVC is also approved to be hauled by trucks to the Port Waratah Coal Services in Newcastle, to be loaded onto ships for export to international customers (from the Carrington Coal Terminal).

The CVC is currently approved to transport:

- A maximum of 600,000 tonnes of coal per annum on public roads for export.
- A maximum of 180,000 tonnes of coal per annum on public roads for domestic customers.

Under current restrictions, maximum laden coal truck movements from the CVC are not permitted to exceed:

- 270 per day
- 32 per hour
- An average of 16 per hour during peak hour periods

The designated haulage route between the CVC and the coal terminal, as detailed in the Delta Coal Road Transport Protocol indicates that all coal trucks must:

- Turn left onto Ruttleys Road
- Turn right onto the Pacific Highway
- Access the port via the pacific Motorway (M1)

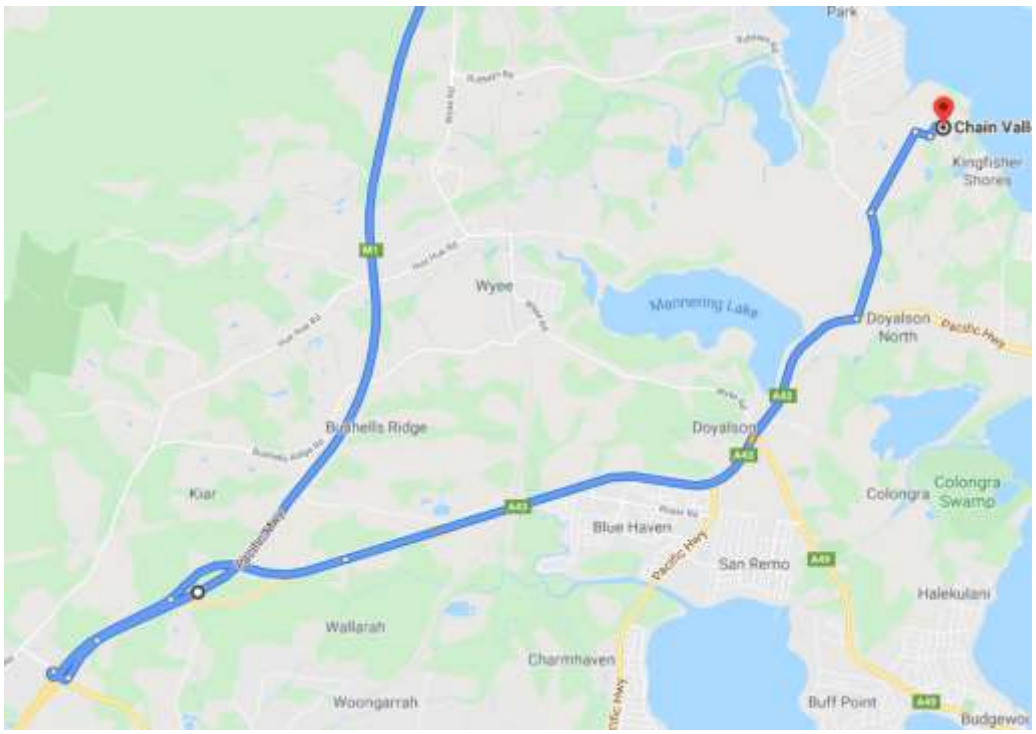


Figure 1-2 Approved haulage route, CVC to coal terminal

The Delta Coal Road Transport Protocol specifies that:

- Laden coal truck will not leave CVC prior to 5:30 am or after 5:30 pm.
- Site supervisors allocate tasks and truck departure times to support a regular trucking schedule.
- Drivers depart the CVC at intervals directed by the supervisor (with a minimum two-minute separation.

It is noted that since 2017 all of the coal mined and processed at the collieries has been delivered to the Vales Power Station, with no coal exports. This has resulted in a significant reduction in the volumes of heavy vehicle activity associated with the operation of the collieries.

Based upon discussions with the mine operator, coal exports are not expected to recommence and Vales Power Station will continue to use all the coal produced at the collieries.

It is also noted that as part of the project approval for the colliery, if the number of employees working at the MC exceeds 70, Delta Coal are required to upgrade the intersection of Ruttleys Road and MC access road, to provide a channelised right turn into the site.

1.1 Purpose of this report

The purpose of this report is to quantify the traffic and transport related impacts of the proposed increases in staffing levels at the collieries.

1.2 Study limitations and assumptions

The study limitations and key assumptions applicable to the TIA include:

- A site inspection was undertaken of the road network in proximity to the CVC and MC (June 2020).
- Intersection traffic modelling using SIDRA 8 was completed for the following intersections:
  - Ruttleys Road and Construction Road

  - Construction Road and CVC site access
  - Ruttleys Road and MC access road
- Intersection analysis was undertaken for the current situation (based on traffic surveys completed in June 2020) and a ten-year horizon (to 2030).
- An annual growth rate of 2.1 percent has been applied to the observed 2020 traffic volumes to determine the background 2030 horizon year traffic volumes.
- Analysis has been completed for low (a total of 300 staff), medium (a total of 350 staff) and high (a total of 450 staff) growth scenarios.
- The expected increases in staff levels have been pro-rated between the CVC/MC sites and work shifts, in accordance with the current staffing arrangements, as described in Section 3.
- The trips associated with the increases in staff, have been distributed onto the road network in accordance with the residential locations of the current staff, as described in Section 3.2.

1.3 Literature review

In July 2020, GHD completed the *Greater Lake Munmorah Structure Plan Road Development Strategy* on behalf of the Central Coast Council. The Structure Plan area has been divided into ten precincts and is expected to provide:

- An additional 2,744 dwellings
- 825 new jobs

The main objectives of the Strategy were to:

- Review the current situation and forecast land use changes in the Greater Lake Munmorah Structure Plan Study Area.
- Develop suitable traffic models to assess the future network, to test options for enhancing the road network.
- Determine key infrastructure requirements for vehicles, public and active transport.

Key outputs of the Strategy as they relate to this assessment are as follows:

- In the 2029 horizon year, the intersection of Pacific Highway and Ruttleys Road is expected to operate with a good level of service.
- Based on the outputs of the strategic model, in the short term (0 – 10 years) annual traffic growth of 1.5 percent – 2.1 percent is expected within the Lake Munmorah Study Area.

1.4 Report structure

The remainder of this report is structured as follows:

- Section 2, Existing conditions: provides a review of the traffic and transport facilities and road network in proximity to the collieries and their current operation.
- Section 3, Proposed development: provides a summary of the activity associated with the proposed increases in staffing levels.
- Section 4, Impact assessment: quantifies the traffic impacts of the proposed increases in staffing levels.
- Section 5 Summary and conclusion.

2. Existing conditions

2.1 Existing road network characteristics

2.1.1 Road hierarchy

Roads within NSW are categorised in the following two ways:

- By Road Classification.
- By the function that they perform.

Road Classification

Roads are classified (as defined by the *Roads Act 1993*) based on their importance to the movement of people and goods within NSW (as a primary means of communication).

The classification of a road allows Transport for NSW to exercise authority of all or part of the road. Classified roads include Main Roads, State Highways, Tourist Roads, Secondary Roads, Tollways, Freeways and Transitways.

For management purposes, Transport for NSW has three administrative classes of roads. These are:

- **State Roads –** Major arterial links through NSW and within major urban areas. They are the principle traffic carrying roads and fully controlled by Roads and Maritime with maintenance fully funded by Transport for NSW. State Roads include all Tollways, Freeways and Transitways; and all or part of a Main Road, Tourist Road or State Highway.
- **Regional Roads** – Roads of secondary importance between State Roads and Local Roads which, with State Roads provide the main connections to and between smaller towns and perform a sub-arterial function in major urban areas. Regional roads are the responsibility of councils for maintenance funding, though Transport for NSW funds some maintenance based on traffic and infrastructure. Traffic management on Regional Roads is controlled under the delegations to local government from Transport for NSW. Regional Roads may include all or part of a Main Road, Secondary Road, Tourist Road or State Highway; or other roads as determined by Transport for NSW.
- **Local Roads** – The remainder of the Council controlled roads. Local Roads are the responsibility of councils for maintenance funding. Transport for NSW may fund some maintenance and improvements based on specific programs (e.g. urban bus routes, road safety programs). Traffic management on Local Roads is controlled under the delegations to local government from Transport for NSW.

Functional Hierarchy

Functional road hierarchy involves the relative balance of the mobility and access functions of a road. Transport for NSW define four levels in a typical functional road hierarchy, ranking from high mobility and low accessibility, to high accessibility and low mobility. These road classes are:

- **Arterial Roads** – generally controlled by Transport for NSW, typically no limit in flow and designed to carry vehicles long distance between regional centres.
- **Sub-Arterial Roads** – can be managed by either Transport for NSW or local Council. Typically, their operating capacity ranges between 10,000 and 20,000 vehicles per day, and their aim is to carry through traffic between specific areas in a sub region, or provide connectivity from arterial road routes (regional links).

- **Collector Roads** – provide connectivity between local roads and the arterial road network and typically carry between 2,000 and 10,000 vehicles per day.
- **Local Roads** – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

A summary of the key roads in proximity to the subject site is provided below and shown in Figure 1-1.

2.1.2 Ruttleys Road

Ruttleys Road (see Figure 2-1 and Figure 2-2) is a local road that connects the Pacific Highway to Wyee Road. The road typically provides double centre lines and sealed shoulders.

Ruttleys Road has single traffic lanes in each direction, with a designated speed limit of 80 km hour.

Bicycle logos are painted on both shoulders of Ruttleys Road to designate it as an on-road cycle route.

At the intersection with the Construction Road, Ruttleys Road provides short right turn and left-turn lanes.

Figure 2-1 Ruttleys Road looking south of Construction Road

Figure 2-2 Ruttleys Road looking north of Construction Road

2.1.3 Construction Road

The Construction Road is a local road that provides access to the CVC and maintenance access to Vales Point Power Station from Ruttleys Road. The primary access to Vales Point Power Station from Ruttleys Road is located further to the north on Ruttleys Road. At the intersection with Ruttleys Road, a left turn slip lane and a short right turn lane are provided on Construction Road (see Figure 2-3).

Construction Road intersects the CVC site access road intersects at a priority controlled (Stop) junction (see Figure 2-4).

Figure 2-3 Construction Road looking south to Ruttleys Road

Figure 2-4 CVC site access looking west to the Construction Road

2.1.4 MC access road

The MC access road (see Figure 2-5) is an unmarked road that provides bi-directional travel. It has a posted speed limit of 15 km/h.

The MC access road intersects Ruttleys Road at a priority controlled junction with short turn lanes for vehicles turning left into the site and a short acceleration lane for vehicles turning left out of the site.

Figure 2-5 MC access road looking west towards Ruttleys Road

2.1.5 Freight routes

The Transport for NSW Restricted Access Vehicle (RAV) map identifies Ruttleys Road (between the Pacific Highway and Construction Road) as being part of a 26 m B-double route.

2.1.6 Active and public transport

Active Transport

There are no formal pedestrian facilities provided in the vicinity of the CVC and MC, which reflects the relatively remote location of the subject sites.

Bicycle logos on the shoulders of Ruttleys Road to identify it as part of a cycle route (see Figure 2-6).

Figure 2-6 Bicycle logo on Ruttleys Road

Public transport

The following bus services operate on Ruttleys Road in proximity to the subject site:

- 95 - Lake Haven to Morisset via Gwandalan and Mannering Park.
- 97 - Lake Haven to Wyee and Mannering Park (Loop Service).

2.2 Crash data

Crash data for the last five years of available data (2014 – 2018) indicates ten crashes have occurred at the intersection of Ruttleys Road and the Pacific Highway, as follows:

- Five crashes involved rear-end collisions.
- One crash involved a vehicle driving off the road.
- One crash involved a vehicle undertaking an (illegal) U-turn.
- Two crashes involved a collision between two vehicles travelling in adjacent legs of the intersection
- One crash involved two vehicles travelling in the same direction sideswiping each other.

It is further noted:

- One crash resulted in minor injuries
- Four crashes were non-casualty
- Three crashes were moderate injury
- Two crashes resulted in serious injuries.

A further two crashes were recorded on Ruttleys Road as follows:

- One crash involving a vehicle emerging from a driveway (resulting in a serious injury).

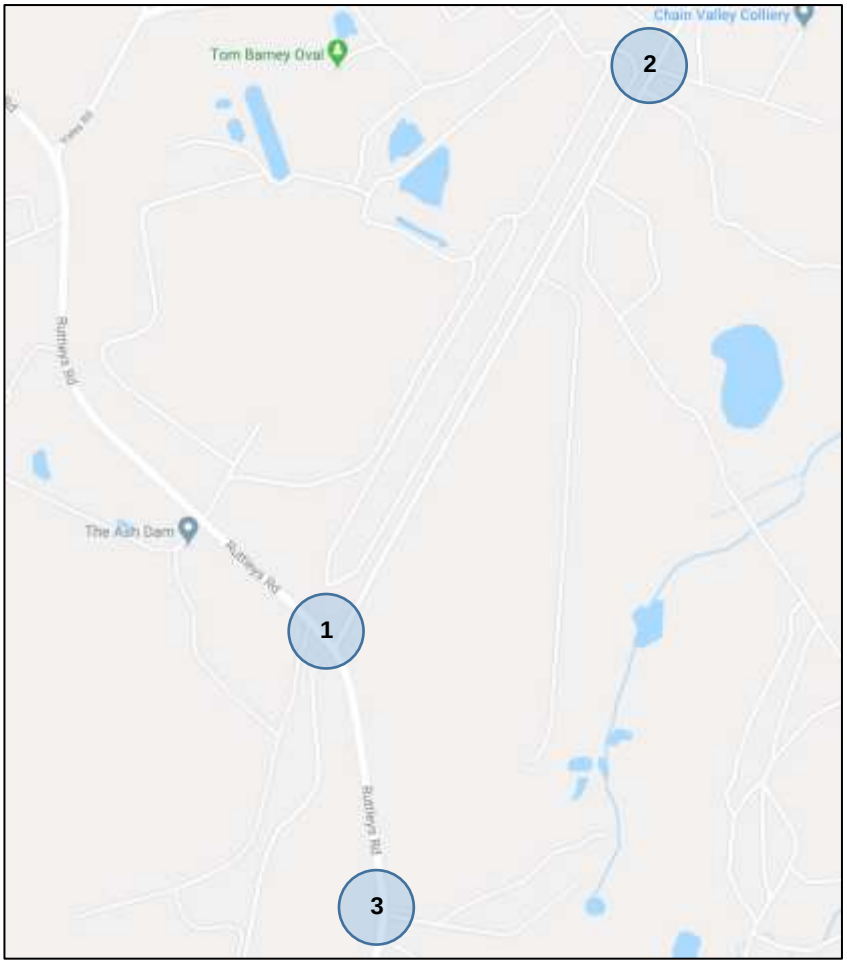
- One crash involving a vehicle off the road and hitting an object (resulting in a moderate injury).

There are no recorded crashes in the past five years of available data at any of the intersections under consideration.

2.3 Traffic surveys

In order to identify the existing traffic conditions in proximity to the CVC and MC, weekday AM and PM peak periods (Monday 22nd June 2020) and weekend peak period (Saturday 20th June 2020) traffic counts were undertaken by Trans Traffic Survey at the following intersections:

1. Ruttleys Road and Construction Road
2. Construction Road and CVC site access
3. Ruttleys Road and MC access road



Source: Google maps modified by GHD

Figure 2-7 Traffic survey locations

The traffic counts were undertaken in 15-minute intervals for the following times, to coincide with peak periods of the road network and mine activity:

- Weekday 5:00 am – 9:00 am
- Weekday 1:00 pm – 5:00 pm
- Saturday 5:30 am – 8:30 am

For the intersection of Ruttleys Road/Construction Road and Ruttleys Road/MC access road, the observed traffic network peak hours were identified as the following:

- Weekday 7:45 am – 8:45 am
- Weekday 3:30 pm – 4:30 pm
- Saturday 7:30 am – 8:30 am

For the intersection of the Construction Road and the CVC site access, the observed peak hours were identified as:

- Weekday 5:15 am – 6:15 am
- Weekday 3:45 pm – 4:45 pm
- Saturday 5:30 am – 6:30 am

The above data indicates that during weekday morning periods and weekends, peak activity at the CVC occurs prior to the general peak activity on the adjoining road network. This is consistent with the staff shifts (see Section 2.5).

However, for a conservative approach, the general road network peak hour traffic volumes recorded at each of the three intersections has been used to determine the background traffic volumes in proximity to the subject sites.

The intersection survey outputs are included in Appendix A. The peak hour volumes identified in the traffic surveys are displayed in Appendix B.[1]

2.4 Current network operation

The operation of the intersections of interest has been assessed using SIDRA 8.

SIDRA calculates the amount of delay to vehicles using an intersection and, amongst other performance measures, gives a Level of Service (LoS) rating which indicates the relative performance of traffic movements within the intersection.

Table 2-1 presents the criteria generally applied to intersection performance. The LoS is determined from the calculated delay to traffic movements, which is a representation of driver frustration, fuel consumption and increased travel time. There are six LoS measures ranging from A (very low delay and very good operating conditions) to F (over saturation where arrival rates exceed intersection capacity). Typically a LoS D or better is considered to be acceptable, however, a LoS E may be acceptable if it also operates with a low degree of saturation.

Table 2-1 Intersection Level of Service Criteria

LoS	Average Delay/ Vehicle (sec)	Traffic Signals & Roundabouts	Give-way & Stop signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28 to 42	Satisfactory	Satisfactory, but accident study required

[1] It is noted that based on discussions with Central Coast Council's traffic engineer, it was agreed that no adjustments to the peak hour traffic volumes was required to account for the potential impacts associated with Covid 19.

LoS	Average Delay/ Vehicle (sec)	Traffic Signals & Roundabouts	Give-way & Stop signs
D	42 to 56	Operating near capacity	Near capacity, accident study required
E	56 to 70	At capacity, excessive delays; roundabout requires other control mode	At capacity; requires other control mode
F	Exceeding 70	Unsatisfactory; requires additional capacity	Unsatisfactory, requires other control mode.

The layout of the intersections of interest (as modelled in SIDRA) are displayed below in Figure 2-8 to Figure 2-10.

