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CHAIN VALLEY COLLIERY

Miniwall S5 and Northern Pillar Area EXTRACTION PLAN (CVC-EP-MWS5&NPA)

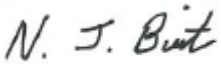
AMENDMENT 3

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1 Title block

Title block requirements	
Name of applicant company	Delta Power & Energy (Chain Valley) Pty Ltd trading as Delta Coal
Name of mine	Chain Valley Colliery
Development consent	SSD-5465
Mining lease(s)	ML1785, ML1784 and ML1051
Extraction Plan title	Miniwall S5 and Northern Pillar Area Extraction Plan
Version	4
Date	17 November 2025
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Blue type represents Amendment 1 to the Miniwall S5 and Northern Pillar Area Extraction Plan.
Green type represents Amendment 2 to the Miniwall S5 and Northern Pillar Area Extraction Plan.
Purple type represents Amendment 3 to the Miniwall S5 and Northern Pillar Area Extraction Plan.

2 Development of the plan

2.1 Purpose

The primary objective of the Chain Valley Colliery (CVC) Miniwall S5 (MWS5) and Northern Pillar Area (NPA) Extraction Plan (EP) is to satisfy the requirements set out in Condition 7, Schedule 4 of State significant development (SSD) consent SSD-5465 (as modified). This EP outlines the actions and procedures to be undertaken to ensure compliance with CVC's statutory requirements. This EP applies to Miniwall S5 and the Northern Pillar Area (Appendix 14-Graphical Plans, Plan 1).

Overall, the purpose of this EP is to:

- identify potential environmental impacts associated with the proposed extraction activities within the MWS5 and NPA; and
- identify the monitoring and management controls and mitigation measures that will be implemented to minimise the potential environmental impacts.

2.1.1 Extraction Plan Amendment 1 (June 2024)

This amendment of the EP has been developed to reflect a change in the mine layout of the Northern Pillar Area extraction to that previously approved in the EP. The change in mine layout was initiated in first-workings development in the NPA, due to the unplanned interception of geological structures and optimisation of the mines layout from the inference of these structures to other planned first-workings panels. Subsequently the mine layout proposed differs to the mine layout presented in the previous EP. The amendment updates mine layout plans to reflect the current mine layout and proposed areas of secondary pillar extraction, which remain within the 'subsidence boundaries' of the previously approved version of this extraction plan. An updated subsidence prediction report has also been included in this amendment which considers the current mine layout and proposed secondary extraction areas within.

At the time of preparing Amendment 1 of the EP, the Miniwall S5 extraction was completed (August 2021) at which time the colliery progressed to a bord and pillar and partial pillar extraction operation only.

2.1.2 Extraction Plan Amendment 2 (April 2025)

Amendment 2 of the EP has been developed to reflect a minor change in extraction method for a small portion of the NPA. Amendment 2 permits the utilisation of a double-sided lifting method of pillar extraction in the NPA, specifically in panels HBE1. Locations of secondary extraction are unchanged from the updated areas in Amendment 1 of the EP.

The amendment is supported by geotechnical assessment and subsidence prediction for a double-sided lifting scenario in the HBE1 panel, included in Appendix 15.1. The location and proposed design of the double-sided lifting in HBE1 is depicted as Method E on Plan 9 – Mining Sequence in **Appendix 14** – Graphical plans.

2.1.3 Extraction Plan Amendment 3 (November 2025)

Amendment 3 of the EP has been developed to reflect an update to the proposed areas of secondary pillar extraction. The proposed areas are the North East and North Headings, which remain within Zone B as specified in the CVC Development Consent SSD-5465.

The amendment is supported by geotechnical assessment and subsidence prediction for a double-sided lifting scenario in the North East and North Headings, included in Appendix 15.4. The location and proposed design of the double-sided lifting in North East and North Headings is depicted as Method A on Plan 9 – Mining Sequence in Appendix 14 – Graphical plans

2.2 Background

CVC is an underground coal mine on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney. The pit-top is located 3 km south of the township of Mannering Park.