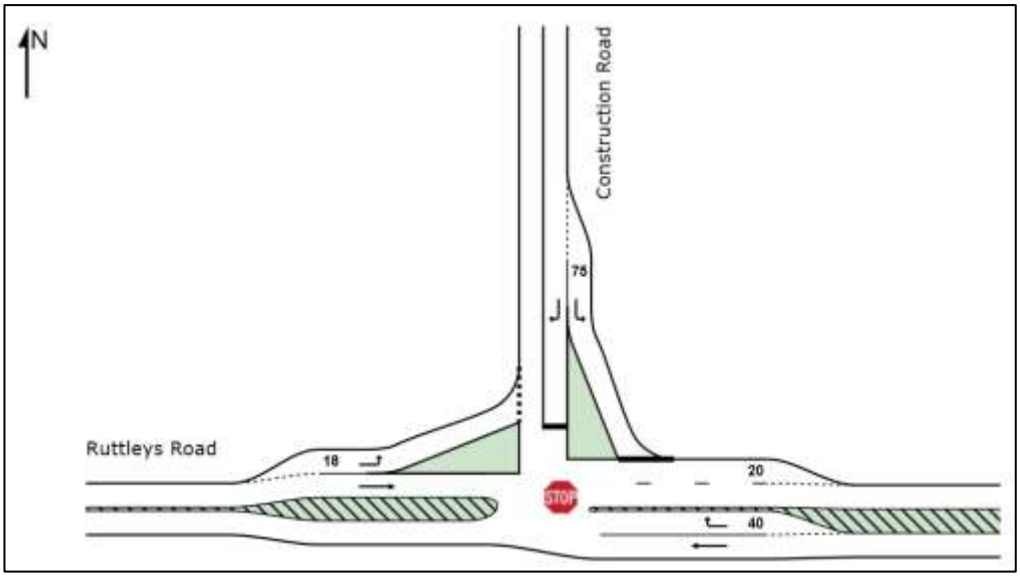


Figure 2-8 Ruttleys Road and Construction Road

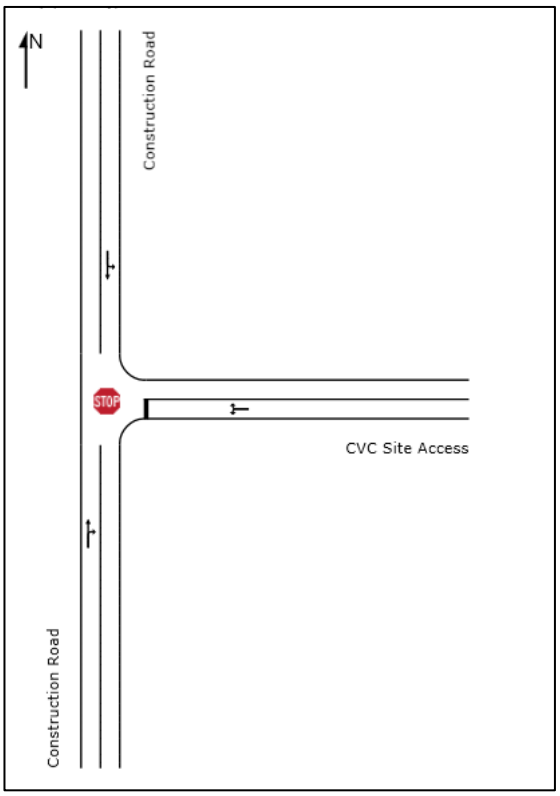


Figure 2-9 Construction Road and CVC site access

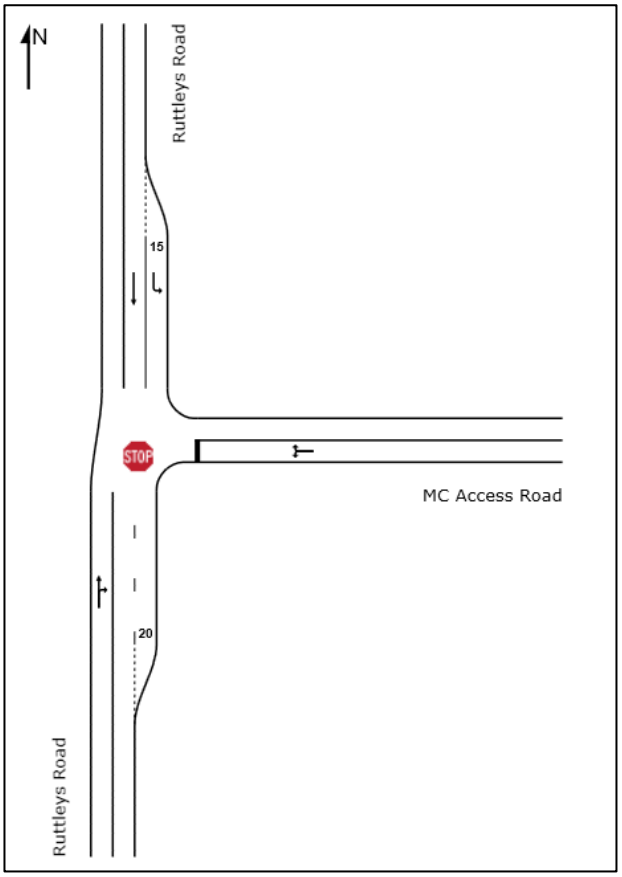


Figure 2-10 Ruttleys Road and MC access road

The results of the SIDRA intersection modelling analysis, based on the existing traffic volumes and road geometry, are summarised in Table 2-2.

The SIDRA results indicate that all of the intersections of interest currently operate with a good level of service, at LoS A, during the weekday AM and PM and Saturday peak periods.

SIDRA outputs for the existing situation are included in Appendix C.

Table 2-2 Current Intersection Performance

Intersection	AM Peak			PM Peak			Saturday Peak		
	Av Delay (sec)	LOS	95th % Queue (m)	Av Delay (sec)	LOS	95th % Queue (m)	Av Delay (sec)	LOS	95th % Queue (m)
Ruttleys Road and Construction Road									
Ruttleys Road (east)	0.3	A	0	0.1	A	0	0.2	A	0
Construction Road	13.7	A	1	13.1	A	1	9.9	A	0
Ruttleys Road (west)	0.2	A	0	0.1	A	0	0.1	A	0
All vehicles	**0.8**	**A**	**-**	**1.1**	**A**	**-**	**0.2**	**A**	**-**
Construction Road and CVC site access									
Construction Road (south)	6.3	A	1	5.6	A	0	6.3	A	1
Site Access	6.7	A	0	6.7	A	1	6.7	A	0
Construction Road (north)	3.5	A	0	3.5	A	0	3.5	A	0
All vehicles	**6.3**	**A**	**-**	**6.5**	**A**	**-**	**6.3**	**A**	**-**
Ruttleys Road and MC site access									
Ruttleys Road (south)	0.0	A	0	0.0	A	0	0.1	A	0
MC Access Road	6.7	A	0	10.1	A	0	4.2	A	0
Ruttleys Road (north)	0.1	A	0	0.0	A	0	0.1	A	0
All vehicles	**0.2**	**A**	**-**	**0.1**	**A**	**-**	**0.1**	**A**	**-**

2.5 Current employment data

Information provided by the Client indicates that:

- 227 people are employed at the CVC and MC.
- 36 are administrative staff (approximately 15 percent) and 191 are miners (approximately 85 percent).
- Approximately 90 percent of staff are employed at the CVC and 10 percent of employees at the MC.

The administrative staff work typical office hours (approximately 9:00 am – 5:00 pm), while the miners work in shifts, to support the 24-hour operation of the mine.

The Client has provided details of the shifts of workers at the CVC and MC, as detailed in Table 2-3.

Table 2-3 Current Shift Data (mining staff)[2]

Current	Start	Finish	% shift Contribution	Staff
Administration staff	9:00 am	5:00 pm	-	36
Weekday Day Shift A	6:00 am	3:30 pm	20 %	38
Weekday Day Shift B	6:30 am	4:00 pm	15 %	29
Weekday Afternoon Shift A	2:00 pm	11:30 pm	10 %	19
Weekday Afternoon Shift B	2:30 pm	12:00 am	15 %	29
Weekday Night Shift A	10:00 pm	7:30 am	8 %	15
Weekday Night Shift B	10:30 pm	8:00 am	8 %	15
Weekend Dayshift A	6:30 am	6:30 pm	6 %	11
Weekend Dayshift B	7:00 am	7:00 pm	6 %	11
Weekend Nightshift A	5:00 pm	5:00 am	6 %	11
Weekend Nightshift B	5:30 pm	5:30 am	6 %	11
Total			**100 %**	**227**

As detailed in Table 2-3, the majority of staff activity is associated with the weekday day and weekday afternoon shifts.

[2] Shifts A and B are offset by half an hour for efficiency reasons i.e. spreading the demand for shower facilities at the mine.

3. Proposed development

3.1 Trip generation

3.1.1 Additional staff

Analysis has been undertaken for three growth scenarios, as follows:

- Low growth scenario – A total of 300 staff members (73 additional staff).
- Medium growth scenario – A total of 350 staff members (123 additional staff).
- High growth scenario – A total of 450 staff members (223 additional staff).

The expected increases in staff levels have been pro-rated between the CVC/MC sites and work shifts, in accordance with the current staffing arrangements. Accordingly, it has been assumed that:

- 85 percent of new staff will work in the mines and 15 percent will work in administration.
- 90 percent of the new mining staff will be employed at the CVC and 10 percent at the MC.

The additional staff have been allocated to work shifts in accordance with the current activity (see Table 2-3) as displayed in Table 3-1.

Table 3-1 Existing and proposed staffing level (per shift)[3]

Current	Current	Low Growth	Medium Growth	High Growth
Administration staff	36	48	56	71
Weekday Day Shift A	38	50	59	76
Weekday Day Shift B	29	38	44	57
Weekday Afternoon Shift A	19	25	29	38
Weekday Afternoon Shift B	29	38	44	57
Weekday Night Shift A	15	20	24	30
Weekday Night Shift B	15	20	24	30
Weekend Dayshift A	11	15	18	23
Weekend Dayshift B	11	15	18	23
Weekend Nightshift A	11	15	18	23
Weekend Nightshift B	11	15	18	23
Total	**227**	**300**	**350**	**450**
CVC Site	204	270	315	405
MC Site	23	30	35	45

It is noted that based upon the current/future split between the CVC and MC sites, 30 – 45 workers are expected to be employed at the MC site. Accordingly, the number of workers at the MC will remain below 70 and the upgrade for the intersection of Ruttleys Road/MC site access is not expected to be triggered.

3.1.2 Peak hour traffic volumes

For the purposes of analysis to provide a robust analysis, it has been assumed that:

- The administration staff will access the collieries in the weekday AM peak hour and exit it in the weekday PM peak hour.
- The administration staff do not work on Saturdays.
- The weekday day shift access the collieries in the weekday AM peak hour and exit it in the weekday PM peak hour.
- The weekday afternoon shift does not access/egress the site in the weekday AM or PM peak hours.
- The weekday night shift will exit the collieries during the weekday AM peak hour.
- The weekend day shift access the collieries in the Saturday peak hour.
- The weekend night shift exit the collieries in the Saturday park hour.

Based on the proposed additional staff members and the assumptions listed above, the peak hour traffic generation (by growth scenario) is presented in Table 3-2.

Table 3-2 Trip Generation Data

Shift	Inbound			Outbound		
	Low Growth	Medium Growth	High Growth	Low Growth	Medium Growth	High Growth
AM Peak Hour						
Administration	12	20	35	-	-	-
Weekday Day Shift	21	36	66	-	-	-
Weekday Night Shift	-	-	-	10	17	30
Total	**33**	**56**	**101**	**10**	**17**	**30**
CVC Site	30	50	91	9	15	27
MC Site	3	6	10	1	2	3
PM Peak Hour						
Administration	-	-	-	12	20	35
Weekday Day Shift	-	-	-	21	36	66
Total	**-**	**-**	**-**	**33**	**56**	**101**
CVC Site	-	-	-	30	50	91
MC Site	-	-	-	3	6	10

Shift	Inbound			Outbound		
	Low Growth	Medium Growth	High Growth	Low Growth	Medium Growth	High Growth
Saturday Peak Hour						
Weekend Dayshift	7	12	23	-	-	-
Weekend Nightshift	-	-	-	7	12	23
Total	**7**	**12**	**23**	**7**	**12**	**23**
CVC Site	7	11	20	7	11	20
MC Site	0	1	3	0	1	3

The traffic impacts associated with the **additional** staff identified in Table 3-2, have been assessed at the intersections of interest in the 2030 horizon year, accounting for the background traffic volumes on Ruttleys Road (see Section 4).

3.1.3 Coal Trucks

As described in Section 1.2, under current restrictions, maximum laden coal truck movements from the CVC are not permitted to exceed:

- 270 per day
- 32 per hour

Information provided by the Client, coal exports are not expected to recommence and Vales Power Station will continue to use all the coal produced at the collieries and be transported by conveyors.

However, in order to be conservative, it has been assumed that in the 2030 horizon year that 32 coal trucks will enter and exit the CVC site in each peak hour of analysis.

3.2 Trip distribution

3.2.1 Staff

The Client has provided a list of the residential locations of the current employees (by local government area). For the purposes of analysis, it has been assumed that the proposed new workers will have similar residential locations.

Detail of the key residential locations for CVC and MC employees is displayed in Table 3-3.

Table 3-3 Staff Residential Locations

Residential Location	Proportion of Employees
Lake Macquarie City Council	57%
Central Coast Council	13%
Newcastle City Council	12%
Cessnock City Council	10%
Maitland City Council	8%
Total	***100%***

For the purpose of assessment, it has been assumed that (see Figure 3-1):

- Workers residing in Lake Macquarie:
  - 50 percent will access the collieries from the south via Pacific Highway
  - 50 percent will access the collieries from the north via Wyee Road
- Workers residing in the Central Coast and Newcastle will access the collieries from the south via the Pacific Highway.
- Workers residing in Cessnock and Maitland will access the collieries from the north via Wyee Road.

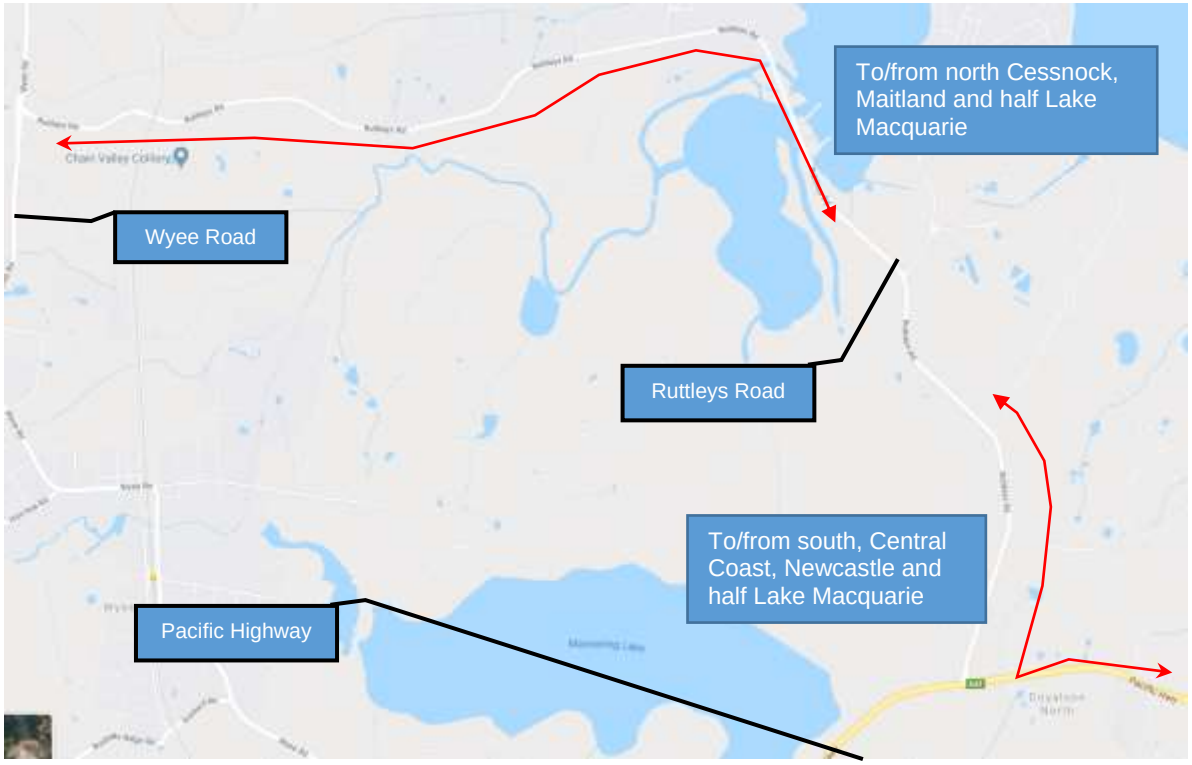


Figure 3-1 Trip distribution

3.2.2 Coal Trucks

In accordance with the haulage route detailed in the Road transport Protocol (see Figure 1-2) it is assumed that the outbound coal trucks will:

- Turn left out of the CVC site onto Construction Road.
- Turn left from Construction Road onto Ruttleys Road and travel south towards the Pacific Highway.

3.3 Future road network changes

Based on discussions with Council, there are no planned upgrades to the traffic and transport networks in proximity to the subject sites.

4. Impact assessment

Information provided by the Client indicates that staffing levels are proposed to ramp up from 2021 with all the additional staff employed by 2023.

To account for the additional staff, intersection traffic modelling, using the SIDRA 8, has been undertaken for of the low, medium and high growth scenario in the 2030 horizon year (10-year scenario).

As detailed in section 1.3, the outputs of strategic modelling undertaken for the *Greater Lake Munmorah Structure Plan Strategy* indicates that in the short term, 0 – 10 years) annual traffic growth of 1.5 percent – 2.1 percent is expected within the study area.

To be conservative, a linear annual growth rate of 2.1 percent has been applied to the 2020 traffic survey volumes on Ruttleys Road, to determine the 2030 background traffic volumes.

The forecast 2030 weekday AM and PM and Saturday peak hour traffic volumes are included in Appendix D.

The results of the SIDRA analysis for the 2030 horizon year are summarised as follows:

- Low growth scenario - Table 4-1
- Medium growth scenario - Table 4-2
- High growth scenario - Table 4-3

The intersection modelling analysis indicates that in the 2030 horizon year, all intersections are expected to operate with a good LoS, for all the growth scenarios.

Accordingly, the trips associated with the additional staff at CVC and MC are expected to have a negligible impact on the adjoining road network.

The SIDRA outputs for the 2030 horizon year are included in Appendix E.