Delta Power & Energy (Chain Valley) Pty Ltd (trading as Delta Coal (DC)) commenced as owner and operator of CVC and as the operator of neighbouring Mannering Colliery (MC) on 1 April 2019.

CVC operates under 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).

2.3 Key legislation, policy and guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities at CVC. A number of legislative requirements, government policies and guidelines are applicable. Key items of legislation, policy and guidelines relevant to this EP are:

- Extraction Plan Guideline, October 2022.
- EP&A Act;
- NSW *Protection of the Environment Operations Act 1997* (POEO Act); and
- NSW *Mining Act 1992* (Mining Act).

2.4 Development consent

In accordance with Schedule 2, Condition 2a of SSD-5465 (as modified), in addition to carrying out the works in accordance with the conditions of SSD-5465, DC will carry out works generally in accordance with the Environmental Impact Statement (EIS); Statement of Environmental Effects (SEE) (Mod 1); SEE (Mod 2); SEE (Mod 3); SEE (Mod 4), project layout plans; and Statement of Commitments.

As required by Schedule 4, Condition 7 of SSD-5465, this EP has been prepared in consultation with NSW Department of Planning, Housing and Infrastructure (DPHI) and by suitably qualified and experienced persons whose appointment was endorsed by the Planning Secretary on 22 October 2020 and subsequently on 16 May 2024 for Amendment 1. Amendment 2 of this EP has been performed by those previously endorsed in Amendment 1.

The specific requirements within SSD-5465 that are of relevance to this EP and where they have been addressed are listed in **Appendix 2**.

2.5 Consultation

In accordance with Schedule 4, Condition 7 of SSD-5465, as part of the preparation of this EP, DC has consulted with the local community (via the CVC and MC Community Consultative Committee (CCC) in February, May, August and November 2020. A copy of the meeting minutes are available on the Delta Coal Website (https://www.deltapae.com.au/operations/chain-valley-colliery/community-consultation). The November 2021 CCC presentation is also on the Delta Coal website and it provides some detail of the Extraction Plan consultation in slides 9 and 25.

A hyperlink of the draft EP was provided to the following stakeholders on 17 December 2020 for downloading on the Delta Coal website:

- DPHI – Resource assessments;
- DPHI – Resources Regulator – Subsidence Engineer;
- DPHI – Resource Regulator – Environment Inspector;

- DPHI – Biodiversity and Conservation Division (BCD);
- DPI – Water;
- DPI – Cabinet;
- Heritage NSW
- NSW-EPA;
- NSW Department of Primary Industries – Fisheries (DPI – Fisheries);
- Roads and Maritime Services (RMS);
- Lake Macquarie City Council;
- Central Coast Council;
- NSW National Parks and Wildlife Service (NPWS);
- Subsidence Advisory NSW;
- Registered Aboriginal Parties and
- CVC and MC CCC members

A summary of the comments received and amendments are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**.

Table 1: Consultation summary

Stakeholder	Comments	Response
DPHI – Resource Assessments	• Request for information (RFI) provided on 5 March 2020. See attached DPIE RFI letter and attachment (Appendix 1).	• Updated Extraction Plan, Plan 2 and Subsidence Management TARP (Appendix 1 - DPIE Consultation tables)
DPHI – Resource Regulator – Subsidence Engineer	• No comments provided on the draft Extraction Plan or Subsidence Monitoring Program	• None required
DPHI – Resources Regulator – Environment Inspector	• No comments provided on Extraction Plan	• None required
DPHI – BCD	• No comments provided on Extraction Plan	• None required
DPI – Water	• No comments provided on Extraction Plan	• None required
DPI Cabinet	• No comments provided on Draft	• None required
NSW EPA	• Encourages plans but does not make comments or conducts reviews	• None required
DPI – Fisheries	• Based on the previous mining activities and the changes to the mining methods in the current proposal the Department (i.e Fisheries) has no objections to the works proceeding as described.	• None required
Lake Macquarie City Council	• No comments provided on the Extraction Plan • Comments received from LMCC on the Benthic Communities Management Plan via tracked	• Benthic Communities Management Plan (Appendix 7) updated considering LMCC comments. EMM Consulting marine ecologist provided