Table 4-1 Intersection performance (2030): Low growth scenario

Intersection	AM Peak			PM Peak			Saturday Peak		
	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)
Ruttleys Road and Construction Road									
Ruttleys Road (east)	1.4	A	3	0.9	A	3	1.9	A	2
Construction Road	17.4	B	4	16.4	B	5	14.8	B	2
Ruttleys Road (west)	0.4	A	1	0.1	A	0	0.2	A	0
All vehicles	**2.0**	**A**	**-**	**2.2**	**A**	**-**	**2.4**	**A**	**-**
Construction Road and CVC site access									
Construction Road (south)	6.9	A	3	7.8	A	2	7.3	A	2
CVC Site Access	8.9	A	2	7.5	A	4	8.7	A	2
Construction Road (north)	3.5	A	0	3.5	A	0	3.5	A	0
All vehicles	**7.4**	**A**	**-**	**7.6**	**A**	**-**	**7.8**	**A**	**-**
Ruttleys Road and MC site access									
Ruttleys Road (south)	0.1	A	1	0.1	A	0	0.1	A	0
MC Access Road	9.1	A	1	13.9	A	1	4.9	A	0
Ruttleys Road (north)	0.2	A	0	0.1	A	0	0.0	A	0
All vehicles	**0.3**	**A**	**-**	**0.2**	**A**	**-**	**0.1**	**A**	**-**

Table 4-2 Intersection performance (2030): Medium growth scenario

Intersection	AM Peak			PM Peak			Saturday Peak		
	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)
Ruttleys Road and Construction Road									
Ruttleys Road (east)	1.6	A	3	0.9	A	3	2.0	A	2
Construction Road	17.2	B	4	16.3	B	6	14.4	A	2
Ruttleys Road (west)	0.5	A	1	0.1	A	0	0.2	A	0
All vehicles	**2.2**	**A**	**-**	**2.4**	**A**	**-**	**2.5**	**A**	**-**
Construction Road and CVC site access									
Construction Road (south)	6.9	A	4	7.8	A	2	7.3	A	2
Site Access	8.6	A	2	7.4	A	4	8.5	A	2
Construction Road (north)	3.5	A	0	3.5	A	0	3.5	A	0
All vehicles	**7.3**	**A**	**-**	**7.5**	**A**	**-**	**7.8**	**A**	**-**
Ruttleys Road and MC site access									
Ruttleys Road (south)	0.2	A	1	0.1	A	0	0.1	A	0
MC Access Road	9.2	A	1	13.6	A	1	4.8	A	0
Ruttleys Road (north)	0.2	A	0	0.1	A	0	0.1	A	0
All vehicles	**0.3**	**A**	**-**	**0.2**	**A**	**-**	**0.2**	**A**	**-**

Table 4-3 Intersection performance (2030): High growth scenario

Intersection	AM Peak			PM Peak			Saturday Peak		
	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)	Av Delay (sec)	LoS	95th % Queue (m)
Ruttleys Road and Construction Road									
Ruttleys Road (east)	1.9	A	4	0.9	A	3	2.1	A	2
Construction Road	16.9	B	4	16.2	B	6	13.7	A	2
Ruttleys Road (west)	0.7	A	1	0.1	A	0	0.4	A	0
All vehicles	**2.5**	**A**	**-**	**2.8**	**A**	**-**	**2.7**	**A**	**-**
Construction Road and CVC site access									
Construction Road (south)	6.8	A	5	7.8	A	2	7.2	A	2
Site Access	8.3	A	2	7.3	A	5	8.3	A	2
Construction Road (north)	3.5	A	0	3.5	A	0	3.5	A	0
All vehicles	**7.2**	**A**	**-**	**7.3**	**A**	*****	**7.6**	**A**	**-**
Ruttleys Road and MC site access									
Ruttleys Road (south)	0.3	A	1	0.1	A	0	0.1	A	0
MC Access Road	9.3	A	1	13.4	A	1	4.8	A	0
Ruttleys Road (north)	0.2	A	0	0.1	A	0	0.1	A	0
All vehicles	**0.4**	**A**	**-**	**0.2**	**A**	**-**	**0.2**	**A**	**-**

5. Summary and conclusion

GHD has been engaged by Great Southern Energy Pty Ltd (trading as Delta Coal) to undertake a Traffic Impact Assessment to support the Consent Modification Statement of Environmental Effects (SEE), that will facilitate an increase to staffing levels at the Chain Valley Colliery and Mannering Colliery.

Chain Valley Colliery (CVC) and Mannering Colliery (MC) is an underground coal mine and coal processing site, located approximately 60 km south of Newcastle.

Based on the information provided by the Client:

- The collieries currently have a workforce of 227 staff.
- This is expected to increase to approximately 330 staff by 2023.

The analysis was undertaken for three scenarios, as follows:

- Low growth scenario – A total 300 staff members (73 additional staff).
- Medium growth scenario – A total 350 staff members (123 additional staff).
- High growth scenario – A total 450 staff members (223 additional staff).

Additionally, in order to provide a robust analysis, it has been assumed that 32 coal trucks will access/egress the colliery during peak periods of road network activity.

Traffic surveys and intersection modelling using SIDRA 8 (for a weekday AM, weekday PM and Saturday peak periods, for all three growth scenarios) has been undertaken in the 2020 and 2030 horizon year at the following intersections to analyse the traffic impacts of the proposed additional staff members:

1. Ruttleys Road and Construction Road
2. Construction Road and CVC site access
3. Ruttleys Road and MC access road

To be conservative, a linear annual growth rate of 2.1 percent has been applied to the 2020 traffic survey volumes on Ruttleys Road, to determine the 2030 background traffic volumes.

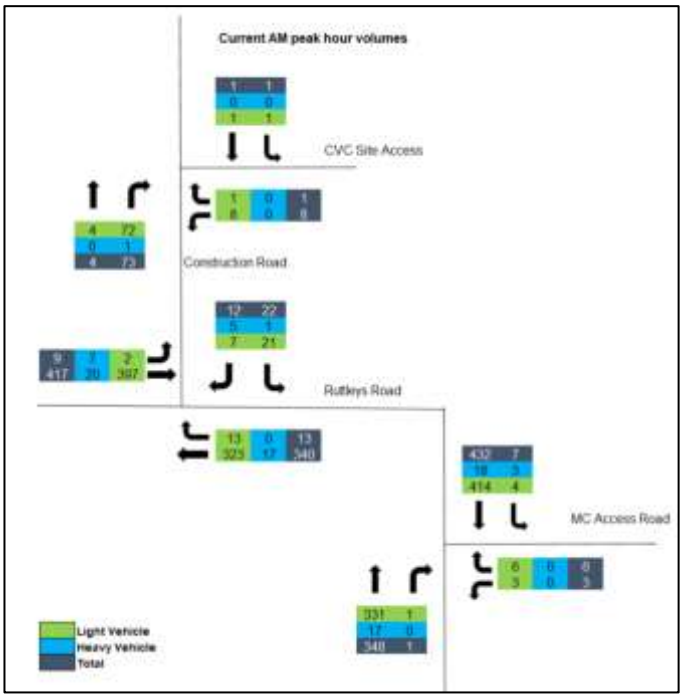
The results of the SIDRA modelling indicates that the intersections of interest are expected to operate with a good level of service in the 2030 horizon year for all three growth scenarios.

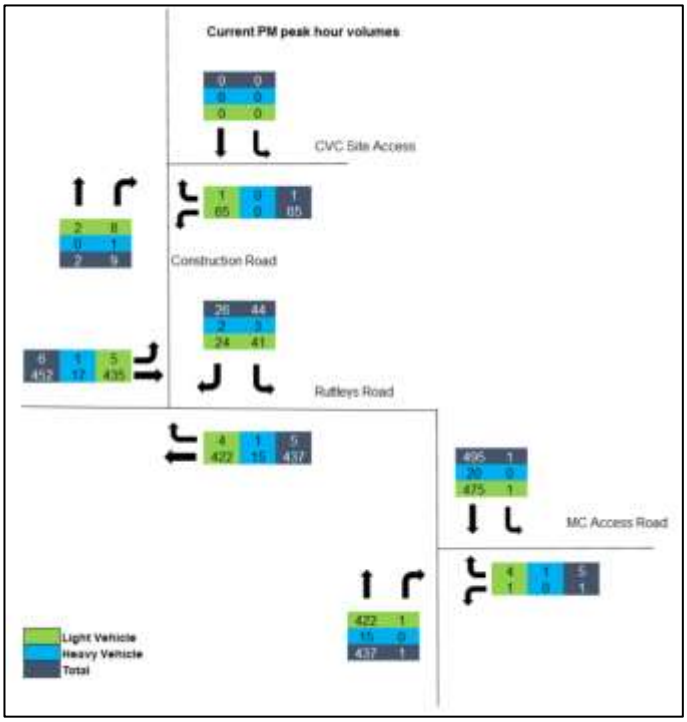
In conclusion, it is expected that the vehicle activity associated with the proposed increases in staff will have a negligible impact on the adjoining road network.

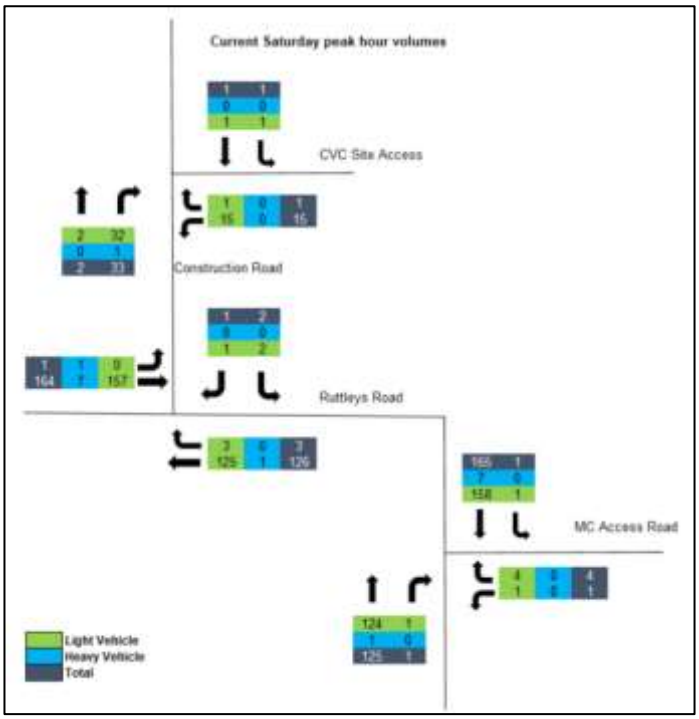
Appendices

Appendix A – Traffic Survey Outputs

Appendix B – Peak Hour Traffic Volumes






Current Saturday peak hour volumes
CVC Site Access
Construction Road
Ruttleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total

Appendix C – SIDRA Outputs - Existing

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - AM Peak Existing]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate	Aver. No Cycles	Ave Sp
East: Ruttleys Road												
5	T1	358	5.0	0.191	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	
6	R2	14	0.0	0.009	8.1	LOS A	0.0	0.3	0.47	0.69	0.47	
Approach		372	4.8	0.191	0.3	NA	0.0	0.3	0.02	0.02	0.02	
North: Construction Road												
7	L2	23	4.5	0.021	11.5	LOS A	0.1	0.6	0.47	0.84	0.47	
9	R2	13	41.7	0.033	17.7	LOS B	0.1	1.0	0.65	1.01	0.65	
Approach		36	17.6	0.033	13.7	LOS A	0.1	1.0	0.53	0.90	0.53	
West: Ruttleys Road												
10	L2	9	77.8	0.006	8.6	LOS A	0.0	0.3	0.07	0.56	0.07	
11	T1	439	4.8	0.232	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	
Approach		448	6.3	0.232	0.2	LOS A	0.0	0.3	0.00	0.01	0.00	
All Vehicles		856	6.2	0.232	0.8	NA	0.1	1.0	0.03	0.05	0.03	

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - AM Peak Existing]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate	Aver. No Cycles	Average Speed km/h
South: Construction Road												
2	T1	4	0.0	0.035	0.0	LOS A	0.2	1.4	0.02	0.60	0.02	70.2
3	R2	77	1.4	0.035	6.6	LOS A	0.2	1.4	0.02	0.60	0.02	48.6
Approach		81	1.3	0.035	6.3	NA	0.2	1.4	0.02	0.60	0.02	49.4
East: CVC Site Access												
4	L2	8	0.0	0.005	6.7	LOS A	0.0	0.2	0.01	0.99	0.01	46.4
6	R2	1	0.0	0.005	6.4	LOS A	0.0	0.2	0.01	0.99	0.01	46.1
Approach		9	0.0	0.005	6.7	LOS A	0.0	0.2	0.01	0.99	0.01	46.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		93	1.1	0.035	6.3	NA	0.2	1.4	0.02	0.64	0.02	49.5

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - AM Peak Existing]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate	Aver. No Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	366	4.9	0.195	0.0	LOS A	0.0	0.1	0.00	0.00	0.00	79.9
3	R2	1	0.0	0.195	10.5	LOS A	0.0	0.1	0.00	0.00	0.00	25.4
Approach		367	4.9	0.195	0.0	NA	0.0	0.1	0.00	0.00	0.00	79.4
East: MC Access Road												
4	L2	3	0.0	0.014	4.8	LOS A	0.0	0.3	0.52	0.89	0.52	23.5
6	R2	6	0.0	0.014	7.5	LOS A	0.0	0.3	0.52	0.89	0.52	23.5
Approach		9	0.0	0.014	6.7	LOS A	0.0	0.3	0.52	0.89	0.52	23.5
North: Ruttleys Road												
7	L2	6	33.3	0.004	8.7	LOS A	0.0	0.0	0.00	0.71	0.00	53.9
8	T1	455	4.2	0.240	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		461	4.6	0.240	0.1	NA	0.0	0.0	0.00	0.01	0.00	79.4
All Vehicles		838	4.6	0.240	0.2	NA	0.0	0.3	0.01	0.02	0.01	77.3

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - PM Peak Existing]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	460	3.4	0.241	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	5	20.0	0.004	8.9	LOS A	0.0	0.2	0.51	0.58	0.51	57.2
Approach		465	3.6	0.241	0.1	NA	0.0	0.2	0.01	0.01	0.01	79.5
North: Construction Road												
7	L2	46	6.8	0.044	11.9	LOS A	0.2	1.4	0.50	0.87	0.50	60.3
9	R2	27	7.7	0.062	15.2	LOS B	0.2	1.4	0.66	1.00	0.66	56.2
Approach		74	7.1	0.062	13.1	LOS A	0.2	1.4	0.56	0.92	0.56	58.8
West: Ruttleys Road												
10	L2	6	16.7	0.003	7.6	LOS A	0.0	0.1	0.04	0.59	0.04	60.5
11	T1	476	3.8	0.250	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		482	3.9	0.250	0.1	LOS A	0.0	0.1	0.00	0.01	0.00	79.6
All Vehicles		1021	4.0	0.250	1.1	NA	0.2	1.4	0.04	0.07	0.04	77.6

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - PM Peak Existing]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.005	0.0	LOS A	0.0	0.2	0.02	0.53	0.02	71.6
3	R2	9	11.1	0.005	6.6	LOS A	0.0	0.2	0.02	0.53	0.02	49.2
Approach		12	9.1	0.005	5.6	NA	0.0	0.2	0.02	0.53	0.02	52.2
East: CVC Site Access												
4	L2	68	0.0	0.039	6.7	LOS A	0.2	1.2	0.01	0.99	0.01	46.4
6	R2	1	0.0	0.039	6.3	LOS A	0.2	1.2	0.01	0.99	0.01	46.1
Approach		69	0.0	0.039	6.7	LOS A	0.2	1.2	0.01	0.99	0.01	46.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		83	1.3	0.039	6.5	NA	0.2	1.2	0.01	0.91	0.01	47.5

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - PM Peak Existing]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	460	3.4	0.243	0.0	LOS A	0.0	0.1	0.00	0.00	0.00	79.9
3	R2	1	0.0	0.243	11.3	LOS A	0.0	0.1	0.00	0.00	0.00	25.4
Approach		461	3.4	0.243	0.0	NA	0.0	0.1	0.00	0.00	0.00	79.5
East: MC Access Road												
4	L2	1	0.0	0.016	5.2	LOS A	0.0	0.4	0.66	0.93	0.66	23.1
6	R2	5	20.0	0.016	11.0	LOS A	0.0	0.4	0.66	0.93	0.66	22.2
Approach		6	16.7	0.016	10.1	LOS A	0.0	0.4	0.66	0.93	0.66	22.3
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	521	4.0	0.274	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		522	4.0	0.274	0.0	NA	0.0	0.0	0.00	0.00	0.00	79.8
All Vehicles		989	3.8	0.274	0.1	NA	0.0	0.4	0.01	0.01	0.01	78.4

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - Sat Peak Existing]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	133	0.8	0.068	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
6	R2	3	0.0	0.002	7.3	LOS A	0.0	0.1	0.28	0.54	0.28	64.1
Approach		136	0.8	0.068	0.2	NA	0.0	0.1	0.01	0.01	0.01	79.5
North: Construction Road												
7	L2	2	0.0	0.001	10.0	LOS A	0.0	0.0	0.27	0.82	0.27	63.2
9	R2	1	0.0	0.001	9.6	LOS A	0.0	0.0	0.33	0.83	0.33	62.9
Approach		3	0.0	0.001	9.9	LOS A	0.0	0.0	0.29	0.82	0.29	63.1
West: Ruttleys Road												
10	L2	2	50.0	0.001	8.1	LOS A	0.0	0.1	0.03	0.58	0.03	52.4
11	T1	173	4.3	0.091	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		175	4.8	0.091	0.1	LOS A	0.0	0.1	0.00	0.01	0.00	79.5
All Vehicles		314	3.0	0.091	0.2	NA	0.0	0.1	0.01	0.02	0.01	79.3

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - Sat Peak Existing]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.016	0.0	LOS A	0.1	0.6	0.02	0.60	0.02	70.3
3	R2	35	3.0	0.016	6.7	LOS A	0.1	0.6	0.02	0.60	0.02	48.7
Approach		37	2.9	0.016	6.3	NA	0.1	0.6	0.02	0.60	0.02	49.5
East: CVC Site Access												
4	L2	16	0.0	0.010	6.7	LOS A	0.0	0.3	0.01	0.99	0.01	46.4
6	R2	1	0.0	0.010	6.3	LOS A	0.0	0.3	0.01	0.99	0.01	46.1
Approach		17	0.0	0.010	6.7	LOS A	0.0	0.3	0.01	0.99	0.01	46.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		56	1.9	0.016	6.3	NA	0.1	0.6	0.02	0.71	0.02	49.1

MOVEMENT SUMMARY

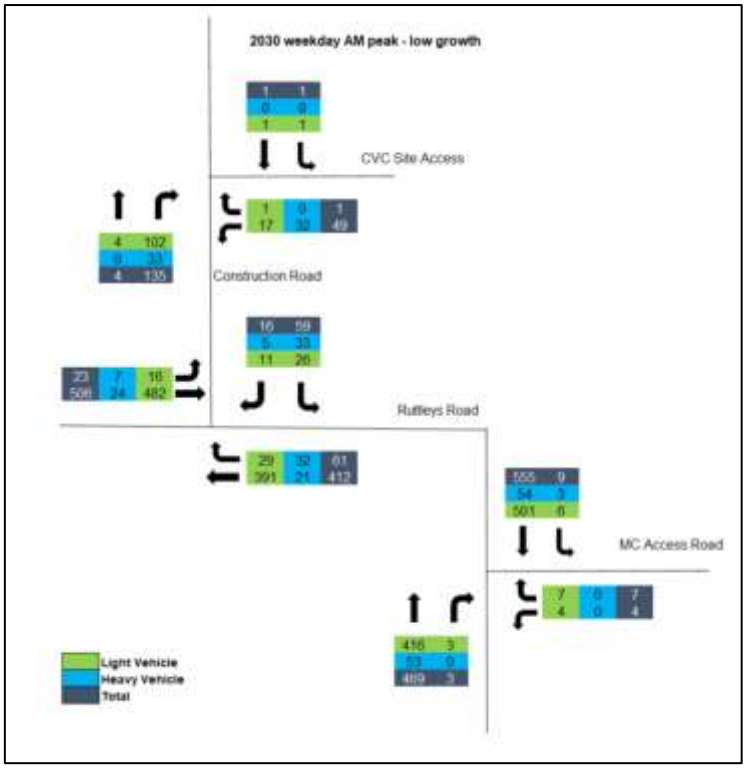
Site: [Ruttleys Road/MC Access Road - Sat Peak Existing]

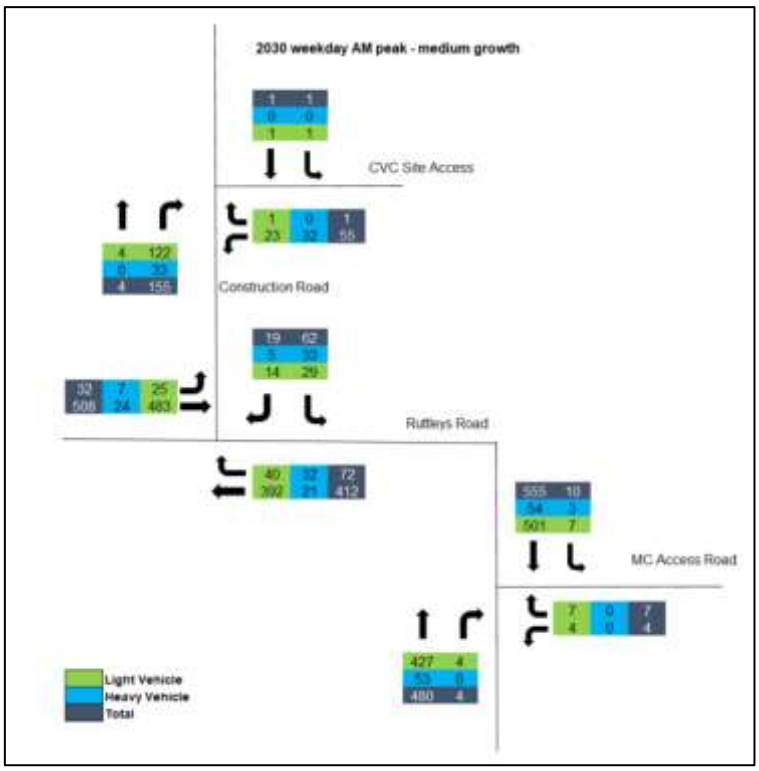
New Site
Site Category: (None)
Stop (Two-Way)

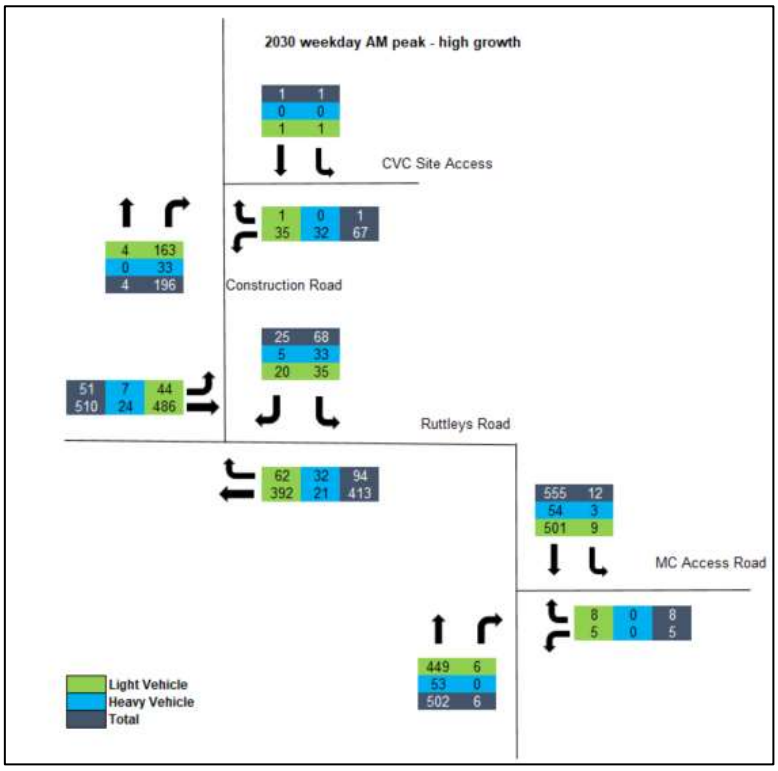
Movement Performance - Vehicles

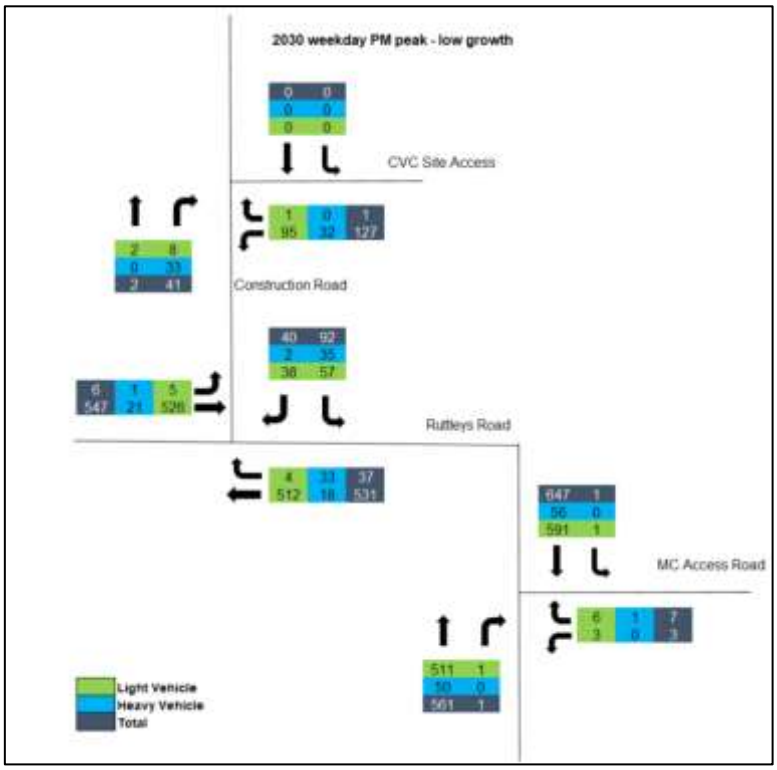
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Ruttleys Road												
2	T1	132	0.8	0.069	0.0	LOS A	0.0	0.1	0.01	0.01	0.01	7
3	R2	1	0.0	0.069	8.2	LOS A	0.0	0.1	0.01	0.01	0.01	2
Approach		133	0.8	0.069	0.1	NA	0.0	0.1	0.01	0.01	0.01	7
East: MC Access Road												
4	L2	1	0.0	0.005	3.7	LOS A	0.0	0.1	0.31	0.85	0.31	2
6	R2	4	0.0	0.005	4.3	LOS A	0.0	0.1	0.31	0.85	0.31	2
Approach		5	0.0	0.005	4.2	LOS A	0.0	0.1	0.31	0.85	0.31	2
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	6
8	T1	174	4.2	0.092	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	8
Approach		175	4.2	0.092	0.1	NA	0.0	0.0	0.00	0.00	0.00	7
All Vehicles		313	2.7	0.092	0.1	NA	0.0	0.1	0.01	0.02	0.01	7

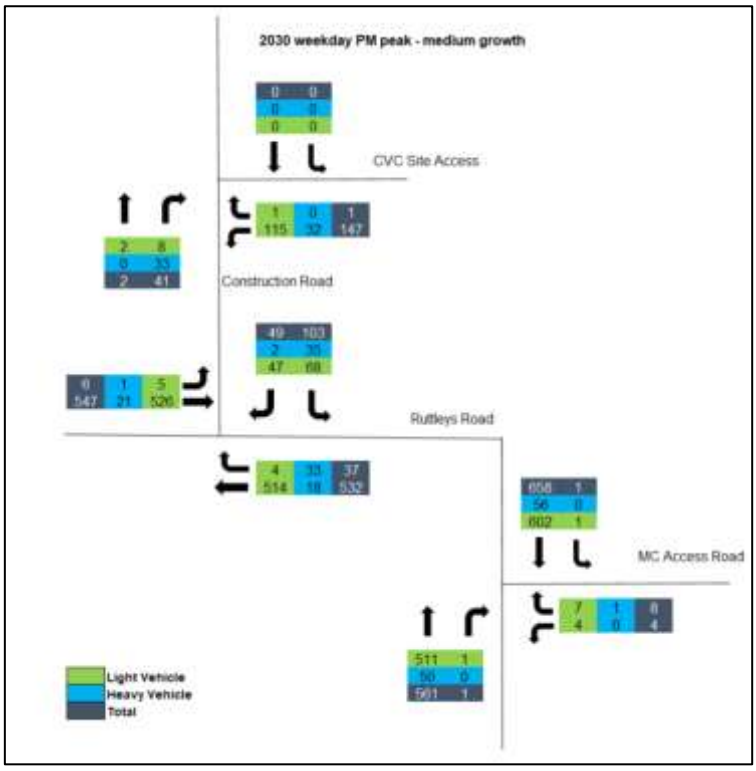
Appendix D – 2030 Traffic Volumes (low, medium and high growth scenarios)

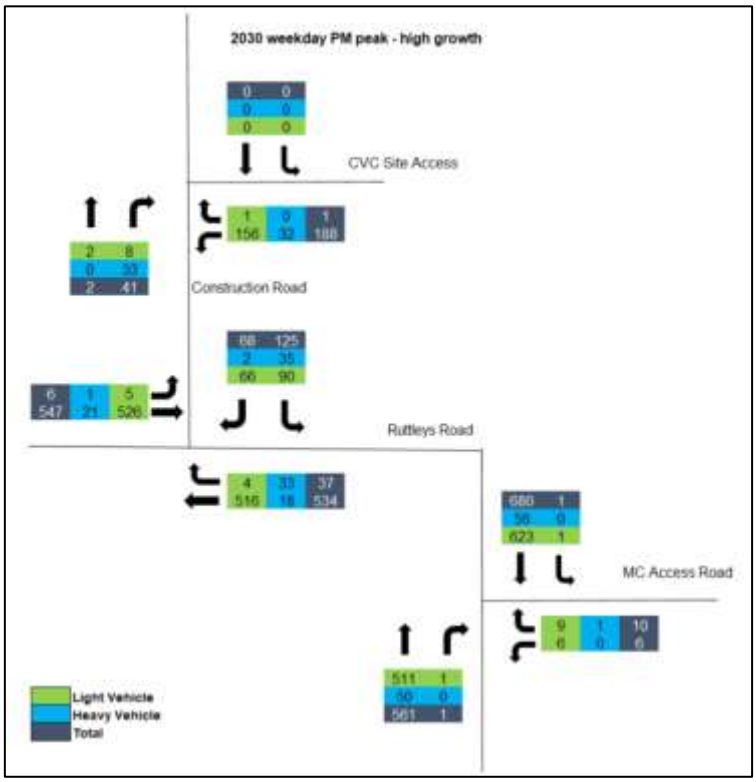


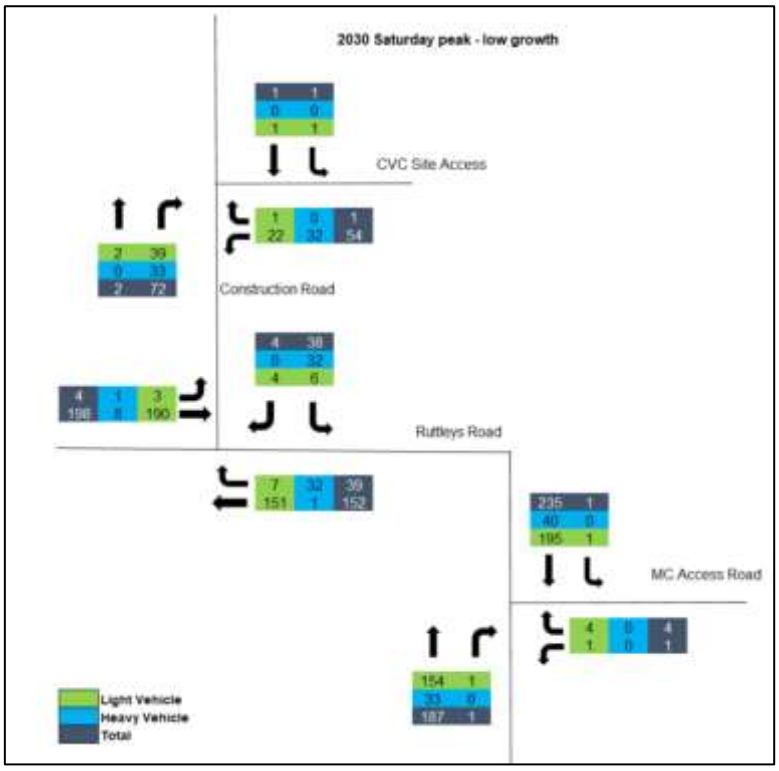


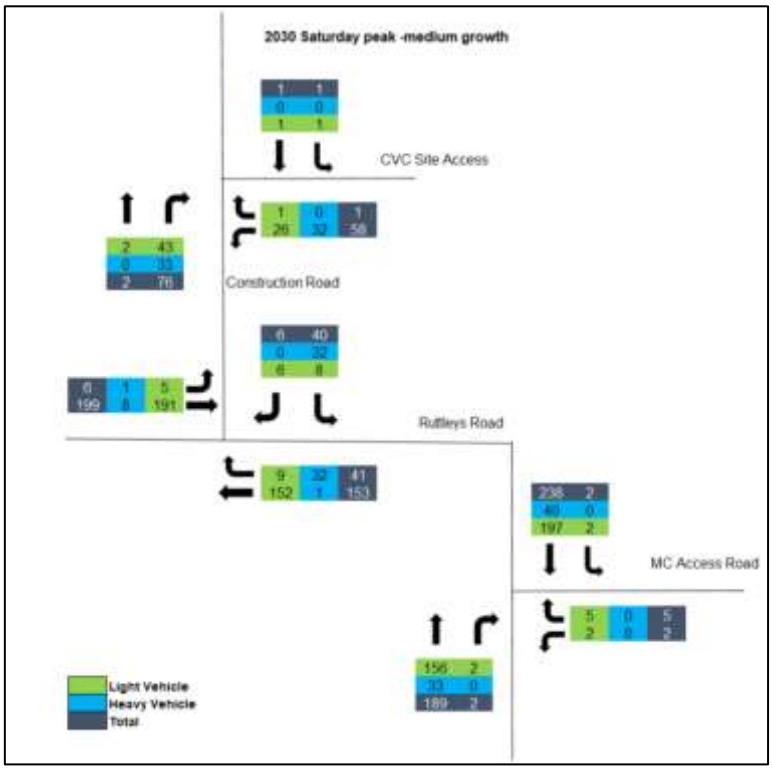

2030 weekday AM peak - high growth
1 1
0 0
1 1
CVC Site Access
1 0 1
35 32 67
4 163
0 33
4 196
Construction Road
25 68
5 33
20 35
51 7 44
510 24 486
Ruttleys Road
62 32 94
392 21 413
555 12
54 3
501 9
MC Access Road
8 0 8
5 0 5
449 6
53 0
502 6
Light Vehicle
Heavy Vehicle
Total

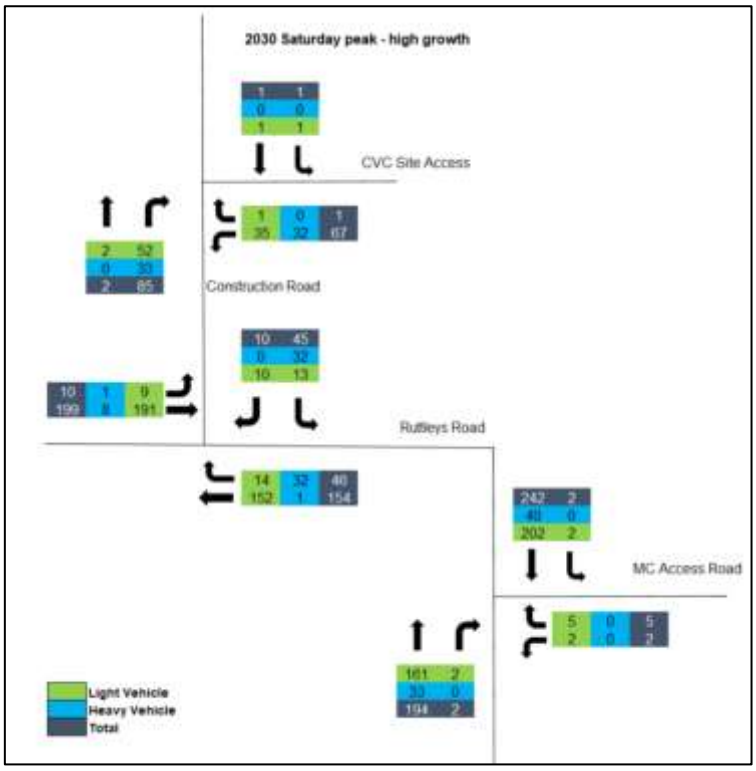

2030 weekday PM peak - low growth
0 0
0 0
0 0
CVC Site Access
1 0 1
95 32 127
2 8
0 33
2 41
Construction Road
40 92
2 35
38 57
6 1 5
547 21 526
Ruttleys Road
4 33 37
512 18 531
647 1
56 0
591 1
MC Access Road
6 1 7
3 0 3
511 1
50 0
561 1
Light Vehicle
Heavy Vehicle
Total


2030 weekday PM peak - medium growth
CVC Site Access
Construction Road
Ruttleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total


2030 weekday PM peak - high growth
CVC Site Access
Construction Road
Ruttleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total


2030 Saturday peak - low growth
CVC Site Access
Construction Road
Ruttleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total


2030 Saturday peak -medium growth
CVC Site Access
Construction Road
Ruttleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total


2030 Saturday peak - high growth
CVC Site Access
Construction Road
Rutleys Road
MC Access Road
Light Vehicle
Heavy Vehicle
Total

Appendix E – SIDRA Outputs - 2030

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - AM Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	434	5.1	0.231	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	64	52.5	0.065	10.7	LOS A	0.3	3.2	0.09	0.72	0.09	49.3
Approach		498	11.2	0.231	1.4	NA	0.3	3.2	0.08	0.09	0.08	74.0
North: Construction Road												
7	L2	62	55.9	0.093	16.5	LOS B	0.4	3.9	0.89	0.96	0.59	48.0
9	R2	17	31.3	0.058	20.5	LOS B	0.2	1.6	0.75	1.01	0.75	48.1
Approach		79	50.7	0.093	17.4	LOS B	0.4	3.9	0.62	0.97	0.62	48.0
West: Ruttleys Road												
10	L2	24	30.4	0.014	8.0	LOS A	0.1	0.6	0.18	0.55	0.18	55.3
11	T1	533	4.7	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		557	5.9	0.282	0.4	LOS A	0.1	0.6	0.01	0.02	0.01	78.4
All Vehicles		1134	11.3	0.282	2.0	NA	0.4	3.9	0.08	0.12	0.08	73.2