Stakeholder	Comments	Response
	changes in a word document. Two main points in this consultation were; • identifying tests of significance (using ANOSIM) for changes in benthic communities as a result of subsidence vs other environmental variables. • clarification on when exactly a 'significant' change will be determined to have been caused by subsidence, as opposed to being attributed to other things (like water temp, turbidity, DO, etc). • Comments received from LMCC on the Seagrass Management Plan via tracked changes in a word document. Two main points in this consultation were; • A couple of typos • Missing figure numbers and • Alternative options for remediation of seagrass where that may be required	comments statistical analysis and significance of change. Seagrass Management Plan (Appendix 8) updated for typos and missing figure numbers and included alternative seagrass remediation option
Central Coast Council	• No comments provided	• None required
NPWS	• No comments provided	• None required
Transport for NSW - Maritime	• Comments provided by TfNSW-Maritime on Navigational Markers (Appendix 1). • Work boat and vessel TfNSW requirements nominated • Acceptable limits of navigational markers, fixed and buoys • No further action required if within subsidence predictions • Seeked further information on Pelican Navigational marker subsidence predictions.	• Email response provided to TfNSW on 1 February 2021 to answer queries (Appendix 1) • Mine survey contractors notified of TfNSW vessel and boating requirements • Built Features Management Plan (Appendix 10) and Subsidence Management TARP updated (Appendix 4)
Subsidence Advisory NSW	• No comments	• None required
RAPs	• No comments	• None required
CVC and MC CCC members	• No comments	• None required.
NSW Resources Regulator	• The resources regulator has reviewed the request and based on the review of the document, the Resources Regulator advises that it has no specific comments regarding mine safety or mine rehabilitation matters in relation to the proposals.	• None required.
Mining Exploration & Geoscience Department of Regional NSW	• MEG has reviewed the information supplied and has no specific comments in relation to *Mining Act 1992* considerations and raises no issues regarding the EP amendment at this stage.	• None required.
Department of Planning Housing and Infrastructure (DPHI)	• Approved	• Nil

Landholders with registered water bores around Chain Valley Colliery were contacted as part of the preparation of the EIS. No currently active water bores were identified at this time as requiring management. No further

impacts to landholders are anticipated from the proposed extraction within the MWS5 and NPA and thus no further consultation is required.

Further consultation was undertaken with the NSW Resources Regulator and Mining Exploration & Geoscience Department of Regional NSW as part of the preparation of Version 2, while no specific comments were made, Table 1 has been updated in blue with consultation on Amendment 1 of the EP and green for Amendment 2 of the EP.

2.6 Subsidence predictions and impact reviews

2.6.1 Amendment 3 – Subsidence Prediction and Impact Review

In 2025 Mine Advice Pty Ltd undertook a geotechnical and subsidence prediction assessment (Chain Valley 11/1, April 2025) for the proposed double sided lifting method of secondary extraction in the Northeast and North Headings. A follow up report was completed in 2025 by Mine Advice Pty Ltd to assess the Barrier Pillar Adequacy between Extracted Miniwalls and Proposed Double Sided Lifting Areas (Chain Valley 12/1, November 2025). The two reports have been included as **Appendix 15.4**. Subsidence predictions for the proposed double-sided lifting secondary extraction within the Northeast and Norh Headings areas were:

	Cover Depth (m)	Panel Width (m)	W/H Ratio (to base of lake)	S_{max} (mm)	S_{rib} (mm)	Angle of Draw (°) Likely/Worst-Case
Northeast Mains (4 rows)	170	118	0.69	192	87	14/23
North Mains (4 rows)	200	118	0.59	128	70	12/21
North Mains (5 rows)	200	142	0.71	192	87	14/23

Table 2 – Northeast and North Headings Subsidence Predictions

To be conservative the maximum subsidence prediction adopted is 192 mm, within the 780 mm mining induced vertical subsidence limit for Zone B as specified in the CVC Development Consent SSD-5465.