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - AM Peak 2030 Low Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	4	0.0	0.009	0.0	LOS A	0.4	3.3	0.02	0.62	0.02	70.1
3	R2	142	24.4	0.009	7.1	LOS A	0.4	3.3	0.02	0.62	0.02	48.4
Approach		146	23.7	0.009	6.9	NA	0.4	3.3	0.02	0.62	0.02	48.9
East: CVC Site Access												
4	L2	52	65.3	0.039	8.9	LOS A	0.2	1.9	0.01	1.10	0.01	37.3
6	R2	1	0.0	0.039	8.6	LOS A	0.2	1.9	0.01	1.10	0.01	45.1
Approach		53	64.0	0.039	8.9	LOS A	0.2	1.9	0.01	1.10	0.01	37.4
North: Construction Road												
7	L2	1	0.0	0.001	8.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		201	34.0	0.009	7.4	NA	0.4	3.3	0.02	0.75	0.02	45.4

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - AM Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	494	11.3	0.276	0.1	LOS A	0.1	0.5	0.01	0.01	0.02	79.7
3	R2	3	0.0	0.276	12.6	LOS A	0.1	0.5	0.01	0.01	0.02	25.4
Approach		497	11.2	0.276	0.1	NA	0.1	0.5	0.01	0.01	0.02	78.7
East: MC Access Road												
4	L2	4	0.0	0.025	5.7	LOS A	0.1	0.5	0.65	0.94	0.65	23.2
6	R2	7	0.0	0.025	11.0	LOS A	0.1	0.5	0.65	0.94	0.65	23.2
Approach		12	0.0	0.025	9.1	LOS A	0.1	0.5	0.65	0.94	0.65	23.2
North: Ruttleys Road												
7	L2	9	33.3	0.006	8.7	LOS A	0.0	0.0	0.00	0.71	0.00	53.9
8	T1	584	9.7	0.319	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		594	10.1	0.319	0.2	NA	0.0	0.0	0.00	0.01	0.00	79.2
All Vehicles		1102	10.5	0.319	0.3	NA	0.1	0.5	0.01	0.02	0.01	77.0

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - PM Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	558	3.4	0.294	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	39	89.2	0.054	12.9	LOS A	0.2	3.1	0.64	0.76	0.64	42.2
Approach		597	9.0	0.294	0.9	NA	0.2	3.1	0.04	0.05	0.04	75.5
North: Construction Road												
7	L2	97	38.0	0.136	15.5	LOS B	0.6	5.2	0.60	0.98	0.60	51.4
9	R2	42	5.0	0.132	18.6	LOS B	0.4	2.9	0.77	1.00	0.77	54.2
Approach		139	28.0	0.136	16.4	LOS B	0.6	5.2	0.65	0.99	0.65	52.2
West: Ruttleys Road												
10	L2	6	16.7	0.003	7.7	LOS A	0.0	0.1	0.14	0.56	0.14	60.0
11	T1	576	3.8	0.303	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		582	4.0	0.303	0.1	LOS A	0.0	0.1	0.00	0.01	0.00	79.6
All Vehicles		1318	8.8	0.303	2.2	NA	0.6	5.2	0.09	0.13	0.09	73.7

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - PM Peak 2030 Low Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.027	0.0	LOS A	0.1	1.7	0.03	0.62	0.03	71.5
3	R2	43	80.5	0.027	8.2	LOS A	0.1	1.7	0.03	0.62	0.03	48.7
Approach		45	76.7	0.027	7.8	NA	0.1	1.7	0.03	0.62	0.03	49.5
East: CVC Site Access												
4	L2	134	25.2	0.084	7.5	LOS A	0.4	3.5	0.01	1.04	0.01	42.4
6	R2	1	0.0	0.084	6.4	LOS A	0.4	3.5	0.01	1.04	0.01	46.1
Approach		135	25.0	0.084	7.5	LOS A	0.4	3.5	0.01	1.04	0.01	42.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		182	37.6	0.084	7.6	NA	0.4	3.5	0.02	0.92	0.02	44.2

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - PM Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	591	8.9	0.322	0.0	LOS A	0.0	0.2	0.01	0.00	0.01	79.9
3	R2	1	0.0	0.322	14.6	LOS B	0.0	0.2	0.01	0.00	0.01	25.4
Approach		592	8.9	0.322	0.1	NA	0.0	0.2	0.01	0.00	0.01	79.8
East: MC Access Road												
4	L2	3	0.0	0.035	6.4	LOS A	0.1	0.8	0.77	0.96	0.77	22.5
6	R2	7	14.3	0.035	17.1	LOS B	0.1	0.8	0.77	0.96	0.77	21.9
Approach		11	10.0	0.035	13.9	LOS A	0.1	0.8	0.77	0.96	0.77	22.1
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	681	8.7	0.369	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.8
Approach		682	8.6	0.369	0.1	NA	0.0	0.0	0.00	0.00	0.00	79.8
All Vehicles		1284	8.8	0.369	0.2	NA	0.1	0.8	0.01	0.01	0.01	78.0

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - Sat Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	160	0.7	0.083	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
6	R2	41	82.1	0.031	9.4	LOS A	0.2	1.9	0.38	0.58	0.38	44.8
Approach		201	17.3	0.083	1.9	NA	0.2	1.9	0.08	0.12	0.08	68.9
North: Construction Road												
7	L2	40	84.2	0.042	15.2	LOS B	0.2	2.2	0.38	0.89	0.38	44.6
9	R2	4	0.0	0.005	10.1	LOS A	0.0	0.1	0.39	0.85	0.39	62.4
Approach		44	76.2	0.042	14.8	LOS B	0.2	2.2	0.38	0.88	0.38	45.9
West: Ruttleys Road												
10	L2	4	25.0	0.002	7.9	LOS A	0.0	0.1	0.14	0.55	0.14	57.8
11	T1	208	4.0	0.110	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		213	4.5	0.110	0.2	LOS A	0.0	0.1	0.00	0.01	0.00	79.4
All Vehicles		458	17.0	0.110	2.4	NA	0.2	2.2	0.07	0.14	0.07	69.7

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - Sat Peak 2030 Low Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.040	0.0	LOS A	0.2	2.2	0.02	0.63	0.02	70.2
3	R2	76	45.8	0.040	7.5	LOS A	0.2	2.2	0.02	0.63	0.02	48.3
Approach		78	44.6	0.040	7.3	NA	0.2	2.2	0.02	0.63	0.02	48.7
East: CVC Site Access												
4	L2	57	59.3	0.042	8.7	LOS A	0.2	2.0	0.01	1.09	0.01	38.0
6	R2	1	0.0	0.042	6.5	LOS A	0.2	2.0	0.01	1.09	0.01	46.1
Approach		58	58.2	0.042	8.7	LOS A	0.2	2.0	0.01	1.09	0.01	38.1
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		138	49.6	0.042	7.8	NA	0.2	2.2	0.02	0.82	0.02	43.8

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - Sat Peak 2030 Low Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	197	17.6	0.113	0.0	LOS A	0.0	0.1	0.01	0.00	0.01	79.9
3	R2	1	0.0	0.113	8.8	LOS A	0.0	0.1	0.01	0.00	0.01	25.4
Approach		198	17.6	0.113	0.1	NA	0.0	0.1	0.01	0.00	0.01	79.0
East: MC Access Road												
4	L2	1	0.0	0.006	4.0	LOS A	0.0	0.1	0.39	0.85	0.39	23.8
6	R2	4	0.0	0.006	5.1	LOS A	0.0	0.1	0.39	0.85	0.39	23.7
Approach		5	0.0	0.006	4.9	LOS A	0.0	0.1	0.39	0.85	0.39	23.7
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	247	17.0	0.141	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		248	16.9	0.141	0.0	NA	0.0	0.0	0.00	0.00	0.00	79.9
All Vehicles		452	17.0	0.141	0.1	NA	0.0	0.1	0.01	0.01	0.01	77.3

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - AM 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	435	5.1	0.232	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	76	44.4	0.073	10.4	LOS A	0.4	3.4	0.59	0.72	0.59	51.0
Approach		511	10.9	0.232	1.6	NA	0.4	3.4	0.09	0.11	0.09	73.7
North: Construction Road												
7	L2	65	53.2	0.096	16.3	LOS B	0.4	4.0	0.59	0.96	0.59	48.5
9	R2	20	26.3	0.068	20.0	LOS B	0.2	1.7	0.75	1.01	0.75	49.2
Approach		85	46.9	0.096	17.2	LOS B	0.4	4.0	0.63	0.97	0.63	48.7
West: Ruttleys Road												
10	L2	34	21.9	0.019	7.9	LOS A	0.1	0.7	0.19	0.55	0.19	58.4
11	T1	534	4.7	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		567	5.8	0.282	0.5	LOS A	0.1	0.7	0.01	0.03	0.01	78.2
All Vehicles		1163	11.0	0.282	2.2	NA	0.4	4.0	0.09	0.13	0.09	73.0

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - AM Peak 2030 Medium Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	4	0.0	0.078	0.0	LOS A	0.5	3.7	0.02	0.62	0.02	70.0
3	R2	163	21.3	0.078	7.0	LOS A	0.5	3.7	0.02	0.62	0.02	48.4
Approach		167	20.8	0.078	6.9	NA	0.5	3.7	0.02	0.62	0.02	48.8
East: CVC Site Access												
4	L2	58	58.2	0.042	8.7	LOS A	0.2	2.0	0.01	1.09	0.01	38.1
6	R2	1	0.0	0.042	6.7	LOS A	0.2	2.0	0.01	1.09	0.01	46.1
Approach		59	57.1	0.042	8.6	LOS A	0.2	2.0	0.01	1.09	0.01	38.2
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		228	30.0	0.078	7.3	NA	0.5	3.7	0.02	0.74	0.02	45.7

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - AM Peak 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	505	11.0	0.284	0.1	LOS A	0.1	0.7	0.02	0.01	0.02	79.6
3	R2	4	0.0	0.284	12.7	LOS A	0.1	0.7	0.02	0.01	0.02	25.4
Approach		509	11.0	0.284	0.2	NA	0.1	0.7	0.02	0.01	0.02	78.3
East: MC Access Road												
4	L2	4	0.0	0.025	5.7	LOS A	0.1	0.6	0.65	0.94	0.65	23.2
6	R2	7	0.0	0.025	11.2	LOS A	0.1	0.6	0.65	0.94	0.65	23.1
Approach		12	0.0	0.025	9.2	LOS A	0.1	0.6	0.65	0.94	0.65	23.2
North: Ruttleys Road												
7	L2	11	30.0	0.007	8.6	LOS A	0.0	0.0	0.00	0.71	0.00	54.7
8	T1	584	9.7	0.319	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		595	10.1	0.319	0.2	NA	0.0	0.0	0.00	0.01	0.00	79.2
All Vehicles		1116	10.4	0.319	0.3	NA	0.1	0.7	0.01	0.02	0.02	76.8

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - PM Peak 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	560	3.4	0.295	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	39	89.2	0.054	12.9	LOS A	0.2	3.1	0.64	0.76	0.64	42.2
Approach		599	9.0	0.295	0.9	NA	0.2	3.1	0.04	0.05	0.04	75.5
North: Construction Road												
7	L2	108	34.0	0.147	15.2	LOS B	0.6	5.5	0.60	0.98	0.60	52.4
9	R2	52	4.1	0.160	18.6	LOS B	0.5	3.5	0.78	1.00	0.78	54.4
Approach		160	24.3	0.160	16.3	LOS B	0.6	5.5	0.66	0.99	0.66	53.0
West: Ruttleys Road												
10	L2	6	16.7	0.003	7.7	LOS A	0.0	0.1	0.14	0.58	0.14	60.0
11	T1	576	3.8	0.303	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		582	4.0	0.303	0.1	LOS A	0.0	0.1	0.00	0.01	0.00	79.6
All Vehicles		1341	8.6	0.303	2.4	NA	0.6	5.5	0.10	0.14	0.10	73.4

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - PM Peak 2030 Medium Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.027	0.0	LOS A	0.1	1.7	0.03	0.62	0.03	71.5
3	R2	43	80.5	0.027	8.2	LOS A	0.1	1.7	0.03	0.62	0.03	48.7
Approach		45	76.7	0.027	7.8	NA	0.1	1.7	0.03	0.62	0.03	49.5
East: CVC Site Access												
4	L2	155	21.8	0.096	7.4	LOS A	0.5	3.9	0.01	1.03	0.01	42.9
6	R2	1	0.0	0.096	6.4	LOS A	0.5	3.9	0.01	1.03	0.01	46.1
Approach		156	21.6	0.096	7.4	LOS A	0.5	3.9	0.01	1.03	0.01	42.9
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		203	33.7	0.096	7.5	NA	0.5	3.9	0.02	0.93	0.02	44.4

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - PM Peak 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	591	8.9	0.322	0.0	LOS A	0.0	0.2	0.01	0.00	0.01	79.9
3	R2	1	0.0	0.322	14.8	LOS B	0.0	0.2	0.01	0.00	0.01	25.4
Approach		592	8.9	0.322	0.1	NA	0.0	0.2	0.01	0.00	0.01	79.6
East: MC Access Road												
4	L2	4	0.0	0.043	6.6	LOS A	0.1	1.0	0.77	0.96	0.77	22.6
6	R2	8	12.5	0.043	17.2	LOS B	0.1	1.0	0.77	0.96	0.77	22.0
Approach		13	8.3	0.043	13.6	LOS A	0.1	1.0	0.77	0.96	0.77	22.2
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	693	8.5	0.375	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.8
Approach		694	8.5	0.375	0.1	NA	0.0	0.0	0.00	0.00	0.00	79.8
All Vehicles		1298	8.7	0.375	0.2	NA	0.1	1.0	0.01	0.01	0.01	77.7

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - Sat Peak 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	161	0.7	0.084	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
6	R2	43	78.0	0.032	9.3	LOS A	0.2	2.0	0.38	0.58	0.38	45.4
Approach		204	17.0	0.084	2.0	NA	0.2	2.0	0.08	0.12	0.08	68.9
North: Construction Road												
7	L2	42	80.0	0.043	15.0	LOS B	0.2	2.2	0.38	0.89	0.38	45.3
9	R2	6	0.0	0.007	10.2	LOS A	0.0	0.2	0.39	0.86	0.39	62.4
Approach		48	69.6	0.043	14.4	LOS A	0.2	2.2	0.38	0.88	0.38	47.0
West: Ruttleys Road												
10	L2	6	16.7	0.003	7.7	LOS A	0.0	0.1	0.14	0.55	0.14	60.0
11	T1	209	4.0	0.110	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		216	4.4	0.110	0.2	LOS A	0.0	0.1	0.00	0.02	0.00	79.2
All Vehicles		468	16.6	0.110	2.5	NA	0.2	2.2	0.08	0.15	0.08	69.7

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - Sat Peak 2030 Medium Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.042	0.0	LOS A	0.2	2.3	0.02	0.63	0.02	70.1
3	R2	80	43.4	0.042	7.5	LOS A	0.2	2.3	0.02	0.63	0.02	48.3
Approach		82	42.3	0.042	7.3	NA	0.2	2.3	0.02	0.63	0.02	48.7
East: CVC Site Access												
4	L2	61	55.2	0.044	8.6	LOS A	0.2	2.1	0.01	1.09	0.01	38.4
6	R2	1	0.0	0.044	6.5	LOS A	0.2	2.1	0.01	1.09	0.01	46.1
Approach		62	54.2	0.044	8.5	LOS A	0.2	2.1	0.01	1.09	0.01	38.6
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		146	46.8	0.044	7.8	NA	0.2	2.3	0.02	0.82	0.02	44.0

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - Sat Peak 2030 Medium Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	199	17.5	0.115	0.0	LOS A	0.0	0.2	0.01	0.01	0.01	79.7
3	R2	2	0.0	0.115	8.8	LOS A	0.0	0.2	0.01	0.01	0.01	25.4
Approach		201	17.3	0.115	0.1	NA	0.0	0.2	0.01	0.01	0.01	78.0
East: MC Access Road												
4	L2	2	0.0	0.008	4.0	LOS A	0.0	0.2	0.39	0.85	0.39	23.8
6	R2	5	0.0	0.008	5.1	LOS A	0.0	0.2	0.39	0.85	0.39	23.7
Approach		7	0.0	0.008	4.8	LOS A	0.0	0.2	0.39	0.85	0.39	23.8
North: Ruttleys Road												
7	L2	2	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	249	16.9	0.142	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		252	16.7	0.142	0.1	NA	0.0	0.0	0.00	0.01	0.00	79.8
All Vehicles		460	16.7	0.142	0.2	NA	0.0	0.2	0.01	0.02	0.01	76.1

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - AM Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	435	5.1	0.232	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	99	34.0	0.089	10.0	LOS A	0.4	3.9	0.58	0.72	0.58	53.5
Approach		534	10.5	0.232	1.9	NA	0.4	3.9	0.11	0.13	0.11	73.2
North: Construction Road												
7	L2	72	48.5	0.102	15.9	LOS B	0.4	4.1	0.59	0.96	0.59	49.4
9	R2	26	20.0	0.087	19.7	LOS B	0.3	2.2	0.76	1.01	0.76	50.5
Approach		98	40.9	0.102	16.9	LOS B	0.4	4.1	0.63	0.97	0.63	49.7
West: Ruttleys Road												
10	L2	54	13.7	0.030	7.8	LOS A	0.1	1.1	0.21	0.56	0.21	60.5
11	T1	537	4.7	0.284	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		591	5.5	0.284	0.7	LOS A	0.1	1.1	0.02	0.05	0.02	77.6
All Vehicles		1222	10.5	0.284	2.5	NA	0.4	4.1	0.11	0.16	0.11	72.4

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - AM Peak 2030 High Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	4	0.0	0.096	0.0	LOS A	0.6	4.5	0.02	0.63	0.02	89.9
3	R2	206	16.8	0.096	6.9	LOS A	0.6	4.5	0.02	0.63	0.02	48.4
Approach		211	16.5	0.096	6.8	NA	0.6	4.5	0.02	0.63	0.02	48.7
East: CVC Site Access												
4	L2	71	47.8	0.049	8.3	LOS A	0.2	2.3	0.01	1.08	0.01	39.3
6	R2	1	0.0	0.049	6.8	LOS A	0.2	2.3	0.01	1.08	0.01	46.1
Approach		72	47.1	0.049	8.3	LOS A	0.2	2.3	0.01	1.08	0.01	39.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	89.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		284	24.1	0.096	7.2	NA	0.6	4.5	0.02	0.74	0.02	46.1

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - AM Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	528	10.6	0.299	0.1	LOS A	0.1	1.1	0.03	0.01	0.03	79.5
3	R2	6	0.0	0.299	12.8	LOS A	0.1	1.1	0.03	0.01	0.03	25.4
Approach		535	10.4	0.299	0.3	NA	0.1	1.1	0.03	0.01	0.03	77.5
East: MC Access Road												
4	L2	5	0.0	0.030	5.7	LOS A	0.1	0.7	0.66	0.94	0.66	23.1
6	R2	8	0.0	0.030	11.6	LOS A	0.1	0.7	0.66	0.94	0.66	23.1
Approach		14	0.0	0.030	9.3	LOS A	0.1	0.7	0.66	0.94	0.66	23.1
North: Ruttleys Road												
7	L2	13	25.0	0.008	8.5	LOS A	0.0	0.0	0.00	0.71	0.00	56.1
8	T1	584	9.7	0.319	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		597	10.1	0.319	0.2	NA	0.0	0.0	0.00	0.01	0.00	79.1
All Vehicles		1145	10.1	0.319	0.4	NA	0.1	1.1	0.02	0.02	0.02	76.2

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - PM Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	562	3.4	0.296	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
6	R2	39	89.2	0.054	12.9	LOS A	0.2	3.1	0.64	0.76	0.64	42.2
Approach		601	8.9	0.296	0.9	NA	0.2	3.1	0.04	0.05	0.04	75.5
North: Construction Road												
7	L2	132	28.0	0.171	14.7	LOS B	0.7	6.3	0.60	0.98	0.60	53.8
9	R2	72	2.9	0.219	19.1	LOS B	0.7	5.1	0.79	1.01	0.85	54.2
Approach		203	19.2	0.219	16.2	LOS B	0.7	6.3	0.67	0.99	0.69	53.9
West: Ruttleys Road												
10	L2	6	16.7	0.003	7.7	LOS A	0.0	0.1	0.14	0.56	0.14	60.0
11	T1	576	3.8	0.303	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		582	4.0	0.303	0.1	LOS A	0.0	0.1	0.00	0.01	0.00	79.8
All Vehicles		1386	8.4	0.303	2.8	NA	0.7	6.3	0.12	0.17	0.12	72.8

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - PM Peak 2030 High Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.027	0.0	LOS A	0.1	1.7	0.03	0.62	0.03	71.5
3	R2	43	80.5	0.027	8.2	LOS A	0.1	1.7	0.03	0.62	0.03	48.7
Approach		45	76.7	0.027	7.8	NA	0.1	1.7	0.03	0.62	0.03	49.5
East: CVC Site Access												
4	L2	198	17.0	0.120	7.3	LOS A	0.6	4.8	0.01	1.02	0.01	43.6
6	R2	1	0.0	0.120	6.4	LOS A	0.6	4.8	0.01	1.02	0.01	46.1
Approach		199	16.9	0.120	7.3	LOS A	0.6	4.8	0.01	1.02	0.01	43.6
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		246	27.8	0.120	7.3	NA	0.6	4.8	0.02	0.94	0.02	44.7

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - PM Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	591	8.9	0.322	0.0	LOS A	0.0	0.3	0.01	0.00	0.01	79.9
3	R2	1	0.0	0.322	15.3	LOS B	0.0	0.3	0.01	0.00	0.01	25.4
Approach		592	8.9	0.322	0.1	NA	0.0	0.3	0.01	0.00	0.01	79.8
East: MC Access Road												
4	L2	6	0.0	0.055	6.8	LOS A	0.2	1.2	0.77	0.97	0.77	22.6
6	R2	11	10.0	0.055	17.4	LOS B	0.2	1.2	0.77	0.97	0.77	22.1
Approach		17	6.3	0.055	13.4	LOS A	0.2	1.2	0.77	0.97	0.77	22.3
North: Ruttleys Road												
7	L2	1	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	715	8.2	0.386	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.8
Approach		716	8.2	0.386	0.1	NA	0.0	0.0	0.00	0.00	0.00	79.8
All Vehicles		1324	8.5	0.386	0.2	NA	0.2	1.2	0.01	0.01	0.01	77.2

MOVEMENT SUMMARY

Site: [Ruttleys Road/Construction Road - Sat Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
East: Ruttleys Road												
5	T1	161	0.7	0.084	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
6	R2	48	69.6	0.035	9.1	LOS A	0.2	2.0	0.38	0.58	0.38	46.9
Approach		209	16.6	0.084	2.1	NA	0.2	2.0	0.09	0.14	0.09	68.7
North: Construction Road												
7	L2	47	71.1	0.046	14.5	LOS A	0.2	2.3	0.37	0.88	0.37	46.8
9	R2	11	0.0	0.012	10.2	LOS A	0.0	0.3	0.40	0.87	0.40	62.3
Approach		58	58.2	0.046	13.7	LOS A	0.2	2.3	0.38	0.88	0.38	49.0
West: Ruttleys Road												
10	L2	11	10.0	0.005	7.6	LOS A	0.0	0.2	0.15	0.56	0.15	61.8
11	T1	209	4.0	0.110	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		220	4.3	0.110	0.4	LOS A	0.0	0.2	0.01	0.03	0.01	78.8
All Vehicles		487	16.0	0.110	2.7	NA	0.2	2.3	0.09	0.17	0.09	69.4

MOVEMENT SUMMARY

Site: [Construction Road/CVC Site Access - Sat Peak 2030 High Growth]

Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Construction Road												
2	T1	2	0.0	0.046	0.0	LOS A	0.3	2.4	0.02	0.63	0.02	70.1
3	R2	89	38.8	0.046	7.4	LOS A	0.3	2.4	0.02	0.63	0.02	48.3
Approach		92	37.9	0.046	7.2	NA	0.3	2.4	0.02	0.63	0.02	48.7
East: CVC Site Access												
4	L2	71	47.8	0.049	8.3	LOS A	0.2	2.3	0.01	1.08	0.01	39.3
6	R2	1	0.0	0.049	6.5	LOS A	0.2	2.3	0.01	1.08	0.01	46.1
Approach		72	47.1	0.049	8.3	LOS A	0.2	2.3	0.01	1.08	0.01	39.4
North: Construction Road												
7	L2	1	0.0	0.001	6.9	LOS A	0.0	0.0	0.00	0.32	0.00	69.7
8	T1	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.32	0.00	74.3
Approach		2	0.0	0.001	3.5	NA	0.0	0.0	0.00	0.32	0.00	71.9
All Vehicles		165	41.4	0.049	7.6	NA	0.3	2.4	0.02	0.62	0.02	44.3

MOVEMENT SUMMARY

Site: [Ruttleys Road/MC Access Road - Sat Peak 2030 High Growth]

New Site
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

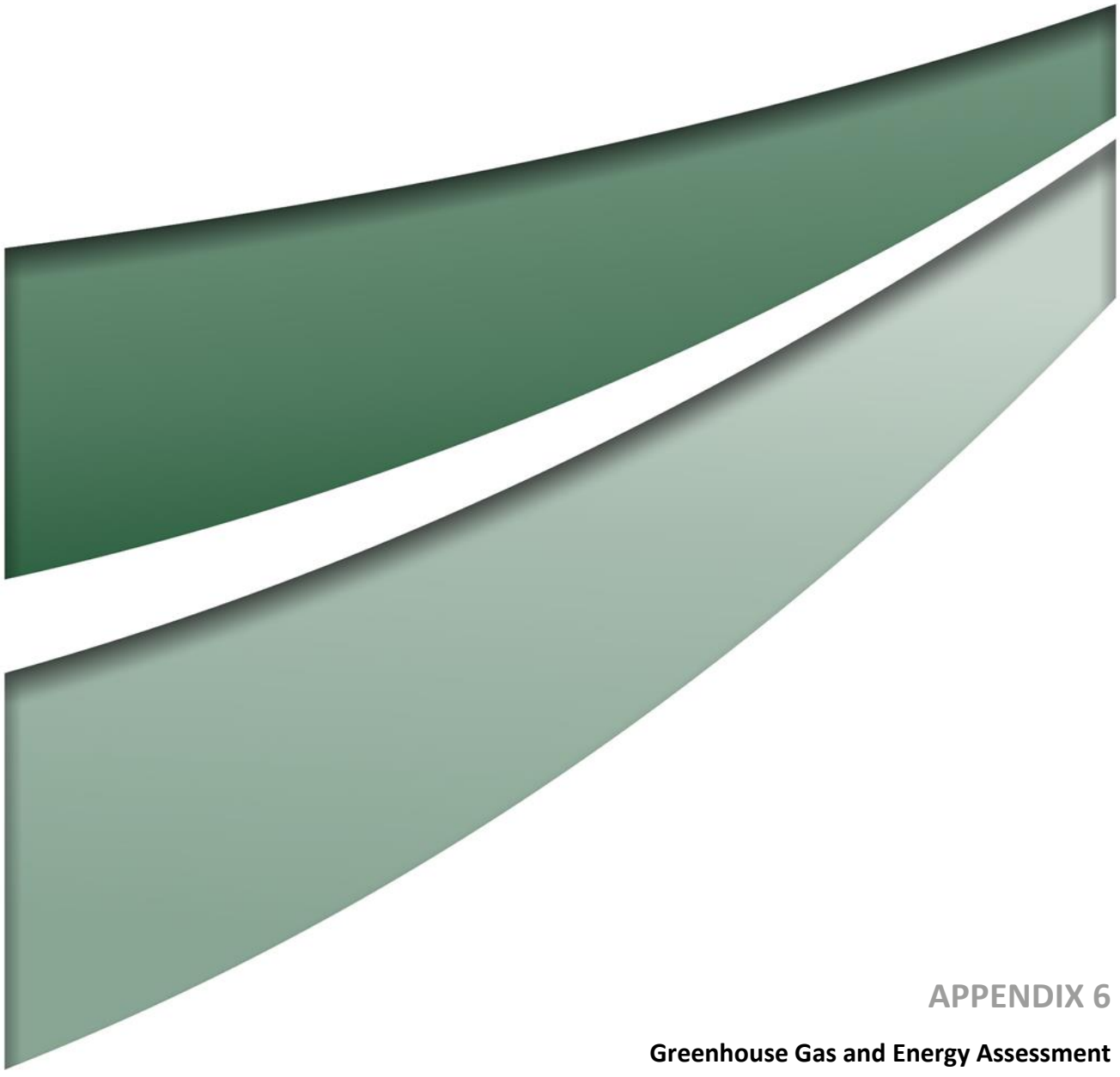
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Ruttleys Road												
2	T1	204	17.0	0.118	0.0	LOS A	0.0	0.2	0.01	0.01	0.01	79.8
3	R2	2	0.0	0.118	8.6	LOS A	0.0	0.2	0.01	0.01	0.01	25.4
Approach		206	16.8	0.118	0.1	NA	0.0	0.2	0.01	0.01	0.01	78.0
East: MC Access Road												
4	L2	2	0.0	0.008	4.6	LOS A	0.0	0.2	0.39	0.85	0.39	23.8
6	R2	5	0.0	0.008	5.2	LOS A	0.0	0.2	0.39	0.85	0.39	23.7
Approach		7	0.0	0.008	4.8	LOS A	0.0	0.2	0.39	0.85	0.39	23.7
North: Ruttleys Road												
7	L2	2	0.0	0.001	8.0	LOS A	0.0	0.0	0.00	0.71	0.00	63.8
8	T1	255	16.5	0.145	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.8
Approach		257	16.4	0.145	0.1	NA	0.0	0.0	0.00	0.01	0.00	79.8
All Vehicles		471	16.3	0.145	0.2	NA	0.0	0.2	0.01	0.02	0.01	76.2

12533734-3042-13/https://projectsportal.ghd.com/sites/pp01_01/chainvalleycollieryt/ProjectDocs/12533734 REP Traffic Assessment Rev 1.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	M Lucas	S Clarke	On line	J Akstein	On line	24/07/20
1	M Lucas	J Akstein	On line	J Akstein	On line	06/08/20
2	M Lucas	J Akstein	On line	J Akstein	On line	18/08/20

www.ghd.com



APPENDIX 6

Greenhouse Gas and Energy Assessment

umwelt
Environmental & Social Consultants

Delta coal

GREENHOUSE GAS AND ENERGY ASSESSMENT

Chain Valley Colliery Modification 4

DRAFT

October 2020

GREENHOUSE GAS AND ENERGY ASSESSMENT

Chain Valley Colliery Modification 4

DRAFT

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Delta Coal

Project Director:	Gabrielle Allan
Project Manager:	Kirsty Davies
Technical Director:	Malcolm Sedgwick
Report No.	20052/R01
Date:	October 2020

Newcastle

75 York Street
Teralba NSW 2284

T| 1300 793 267
E| info@umwelt.com.au

www.umwelt.com.au

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Disclaimer

This document has been prepared for the sole use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by Umwelt (Australia) Pty Ltd (Umwelt). No other party should rely on this document without the prior written consent of Umwelt.

Umwelt undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. Umwelt assumes no liability to a third party for any inaccuracies in or omissions to that information. Where this document indicates that information has been provided by third parties, Umwelt has made no independent verification of this information except as expressly stated.

Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
V1	David Holmes	6 October 2020	Malcolm Sedgwick	6 October 2020

Executive Summary

Chain Valley Colliery (CVC) is an underground coal mine located on the southern shore of Lake Macquarie, which is operated by Delta Coal. Delta Coal seeks to extend the CVC consent boundary to incorporate a recently purchased lease holding from Myuna Colliery (Northern Mining Area), and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations (the Proposed Modification). The coal to be mined from the Northern Mining Area is currently approved to be mined under the development consent for the Myuna Coal Mine. There are no other changes proposed, and the Proposed Modification will allow for a reliable and cost-effective supply of coal for the Vales Point Power Station (VPPS).

A Statement of Environmental Effects (SEE) has been prepared to assess the environmental and social impacts of the Proposed Modification. This report has been prepared to support the preparation of the SEE, and includes greenhouse gas emission projections, an assessment of climate change impacts and an evaluation of greenhouse gas mitigation options. The scope of the greenhouse gas and energy assessment (GHGEA) includes:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification
- estimating energy use directly associated with the Proposed Modification
- qualitatively assessing how the Proposed Modification's greenhouse gas emissions may impact the environment
- estimating the impact of the Proposed Modification's emissions on State, national and international greenhouse gas emission targets/policies
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions and ensure energy use efficiency

The GHGEA found that the Proposed Modification can be associated with the following greenhouse gas emissions.

Greenhouse Gas Emissions		
	(t CO_2-e)	(%) of total emissions
Scope 1	1,235,000	16.2
Scope 2	37,000	0.5
Scope 3	6,344,000	83.3
TOTAL	**7,615,000**	**100**

The Proposed Modification is forecast to produce approximately 1,235,000 t CO_2-e Scope 1 emissions. The majority of Scope 1 emissions are generated by fugitive emissions and diesel combustion. Delta Coal has a direct influence over Scope 1 emissions generated from diesel use, and these emissions will be subject to management and mitigation plans.

The Proposed Modification has a relatively high Scope 1 greenhouse gas emissions intensity, however, most of the Scope 1 emissions are legacy fugitive emissions. The Proposed Modification will utilise the ventilation systems across CVC and Mannering Colliery, which will emit legacy greenhouse gas emissions from old workings unrelated to the Northern Area. Approximately 82% of the fugitive emissions forecast for the Proposed Modification are legacy fugitive emissions which are already approved under the respective Consents for CVC and Mannering Colliery.

The Proposed Modification is forecast to consume approximately 163,000 GJ of electricity, which will generate approximately 37,000 t CO_2-e of Scope 2 emissions. Delta Coal can influence reductions in Scope 2 emissions by driving electricity reduction and efficiency initiatives.

The Proposed Modification's forecast energy use intensity is considered to fall below the normal range when compared with other underground coal mining operations across Australia. The Proposed Modification is expected to be very energy efficient, as the high quality ROM coal only requires a simple processing stage, and produces very low rates of waste material.

Approximately 6,344,000 t CO_2-e of Scope 3 emissions are estimated to be associated with the Proposed Modification. The majority of Scope 3 emissions associated with the Proposed Modification will be generated by third parties who transport and consume coal products. Delta Coal has no operational control over Scope 3 emissions, as these emissions are generated by the activities of other organisations.

Delta Coal will seek to mitigate the Proposed Modification's greenhouse gas emissions through ongoing energy efficiency initiatives and optimising productivity.

The Proposed Modification in isolation is unlikely to limit Australia achieving its national mitigation targets, as the Proposed Modification effectively moves greenhouse gas emissions from the existing Myuna Consent, to the existing CVC Consent.

Table of Contents

Executive Summary i

1.0 Introduction 1

2.0 Assessment framework 2

2.1 Objectives 2

2.2 Scope 2

2.3 Definitions 3

2.4 Impact assessment methodology 3

2.5 Data sources 4

2.6 Assessment boundary 4

2.7 Data exclusions 4

3.0 Impact assessment results 7

3.1 Proposed Modification 7

3.1.1 Greenhouse gas emissions 8

3.1.2 Energy use 8

3.2 Vales Point Power Station 9

4.0 Impact assessment summary 11

4.1 Impact on the environment 11

4.2 Impact on climate change 11

4.3 Impact on policy objectives 12

4.3.1 Australian targets 13

4.3.2 NSW Policy 14

5.0 Greenhouse gas mitigation measures 16

5.1 Potential management measures 16

5.2 The Safeguard Mechanism 16

6.0 Scope 3 emissions 18

6.1 Uncertainty 18

7.0 Conclusion 19

8.0 References 20

Figures

Figure 2.1 Greenhouse Gas Assessment Boundary 6

Tables

Table 1.1 Key features of the Proposed Modification that will impact greenhouse gas emissions 1
Table 2.1 Glossary of terms 3
Table 2.2 Source of activity data used for the assessment 4
Table 2.3 Data exclusions 5
Table 3.1 Summary of the Proposed Modification's greenhouse gas emissions 8
Table 3.2 Scenario assumptions 9
Table 3.3 The VPPS fuel transport related greenhouse gas emissions 9
Table 4.1 A summary of Australia's NDC 14
Table 4.2 A summary of the NSW climate change policy framework 14

Appendices

Appendix A Operation Calculations

1.0 Introduction

Chain Valley Colliery (CVC) is an underground coal mine located on the southern shore of Lake Macquarie, approximately 60 kilometres (km) south of Newcastle, NSW. Great Southern Energy Pty Ltd (trading as Delta Coal), owns and operates CVC. Mining has been undertaken at CVC since 1962 using a combination of bord and pillar and miniwall mining methods.

In early 2019, Delta Coal acquired Lake Coal's CVC assets which included the adjacent Mannering Colliery Pit Top, as well as coal lease areas to the north of the CVC Consent boundary that were previously held by Centennial Myuna Pty Ltd (CMPL). These coal leases form part of the Myuna Colliery, which is subject to project approval (PA) 10_0080 (Myuna Consent).

Delta Coal is proposing a modification to the CVC Consent to extend CVC's mining operations in the Fassifern Seam into an area of the recently purchased Myuna lease holding. The proposed extension area, referred to as the Northern Mining Area, is located immediately to the north of the existing CVC consent boundary and forms part of the Myuna Colliery.

The proposed CVC Modification 4 (the Proposed Modification) seeks to extend the CVC consent boundary to incorporate the Northern Mining Area and permit the transfer of coal mined from the Northern Mining Area to the surface via CVC's operations.

The Proposed Modification effectively moves the greenhouse gas emissions associated with mining 2.6 million tonnes of ROM coal from the Myuna Colliery consent, to the CVC consent.

Table 1.1 includes the key features of the Proposed Modification that will impact greenhouse gas emissions.