2.6.2 Amendment 2 - Subsidence Prediction and Impact Review

In 2025 Byrnes Geotechnical Pty Ltd undertook a geotechnical and subsidence prediction assessment (DCV-27, March 2025) for the alteration in planned secondary extraction mining methods utilised for the HBE1 panel in the NPA. The method assessed was a double-sided lifting (secondary extraction), planned for the HBE1 panel, the DCV-27 report has been included as **Appendix 15.3**. Subsidence predictions for the proposed double-sided lifting secondary extraction within HBE1 in the NPA were:

- Likely – 18 mm
- Possible – 140 mm (18 + 122)
- Very unlikely – 236 mm (18 + 218)

To be conservative the maximum subsidence prediction is adopted of 236 mm, within the 780 mm mining induced vertical subsidence limit for Zone B as specified in the CVC Development Consent SSD-5465.

2.6.3 Amendment 1 - Subsidence Prediction and Impact Review

In 2024 Ross Seedsman and Roger Byrnes from Byrnes Geotechnical Pty Ltd undertook a geotechnical and subsidence prediction assessment for minor modifications to the proposed pillar extraction in the NPA as proposed within Amendment 1 of the EP. The subsidence prediction reports are provided in **Appendix 15.2** and subsidence predictions for the proposed partial extraction design in the northern mining area were:

- Likely – 18 mm
- Possible – 113 mm

- Very Unlikely – 226 mm

To be conservative, the maximum subsidence prediction is adopted of 226 mm, which is within the 780mm mining induced subsidence limit for Zone B as specified in the CVC Development Consent SSD-5465.

2.6.4 MWS5 and NPA Subsidence Prediction and Impact Review

David Hill from Strata2 undertook a geotechnical and subsidence prediction assessment in 2020 for MWS5 and NPA (Appendix 15.3). This report built upon the previous nearby subsidence assessments and site subsidence monitoring results.

The original subsidence assessment was completed by Ditton Geotechnical Services in 2015 to support the MOD 2 SEE. This assessment reviewed updated subsidence data for Miniwalls 1–8, along with existing historic subsidence data from surrounding extracted areas. Later, subsidence data over Miniwalls 1–12 revealed that actual subsidence was approximately 0.37 m above the maximum predicted values (DGS 2018a).

It was assessed that time-dependent subsidence associated with chain pillar overloading in soft floor conditions was resulting in subsidence above original predictions (0.78 m maximum predicted), with the data and associated analyses indicating that the subsidence is likely to be driven by the:

- increased span of the Munmorah Conglomerate and subsequent decrease in overburden stiffness; and
- increased stress applied to the central chain pillars by the deflecting conglomerate likely to having exceeded the bearing strength of the moisture sensitive claystone floor strata.

These learnings have subsequently been incorporated into the design of the S5 Miniwall and Northern Pillar area, namely:

- the subsidence assessment considers the 'bank' of Miniwalls S2-S5, thereby assessing the potential increase in subsidence due to the spanning capabilities of the overlying Munmorah Conglomerate; and
- the S3 to S4 inter-panel chain pillar width was increased from 32.6 m to 40 m to limit pillar system deformation (Strata2 2019)
- the S4 to S5 inter-panel chain pillar width is 40m and
- the S5 Maingate chain pillar is 32.6m wide

Subsidence predictions have been developed for the revised layout in Amendment 1 of the EP based on empirical modelling techniques (Strata2 2020, Byrnes Geotechnical 2024).