Table 1.1 Key features of the Proposed Modification that will impact greenhouse gas emissions

Key Feature	Proposed Operations
Mining methods	• Underground, bord and pillar
Mine life	• 1-2 years
Total resource recovered	• 2.6 M tonne
Maximum annual production	• 2.1 M tonne

2.0 Assessment framework

2.1 Objectives

CVC operates under State significant development (SSD) consent SSD 5465 (CVC Consent), originally granted in 2013, which has been modified twice with a third application currently under assessment by the Department of Planning Industry and Environment (DPIE).

Approval for the Proposed Modification will be sought under section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). A Statement of Environmental Effects (SEE) has been prepared to assess the environmental and social impacts of the Proposed Modification to the CVC Consent.

This Greenhouse Gas and Energy Assessment (GHGEA) has been prepared to support the preparation of the SEE, and includes greenhouse gas emission projections, an assessment of climate change impacts and an evaluation of greenhouse gas mitigation options.

This GHGEA includes an assessment of all relevant downstream emissions, to ensure the Consent Authority can meet the requirements of the *Mining SEPP Part 3 clause 14 (2).*

2.2 Scope

The scope of the GHGEA includes:

- estimating direct and indirect (Scopes 1, 2 and 3) greenhouse gas emissions associated with the Proposed Modification
- estimating energy use directly associated with the Proposed Modification
- qualitatively assessing how the Proposed Modification's greenhouse gas emissions may impact the environment
- estimating the impact of the Proposed Modification's emissions on State, national and international greenhouse gas emission targets/policies
- assessing reasonable and feasible measures to minimise the greenhouse gas emissions of the Proposed Modification and ensure energy use efficiency.

2.3 Definitions

Table 2.1 contains concepts and a glossary of terms relevant to this GHGEA.

Table 2.1 Glossary of terms[1]

Concept	Definition
Greenhouse gases	The greenhouse gases covered by the Kyoto Protocol and referred to in this GHGEA include: • Carbon dioxide • Methane • Nitrous oxide • Hydrofluorocarbons • Perfluorocarbons • Sulphur hexafluoride.
Scope 1 emissions	Direct emissions that occur from sources that are owned or controlled by the Proposed Modification (e.g. fuel use, fugitive emissions). Scope 1 emissions are emissions over which the Proposed Modification has a high level of control.
Scope 2 emissions	Emissions from the generation of purchased electricity consumed by the Proposed Modification.
Scope 3 emissions	Indirect emissions that are a consequence of the activities of the Proposed Modification but occur at sources owned or controlled by other entities (e.g. outsourced services). Scope 3 emissions can include emissions generated upstream of the Proposed Modification by providers of energy, materials and transport. Scope 3 emissions can also include emissions generated downstream of the Proposed Modification by transport providers and product use.

2.4 Impact assessment methodology

The GHGEA framework is based on the methodologies and emission factors contained in the *National Greenhouse Accounts (NGA) Factors* 2019 (DoEE 2019) (the NGA Factors). The assessment framework also incorporates the principles of *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (WRI/WBCSD 2004) (the GHG Protocol).

The GHG Protocol provides an internationally accepted approach to greenhouse gas accounting. The GHG Protocol provides guidance on setting reporting boundaries, defining emission sources and dealing with issues such as data quality and materiality.

Scope 1 and 2 emissions were calculated based on the methodologies and emission factors contained in the NGA Factors 2019 (DEE 2019). Fugitive emissions were calculated using a site specific emission factor generated from historical emissions.

Scope 3 emissions associated with product transport were calculated based on emission factors contained in the *National GHG Inventory: Analysis of Recent Trends and GHG Indicators* (AGO 2007). Other Scope 3 emissions were calculated using methodologies and emission factors contained in the NGA Factors.

All methodologies and calculations have been made assuming that all operations will continue as described in **Section 1.0**.

[1] The GHG Protocol 2004

2.5 Data sources

The calculations in this report are based on activity data developed by Delta Coal during the mine planning process.

Table 2.2 contains the source of activity data.

Table 2.2 Source of activity data used for the assessment

Activity data	Source
On-site fuel consumption	Historical diesel consumption
Electricity consumption	Historical electricity consumption
Fugitive emissions	Historical fugitive emissions
Product consumption	Forecast mine production
Product transport	Forecast product transport distances

A detailed description of activity data and calculations are provided in **Appendix A**.

2.6 Assessment boundary

The GHGEA boundary was developed to include all significant Scope 1, 2 and 3 emissions. **Figure 2.1** demonstrates how the assessment boundary interacts with the potential emission sources under Delta Coal's operational control and other emission sources associated with the Proposed Modification.

2.7 Data exclusions

The GHG Protocol requires inventory data and methodologies to be relevant, consistent, complete, transparent and accurate. The relevance principle states that the greenhouse gas inventory should appropriately reflect greenhouse gas emissions and serve the decision-making needs of users – both internal and external [to the Proposed Modification] (WRI/WBCSD 2004).

An underground coal mine has a number of potential emission sources, however, the dominant emission sources, often targeted by mitigation measures and stakeholders can be summarised as:

- diesel use
- fugitive emissions
- electricity use
- product transport
- product use
- materials use.

The completeness principle states that all relevant emission sources within the chosen inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled (WRI/WBCSD 2004).

The emission sources listed in **Table 2.3** have been excluded from the GHGEA as modelling activity data for these sources is unlikely to generate sufficient emissions to materially change impacts or influence the decision-making outcomes of stakeholders.

Table 2.3 Data exclusions

Emission source	Scope	Description
Combustion of fuel for energy	Scope 1	Small quantities of fuels such as petrol and LPG.
Industrial processes	Scope 1	Sulphur hexafluoride (high voltage switch gear). Hydrofluorcarbon (commercial and industrial refrigeration).
Waste water handling (industrial)	Scope 1	Methane emissions from waste water management.
Solid waste	Scope 3	Solid waste to landfill.
Business travel	Scope 3	Employees travelling for business purposes.
Employee travel	Scope 3	Employees travelling between their place of residence and the CVC site.

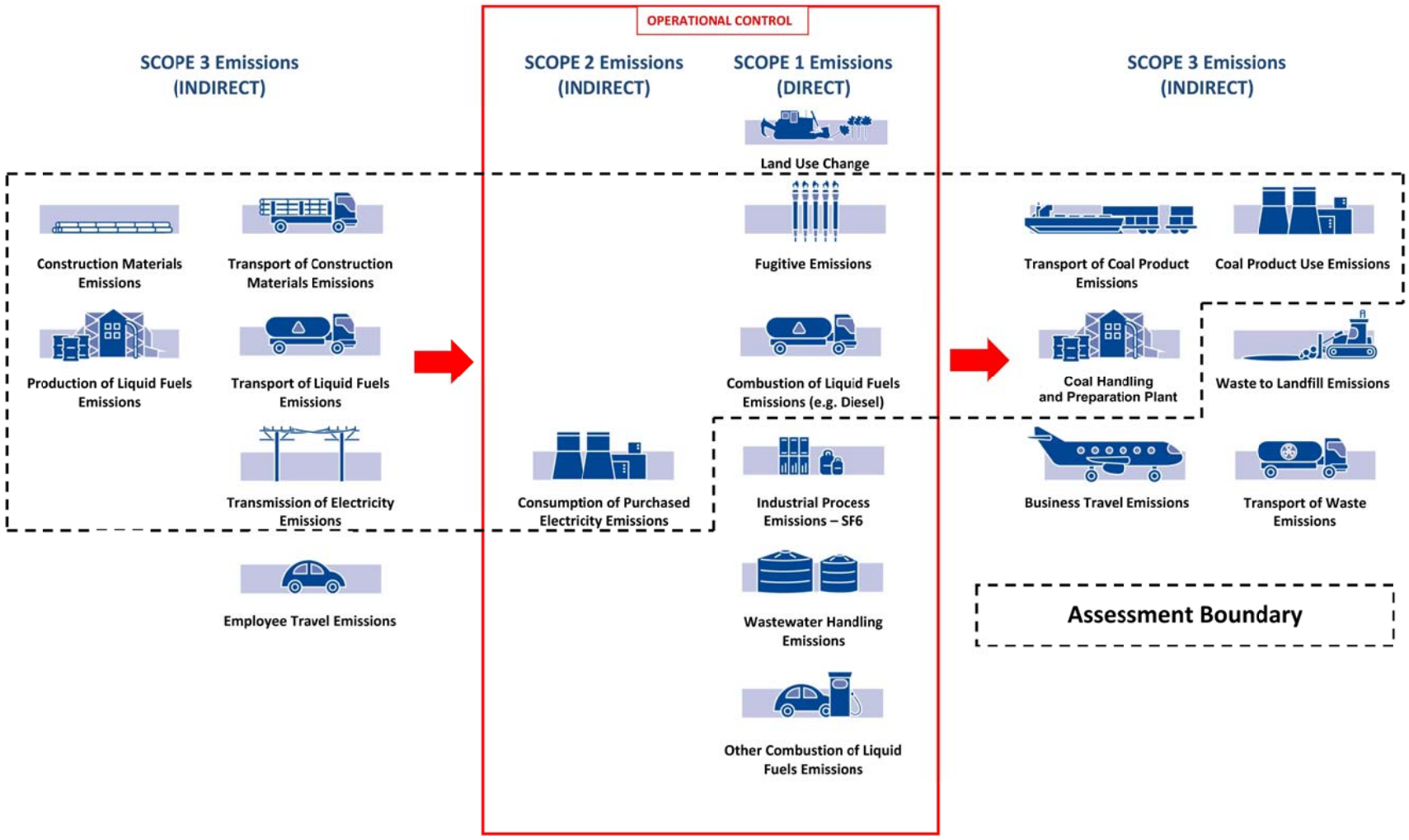


FIGURE 2.1

Greenhouse Gas Assessment Boundary

3.0 Impact assessment results

Greenhouse gas and energy use estimates have been calculated for the Proposed Modification. The greenhouse gas forecasts referenced throughout this document, only relate to the expected impact of the Proposed Modification (i.e. recovery of an additional 2.6 Mt of ROM coal). Forecasts in this document do not include forecast emissions from the currently approved operations.

3.1 Proposed Modification

The following information was used to estimate the GHG emissions from the Proposed Modification:

- approximately 2,600,000 tonnes of ROM coal will be recovered over the life of the Proposed Modification
- existing mining methods will move from miniwall to bord and pillar
- there will be no change to existing coal processing methods
- diesel will average 0.37 litres/ROM coal tonne
- electricity use will average 17.36 kWh/ROM coal tonne
- fugitive emissions will average approximately 474 Kg CO_2-e/ROM coal tonne
- the virgin gas content for the Fassifern coal seam in the Northern Mining area is 5.3m^3/t, with a gas composition of 97% methane and 3% carbon dioxide
- post mining emissions will not be generated, as CVC is classified as a non-gassy mine (i.e. Methane measured in ventilation emissions is below 0.1 %)
- product coal quality will align with the NGA Factors definition of Bituminous Coal (27 GJ/tonne), even though actual product coal quality will average approximately 23 GJ/tonne
- 100% of all product coal will be transferred to VPPS via conveyor
- the VPPS conveyor is owned and operated by Delta Electricity
- the Proposed Modification will not change the currently approved road transport conditions

3.1.1 Greenhouse gas emissions

The greenhouse gas emissions associated with the Proposed Modification are summarised in **Table 3.1** (refer to **Appendix A** for further detail).

Table 3.1 Summary of the Proposed Modification's greenhouse gas emissions

Stage	Scope	Source	Source Totals (t CO_2-e)	Scope Totals (t CO_2-e)
Operation	Scope 1 (Direct)	Diesel use	2,607	1,235,007
		Fugitive emissions	1,232,400	
	Scope 2 (Indirect)	Electricity	36,560	36,560
	Scope 3 (Indirect)	Product use	6,334,146	6,343,022
		Associated with energy extraction and distribution	4,196	
		Product transport	4,680	
Total greenhouse gas emissions associated with the Proposed Modification				**7,614,589**

The Proposed Modification is forecast to generate approximately 1,235,000 t CO_2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. At maximum allowable production, the Proposed Modification has the potential to generate approximately 998,000 t CO_2-e of Scope 1 emissions per annum.

The Proposed Modification has a relatively high Scope 1 greenhouse gas emissions intensity, however, most of the Scope 1 emissions are legacy fugitive emissions. The Proposed Modification will utilise the ventilation systems across CVC and Mannering Colliery, which will emit legacy greenhouse gas emissions from old workings unrelated to the Northern Area. **Table 3.1** demonstrates that the Proposed Modification has the potential to generate approximately 1,233,000 t CO_2-e of fugitive emissions, however, the virgin gas content of the target resource in the Northern Area, only has the potential to generate approximately 228,000 t CO_2-e fugitive emissions. Approximately 82% of the fugitive emissions forecast in **Table 3.1** are legacy fugitive emissions which are already approved under the respective Consents for CVC and Mannering Colliery.

The Proposed Modification is forecast to be associated with approximately 37,000 t CO_2-e of Scope 2 emissions from consuming electricity.

The Proposed Modification is forecast to be associated with approximately 6,344,000 t CO_2-e of Scope 3 emissions. Scope 3 emissions will be generated by third parties who transport and consume coal products.

Scope 2 and 3 emissions have been included in the GHGEA to demonstrate the potential upstream and downstream impacts of the Proposed Modification. All Scope 2 and 3 emissions identified in the GHGEA are attributable to, and may be reported by, other sectors.

3.1.2 Energy use

The Proposed Modification is forecast to require approximately 200,000 GJ of energy from diesel and grid electricity. Energy use by underground coal mines in Australia averages between 140 - 490 Mega joules (MJ) / product tonne (Energetics 2009). The forecast energy use intensity associated with the additional coal extracted by the Proposed Modification is approximately 77 MJ/product tonne.

The Proposed Modification is expected to be very energy efficient, as the high quality ROM coal only requires a simple processing stage, and produces very low rates of waste material. The Proposed Modification will operate without washing, separation and dewatering processes, which reduces the energy demands of the preparation plant, and the energy demands associated with emplacing tailings and reject materials.

3.2 Vales Point Power Station

Delta Electricity and Delta Coal are seeking to generate economic efficiencies and environmental benefits by increasing the proportion of locally supplied fuels to the Vales Point Power Station (VPPS). The combined assets and approvals of Delta Electricity and Delta Coal allow CVC to supply crushed coal to the VPPS via a network of conveyors. The Proposed Modification should allow CVC to increase its current annual supply to the VPPS, and reduce the VPPS's demand for coal sourced from the Hunter and Western Coalfields. The Proposed Modification should reduce VPPS's transport related greenhouse gas emissions associated with sourcing fuel. To try and quantify the benefits of sourcing additional fuel from CVC, **Table 3.2** compares the greenhouse gas emissions associated with the VPPS sourcing fuel under two scenarios. The first scenario represents the base case, which involves the VPPS sourcing fuel from Newcastle Coalfields, Hunter Coal Fields, Western Coalfields and coal fines from Newcastle Port (Base Case scenario). The second scenario represents a potential fuel sourcing mix, which includes the Proposed Modification (Proposed Modification scenario). **Table 3.2** includes the specific assumptions for both scenarios.

Table 3.2 Scenario assumptions

Fuel Source	Base Case Scenario (tonne)	Proposed Modification Scenario (tonne)
CVC – delivered via conveyor	1,000,000	2,100,000
Mandalong – delivered via conveyor	1,100,000	865,000
Hunter Coalfield mine via rail 150 Km	800,000	0
Hunter Coalfield mine via rail 170 Km	50,000	0
Western Coalfield mine via rail 270 Km	15,000	0
Port Fines via truck 60 Km	35,000	35,000
Total fuel use	3,000,000	3,000,000

Under both scenarios the VPPS purchases 3 Mpta of coal based fuels in NSW, which includes 35,000 tpa of coal fines recycled from the Newcastle Port. The Proposed Modification scenario effectively moves fuel supply away from rail, and onto the existing conveyor running between CVC and the VPPS.

Table 3.3 The VPPS fuel transport related greenhouse gas emissions

Emission Source	Base Case Scenario (t CO_2-e)	Proposed Modification Scenario (t CO_2-e)	Net change in emissions (t CO_2-e)
Electricity use	3,402	4,803	1,401
Transport fuel use	2,885	734	-2,151
Total	6,287	5,537	-750

Table 3.3 demonstrates that the Proposed Modification could reduce the VPPS's greenhouse gas emissions associated with transporting fuel. Under the Proposed Modification scenario, the VPPS consumes more electricity to transfer greater fuel tonnages via conveyor, however, the increase in electricity use emissions are more than offset by a reduction in rail fuel use emissions.

Delta Coal also believes that increasing the proportion of fuel sourced from the Newcastle Coalfields may reduce sulphur emissions from the VPPS, and also improve the VPPS efficiency, due to the relatively low ash content of the Newcastle Coalfields.

4.0 Impact assessment summary

The greenhouse gas emissions generated by the Proposed Modification have the potential to impact the physical environment and the emission reduction objectives of State, national and international governing bodies. The following assessment makes the distinction between environmental impacts and impacts on policy objectives.

4.1 Impact on the environment

The Proposed Modification's greenhouse gas emissions are highly mobile and are generated up and down the supply chain. The accumulation of greenhouse gas or carbon in 'carbon sinks' is the primary impact of emissions. Historically, anthropogenic greenhouse gas emissions have accumulated in three major carbon sinks - the ocean (30%), terrestrial plants (30%) and the atmosphere (40%) (BOM and CSIRO 2014).

The accumulation of greenhouse gas in the atmosphere is an important driver of global warming, sea level rise and climate change (IPCC 2013). Sea level rise and climate change may have many ramifications for the natural and built environment. The accumulation of greenhouse gas in the ocean is also an important driver of ocean acidification (IPCC 2013).

The Proposed Modification's direct emissions (Scope 1) could generate approximately 998,000 t CO_2-e per annum.

To put the Proposed Modification's emissions into perspective, if Paris Agreement signatories achieve their intended Nationally Determined Contributions (INDCs), global greenhouse gas emissions are forecast to reach 53,000,000,000 t CO_2-e per annum by 2025 (UNEP 2016). During operation, the Proposed Modification could contribute up to approximately 0.0019 % to global emissions per annum (based on its projected Scope 1 emissions at maximum allowable production). The relative environmental impact of the Proposed Modification is likely to be relative to its proportion of global greenhouse gas emissions.

The Scope 2 and 3 emissions associated with the Proposed Modification should not be compared against global emissions, as global emissions only represent Scope 1 emissions (i.e. the sum of all individual emission sources).

4.2 Impact on climate change

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and persists for an extended period, typically decades or longer (IPCC 2007). Climate change is caused by changes in the energy balance of the climate system. The energy balance of the climate system is driven by atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation (IPCC 2007).

Climate change models forecast many different climate change impacts, which are influenced by future emission scenarios. Climate change forecasts also vary significantly from region to region. A qualitative assessment of climate change requires a regional reference and future emission trajectory assumptions.

CSIRO has modelled Australian climate change projections for 2030 and 2090, using IPCC scenarios RCP2.6, RCP4.5 and RCP8. The Representative Concentration Pathway (RCP) scenarios represent a range of future emission pathways, which include a relatively low emissions future (RCP2.6) though to a relatively high emissions future (RCP8). CSIRO modelling demonstrates that (CSIRO 2015):

- By 2030, annual average temperature is forecast to increase under all three RCPs. The magnitude of warming by 2090 is strongly dependent on the RCP scenario.
- By 2030, the number of days over 35˚C is forecast to increase under all three RCPs. The increase in number of days by 2090 is strongly dependent on the RCP scenario.
- By 2030, rainfall in eastern Australia is likely to remain unchanged under all three RCPs. By 2090, the higher emission RCPs may drive average rainfall lower across eastern Australia.
- By 2030, there is a small tendency for annual maximum daily rainfall in eastern Australia to increase. By 2090, the higher emission RCPs will drive a marked increase in annual maximum daily rainfall in eastern Australia.
- By 2030, mean wind speed and extreme wind speed in eastern Australia is likely to remain unchanged under all three RCPs. There is evidence to suggest extreme wind speeds in Spring may decrease in eastern Australia.
- By 2030, annual evaporation is forecast to increase under all three RCPs. The magnitude of evaporation by 2090 is strongly dependent on the RCP scenario.

The Proposed Modification, in isolation, is unlikely to influence global emission pathways. Future emission pathways will largely be influenced by global scale issues such as; technology, population growth and greenhouse gas mitigation policy.

The extent to which global emissions and atmospheric concentrations of greenhouse gases have a demonstrable impact on climate change will be largely driven by the global response to reducing total global emissions that includes all major emission sources and sinks.

4.3 Impact on policy objectives

The United Nations Framework Convention on Climate Change (UNFCCC) is the leading international forum for setting climate change targets and objectives. The UNFCCC has been responsible for developing internationally accepted greenhouse gas emission reporting methodologies, and has led the development of:

- the Kyoto Protocol
- the Paris Agreement
- specific directives and guidance to improve the implementation of the UNFCCC.

The Kyoto Protocol became international policy in 2005, and it committed the European Union (EU) plus 37 other member states to manage greenhouse gas emissions between 2008 and 2012. A second round of the Kyoto Protocol (the Doha Amendment) committed the EU plus 191 other member states to manage greenhouse gas emissions between 2013 and 2020. Australia was a signatory to both rounds of the Kyoto Protocol and Australia will meet its obligations under the Kyoto Protocol in 2020 (DoEE 2018).

In 2015 the UNFCCC successfully negotiated an international climate change agreement between 195 countries (the Paris Agreement). The Paris Agreement aims to:

- hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels
- increase the ability [of nations] to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production
- make finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

The Paris Agreement seeks to meet its objectives by developing programs and mechanisms that:

- require participating Parties to prepare and communicate greenhouse gas mitigation contributions. Parties are expected to set mitigation targets for 2020, and then develop new targets every five years. Each successive target is expected to represent a larger mitigation effort than the previous target
- promote climate change resilience and adaptation
- provide mitigation and adaptation funding to developing countries
- foster mitigation and adaptation technology transfer between Parties
- require participating Parties to report progress towards their mitigation contributions on an annual basis.

Australia signed the Paris Agreement on 22 April 2016, and Australia's obligations under the Paris Agreement will drive national greenhouse gas policy between 2020 and 2030. Under the Paris Agreement, Australia is obliged to:

- prepare, communicate and maintain a Nationally Determined Contribution (NDC). An NDC outlines the size and type of mitigation contribution each member state will make to the international effort
- pursue domestic mitigation measures, with the aim of achieving the objectives of its NDC
- communicate an NDC every 5 years
- quantify its NDC in accordance with IPCC methodologies, which promote transparency and avoid double counting.

4.3.1 Australian targets

Australia's commitment to the Paris Agreement includes reducing greenhouse gas emissions by 26 - 28 %, on 2005 levels, by 2030 (Commonwealth of Australia, 2015). To meet the requirements of the Paris Agreement, Australia will also have to develop interim targets for 2020 and 2025. Australia's NDC is summarised in **Table 4.1**.

Table 4.1 A summary of Australia's NDC

Emissions reduction target	Economy-wide target to reduce greenhouse gas emissions by 26 to 28 % below 2005 levels by 2030
Coverage	Economy-wide
Scope	Energy Industrial processes and product use Agriculture Land-use, land-use change and forestry Waste
Gases	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3

Australia's NDC prescribes an unconditional economy-wide target to reduce greenhouse gas emissions, and states that future policies will target emissions generated from:

- energy use
- industrial processes
- agriculture, land-use, land-use change and forestry
- waste.

Australia's NDC does not contain sector or state based targets, nor does it make any reference to the mining sector.

The Proposed Modification in isolation is unlikely to limit Australia achieving its national mitigation targets, as the Proposed Modification effectively moves greenhouse gas emissions from the existing Myuna Consent, to the existing CVC Consent.

4.3.2 NSW Policy

The NSW Government has developed its NSW Climate Change Policy Framework, which aims to deliver net-zero emissions by 2050, and a State that is more resilient and responsive to climate change (OEH 2016).

Under the NSW Climate Change Policy Framework, NSW has committed to both follow the Paris Agreement and to work to complement national action. The key policy directions under the NSW Climate Change Policy Framework are summarised in the **Table 4.2**.

Table 4.2 A summary of the NSW climate change policy framework

Policy Direction	Rationale/Goals
Creating an investment environment that manages the emissions reduction transition	Energy will be transformed and investment/job opportunities will be created in emerging industries of advanced energy, transport and carbon farming and environmental services
Boost energy productivity and put downward pressure on energy bills	Boosting energy and resource productivity will help reduce prices and the cost of transitions to net-zero emissions
Grow new industries and capitalise on competitive advantages	Capitalising on the competitive advantage and growth of industries in professional services, advanced energy technology, property management and financial services

Policy Direction	Rationale/Goals
Reduce risks and damage to public and private assets arising from climate change	Embed climate change considerations into asset and risk management as well as support the private sector by providing information and supportive regulatory frameworks for adaptation
Reduce climate change impacts on health and wellbeing	Recognise the increased demand for health and emergency services due to climate change and identify ways to better support more vulnerable communities to health impacts
Manage impacts on natural resources and communities	Coordinate efforts to increase resilience of primary industries and rural communities as climate change impacts water availability, water quality, habitats, weeds and air pollution

The policy framework is being delivered through:

- the Climate Change Fund
- developing an economic appraisal methodology to value greenhouse gas emissions mitigation
- embedding climate change mitigation and adaptation across government operations
- building on NSW's expansion of renewable energy
- developing action plans and strategies.

The Proposed Modification is unlikely to affect the objectives of the NSW Climate Change Policy Framework.

5.0 Greenhouse gas mitigation measures

The following sections discuss potential measures and incentives to mitigate greenhouse gas emissions.

5.1 Potential management measures

Delta Coal has incorporated a range of measures into the Proposed Modification's design, with the aim of minimising potential greenhouse gas emissions and improving energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The Proposed Modification's design inherently minimises greenhouse gas emissions from the mining operations.

The GHGEA estimates that the Proposed Modification's Scope 1 and 2 greenhouse gas emissions will be generated from the following sources:

- fugitive emissions (97%)
- diesel consumption (0.2%)
- electricity consumption (2.8%)

Fugitive emissions arise during the coal production/extraction process whereby methane and carbon dioxide gas trapped within the coal (coal mine waste gas) is released to the atmosphere. In underground coal mines, mine waste gas can be captured from active coal seams and goaf environments (the fractured rock zone left once the coal has been extracted), to improve safety and manage greenhouse gas emissions. Captured mine waste gas can be destroyed by flaring to reduce its greenhouse gas potential or combusted as a fuel source.

Mining planned for the Northern Area intends to use a Bord and Pillar method instead of a Miniwall and First Workings method. The Bord and Pillar method should reduce the historical fugitive emissions intensity, as the Bord and Pillar method does not generate goaf waste, which is a source of fugitive greenhouse gas emissions.

The Proposed Modification will progressively seal goaf areas to reduce methane emissions released by the ventilation system. Where safe to do so, the ventilation system will also be managed to minimise the release of fugitive emissions. The Proposed Modification does not have the pre or post-mining gas drainage infrastructure to capture and manage coal mine waste gas. CVC will not flare coal mine waste gas or use coal mine waste gas to generate electricity.

Energy efficiency measures remain the only reasonable and feasible mitigation options for the CVC. Delta Coal will continue to implement their Greenhouse Gas Management Plan to ensure all reasonable and feasible measures are employed to minimise the release of greenhouse gas emissions.

5.2 The Safeguard Mechanism

The Proposed Modification will be subject to the Safeguard Mechanism emission caps which are currently applied to Chain Valley Colliery and Mannering Colliery. The Safeguard Mechanism sets a maximum emissions cap (a Safeguard Number) for all Australian facilities that emit over 100,000 t CO_2-e per year. If an Australian facility exceeds its Safeguard Number, it is nominally required to offset its exceedance by surrendering Australian Carbon Credit Units to the Clean Energy Regulator (CER).

The CVC Safeguard Number is currently set at 691,140 t CO_2-e per annum, and the Mannering Colliery Safeguard Number is currently set at 210,243 t CO_2-e per annum. The Safeguard Mechanism will provide an incentive for Delta Coal to manage annual greenhouse gas emissions below 901,383 t CO_2-e per annum.

6.0 Scope 3 emissions

Scope 3 emissions are indirect emissions that are associated with the Proposed Modification but occur at sources owned or controlled by other entities. Scope 3 emissions simply acknowledge that products will continue to generate greenhouse gas emissions as they move through a value chain. Delta Coal is not seeking approval to generate Scope 3 emissions, as they are not generated by the Proposed Modification, and approval for Scope 3 emissions has been or will be granted to other parties using other approval pathways.

6.1 Uncertainty

The Scope 3 emissions calculated as part of this assessment use default emission factors. The actual emissions generated at the emission source will depend on the technologies employed by electricity generators.

7.0 Conclusion

The Proposed Modification is forecast to generate approximately 1,235,000 t CO_2-e of Scope 1 emissions from combusting diesel and releasing fugitive emissions. The Proposed Modification has a relatively high Scope 1 greenhouse gas emissions intensity, however, most of the Scope 1 emissions are legacy fugitive emissions. Approximately 82% of the fugitive emissions forecast for the Proposed Modification are legacy fugitive emissions which are already approved under the respective Consents for CVC and Mannering Colliery.

The Proposed Modification's forecast energy use intensity is considered to fall below the normal range when compared with other underground coal mining operations across Australia. The Proposed Modification is expected to be very energy efficient, as the high quality ROM coal only requires a simple processing stage, and produces very low rates of waste material.

The Proposed Modification is also forecast to be associated with approximately 6,344,000 t CO_2-e of Scope 3 emissions. The Proposed Modification's Scope 3 emissions are beyond the operational control of Delta Coal, and the majority of Scope 3 emissions will be generated downstream of the Proposed Modification, when coal products are combusted by electricity generators.

The Proposed Modification in isolation is unlikely to limit Australia achieving its national mitigation targets, as the Proposed Modification effectively moves greenhouse gas emissions from the existing Myuna Consent, to the existing CVC Consent.

Delta Coal has incorporated a range of measures into the Proposed Modification's design to minimise potential greenhouse gas emissions, and improve energy efficiency. Energy efficiency was a key driver for the design of the mine plan as energy usage is a direct driver of cost as well as greenhouse gas emissions. The Proposed Modification's design inherently minimises greenhouse gas emissions from the mining operations, primarily through energy use reduction initiatives and maximising the utilisation of existing infrastructure.

8.0 References

Australian Greenhouse Office (AGO) (2007). National Greenhouse Gas Inventory: Analysis of Recent Trends and Greenhouse Gas Indicators.

Bureau of Meteorology and CSIRO (2014). State of the climate 2014.

Commonwealth of Australia (2015). Australia's 2030 climate change target. Fact Sheet.

CSIRO (2015). Climate change in Australia technical report.

Department of the Environment and Energy (DoEE) (2018). Australia's emissions projections 2018. December 2018.

Department of the Environment and Energy (DoEE) (2019). National Greenhouse Accounts (NGA*)* Factors August 2019.

Energetics (2009). Ulan West Energy Efficiency Design Review.

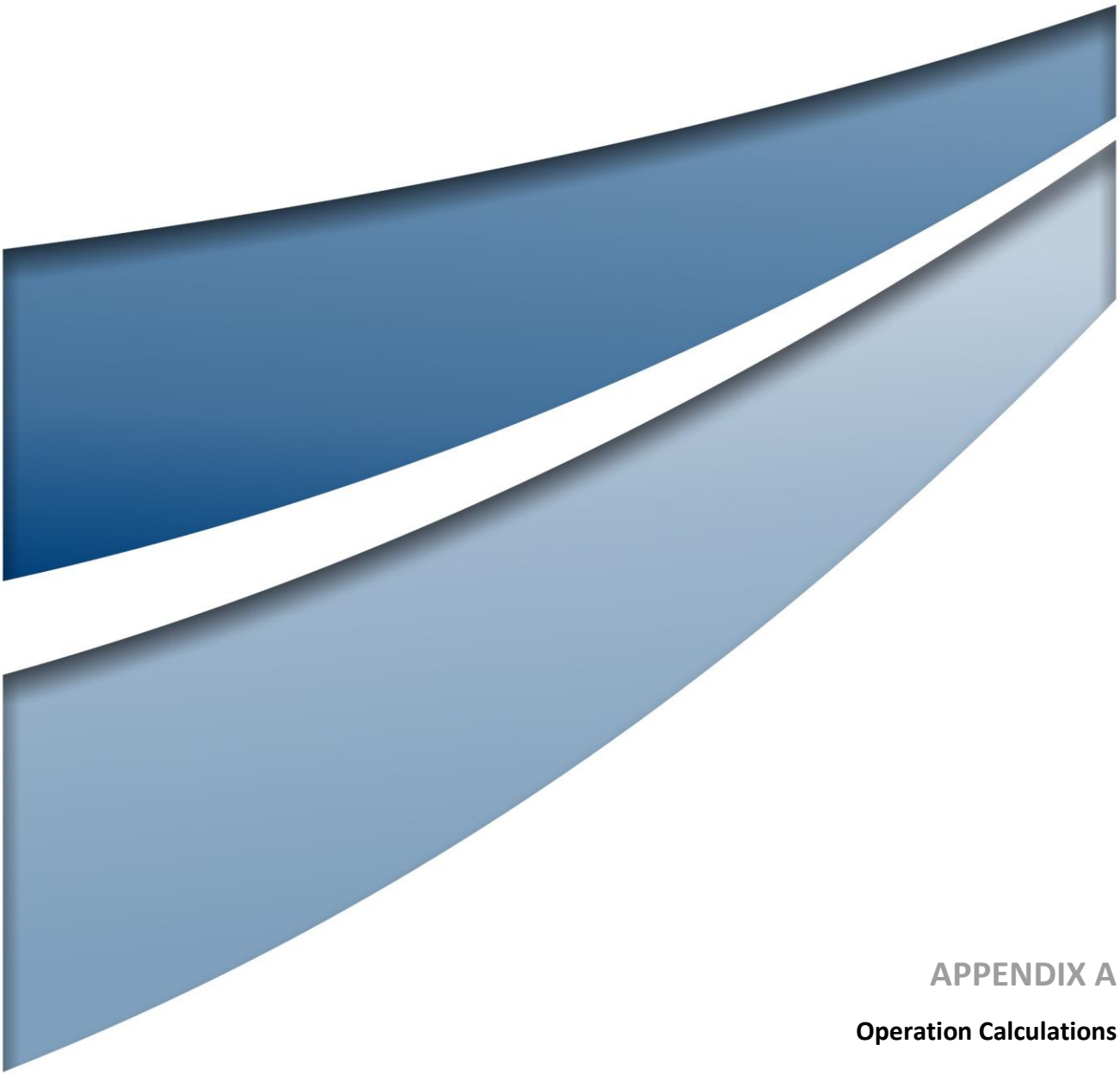
Intergovernmental Panel on Climate Change (IPCC) (2007). Climate Change 2007: Synthesis Report.

Intergovernmental Panel on Climate Change (IPCC) (2013). Climate Change 2013: Working Group I: The physical science basis.

State of New South Wales and Office of Environment and Heritage (OEH) (2016). NSW Climate Change Policy Framework.

United Nations Environment Programme (UNEP) (2016). The Emissions Gap Report 2016.

World Resources Institute and the World Business Council for Sustainable Development (WRI/WBCSD) (2004). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.



APPENDIX A

Operation Calculations

Appendix A – Calculation of Greenhouse Gas Emissions

Stationary Diesel Use

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
kL	GJ/kL	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
962	38.6	37,133	69.9	0.1	0.2
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			2,596	4	7
				Total GHG Emissions (t CO_2-e)	**2,607**

Fugitive Emissions

Activity Data	Energy Use		Emission Factors		
			CO_2	CH_4	N_20
ROM (t)	-	-	kg CO_2-e/ROM t	kg CO_2-e/ROM t	kg CO_2-e/ROM t
2,600,000	N/A	N/A	N/A	474	N/A
			t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)			N/A	1,232,400	N/A
				Total GHG Emissions (t CO_2-e)	**1,232,400**

Electricity

Activity Data	Energy Use	Emission Factors		
		CO_2	CH_4	N_20
GJ	GJ	kg CO_2-e / GJ	kg CO_2-e / GJ	kg CO_2-e / GJ
162,490	162,490	225	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG emissions (t CO_2-e)		36,560	N/A	N/A
			Total GHG Emissions (t CO_2-e)	**36,560**

Product Use

Activity Data		Energy Production		Emission Factors		
				CO_2	CH_4	N_20
Product	Product (t)	GJ/Product t	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Bituminous coal	2,600,000	27.0	70,200,000	90	0.03	0.2
Coking coal	0	30.0	0	91.8	0.02	0.2
				t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG Emissions (t CO_2-e)				6,318,000	2,106	14,040
					Total GHG Emissions (t CO_2-e)	**6,334,146**

Extraction, Production and Distribution of Energy Purchased

Activity Data		Emission Factors		
		CO_2	CH_4	N_20
Purchased energy	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Diesel	37,133	3.6	N/A	N/A
Electricity	162,490	25	N/A	N/A
		t CO_2-e	t CO_2-e	t CO_2-e
Breakdown of individual GHG Emissions (t CO_2-e)		4,196	N/A	N/A
			Total GHG Emissions (t CO_2-e)	**4,196**

Product Transport

Activity Data				Emission Factors		
				Scope 2	Scope 3	Full Life Cycle
Transport mode	Usage	Units	GJ	kg CO_2-e/GJ	kg CO_2-e/GJ	kg CO_2-e/GJ
Conveyor	18,720	GJ	18,720	225	25	250
						t CO_2-e
Breakdown of individual GHG Emissions (t CO2-e)						4,680
					Total GHG Emissions (t CO_2-e)	**4,680**

umwelt
Environmental & Social Consultants

Newcastle | Perth | Canberra | Brisbane | Sydney | Orange

T| 1300 793 267 E| info@umwelt.com.au www.umwelt.com.au