A number of surface and subsurface features of significance were identified from the assessments and inspections within the zone of predicted subsidence (Plan 2 of Appendix 14) as having potential to be affected by far-field movements as a result of the proposed Fassifern Seam workings, including:

- Lake Macquarie and its bed sediments;
- benthic fauna communities;
- seagrass beds;
- groundwater;
- navigational markers and rock outcrops on Lake Macquarie;
- jetties and moorings;
- minor cliffs and steep slopes;
- high water mark (RL 0 m–2.44 m AHD) along the lake foreshore;

- residential buildings and other built features adjacent the foreshore;

These factors have all been reassessed in terms of the updated subsidence predictions (Byrnes Geotechnical, 2024), following a similar process to the previous applications and via the Extraction Plan Risk Assessment (Appendix 3). The extraction design proposed in Amendment 1 of the EP is noted to have lesser subsidence predicted in the area of subsidence impact as previously assessed, as such no additional impact is anticipated for surface and subsurface features under the revised NPA layout.

3 Overview

3.1 Mine planning and design

3.1.1 Area covered by this extraction plan

The area adjacent to the proposed workings has been extensively mined over the past 60 years, within the Wallarah seam and Great Northern seam and previous miniwall extraction in Fassifern Seam (Plan 4 of Appendix 14). The North Mains first workings access the mining area on the Fassifern Seam, noting that previously extracted miniwall and bord and pillar panels are outside the angle of draw.

The mining area covered by this EP and its amendments consists of a single Miniwall panel (S5 – completed 2021) and areas of secondary pillar extraction with a total surface effect area covering approximately 55 ha and 24 ha (Northeast and North Headings) wholly beneath Lake Macquarie (Appendix 14). The Mininwall S5 panel is aligned with the previously approved S2/S3/S4 panels in an east-south-east to west-north-west orientation.

All extraction and subsidence impacts of relevance to MWS5, the NPA and Northeast and North Headings are beneath Lake Macquarie. Therefore, surface features are limited to the lakebed. Impacts to the lake foreshore, cliffs and/or seagrass beds are not predicted.

Mine design has been the primary control to limit impacts and prevent potential for subsidence exceedances. The proposed mine design has included consideration of the high water mark and seagrass communities.

3.1.2 Proposed mine layout

In 2016, CVC encountered large-scale faulting in the Northern Domain. Subsequently, alternative mining areas were required, mine plans needed to be re-evaluated and relevant planning and environmental approvals sought. The primary considerations in this plan have been:

- applying the learnings with respect to subsidence resulting from previous miniwall and pillar extraction (refer Section 2.6);
- minimising the likely exposure of the miniwall panel to normal faults for safety, productivity and subsidence management purposes; and
- controlling the height of fracturing above the extracted area to meet rockhead thickness constraints.

3.1.3 Mining domains

The extraction plan area is covered by mining lease (MLs) ML1785,ML1784 and ML1051 (Plan 5 of Appendix 14). Historical, approved and proposed workings of relevance to this EP are described below.

3.1.3.1 Overlying Wallarah Seam workings

Partial extraction within the Wallarah Seam (overlying the Fassifern Seam) has been undertaken (Plan 4 of Appendix 14) historically within the vicinity of Miniwall S5 and North Headings. There are no historical workings directly above MWS5 or the NPA, however there are historical workings directly above the North Headings.

Wallarah Seam workings are generally 76–82 m above the Fassifern Seam, with the interburden consisting of claystone, sandstone, coal seams and thick conglomerate beds. Due to the large barrier pillar, no subsidence or abutment loading interaction is expected between the Fassifern and Wallarah Seam workings.

3.1.3.2 Existing first workings and secondary extraction

CVC previously completed secondary extraction in the Fassifern Seam Miniwall S4, south of MWS5 and the NPA (Plan 1 of Appendix 14). The first workings currently used to access CVC and MWS5 adjoin these areas.

Due to the compounding nature of subsidence in adjacent extraction panels, a combined subsidence assessment has been prepared, which considers Miniwalls 1 – 12, N1, S1 – S5 and the NPA (Strata2 2020, Byrnes 2024 and Mine Advice 2025) in Appendix 15.

3.1.3.3 Proposed mining activities

It was initially proposed to limit extraction in the approval area to the nominated Miniwall panel (i.e. MWS5) and NPA. This enabled CVC to:

- gain additional monitoring data to validate subsidence predictions;
- improve knowledge on subsidence development mechanisms and controls; and
- optimise the future layout.

This provided continuity of operations and minimised risks associated with exceedances of predicted subsidence.

This amendment covers secondary extraction in the Northeast and North Headings following the before mentioned extraction and monitoring data gathered.

3.1.4 Mining parameters

Mining within MWS5 was completed via miniwall methods with panel widths of 97 m (total extracted void) accessed by a combination of twin gateroads separated by either:

- 40 m (solid width) chain pillars in the case of the S5 tailgate and
- 32.6 m (solid width) chain pillars in the case of the Maingate S5

A miniwall is essentially a longwall with a reduced face width. The reduced panel widths allow for the maintenance of bridging overburden conditions, reducing subsidence and improving face conditions. Secondary extraction in the Northern Pillar Area will be conducted with continuous miners.

The Fassifern Seam in the MWS5,Northern Pillar Area and Northeast and North Headings ranges between 4.8 m and 6.0 m thick, with depth of cover (including sediment) between approximately 140 m and 180 m in the MWS5 and NPA and 180m to 200m in the Northeast and North Headings area. It is proposed to extract a maximum of 3.5 m on the miniwall and pillar extraction with 3.2 m in development, leaving coal both on the floor and in the immediate roof.

Floor coal provides a protective layer above the underlying claystones, which are highly susceptible to deterioration if exposed to water or atmosphere. They are also readily broken up by mining equipment, greatly impacting roadway conditions (where exposed). The roof coal is of significantly higher ash content and would negatively impact on the saleability of the coal product. Left in place, it contributes to improved roadway roof conditions on development.

A summary of the key mining parameters for MWS5, NPA and Northeast and North Headings is provided in Table 3 to Table 6.

Table 3 – Projected coal recovery within MWS5,NPA and Northeast and North Headings

Extraction Area	MWS5	NPA	Northeast and North Headings
Total resource (assumes 21.5 ha area for S5)	1.20 million tonnes (Mt)	10.40 million tonnes (Mt)	Remnant Pillars
Total development extraction	0.07 Mt	2.17 Mt	N\A Previously developed
Total secondary extraction	0.46 Mt	1.47 Mt	0.35 Mt
Total reserves extracted	0.53 Mt	3.64 Mt	N\A Previously developed, secondary extraction only
Percentage recovery	44%	35%	N\A.

Table 4 – Miniwall S5 panel geometry

Panel length (m)	Void width (m)	Extraction height (m)	ROM tonnes (Mt)
1008	97	3.5	0.53

Table 5- Fassifern Seam parameters and development roadway geometry

Panel	Working Seam thickness (m)	Depth of cover (m)	Drivage width (m)	Drivage height (m)
MWS5	3.8 – 4.0	160 – 171	5.4	3.2
NPA	3.6 – 4.0	170 – 140	5.5	3.2
Northeast and North Headings	3.6 – 4.3	190 – 200	5.5	3.2

Table 6- Estimated mining schedule

Panel	Extraction Start date	Extraction End date	Estimated duration (months)
MWS5	April 2021	August 2021	Completed
HBW2/5	September 2024	October 2024	Completed
HBW1	November 2024	December 2024	Completed
HBE2/3/4	January 2025	May 2025	Completed
HBE1	August 2025	December 2025	5
HB Mains	January 2026	February 2026	2
Northeast Headings	February 2026	May 2026	4
North Headings	May 2026	September 2026	5

3.1.5 Consideration of previous working and multi-seam interactions

As part of the preparation of the EP's for S2/S3 and S4, MSEC (2018) and Strata2 (2019), respectively, prepared subsidence assessments, which included consideration of previous Wallarah Seam workings and multi-seam interactions. The assessment acknowledged that:

- Historic first workings have been carried out south-east of MWS5/NPA and beneath the foreshore of Lake Macquarie (Plan 4 of Appendix 14). These workings were found to be outside the 26.5° and 35° angles of draw. It was therefore considered unlikely that the extraction of MWS5 and NPA would affect the load on or the stability of these historic first workings.

No further impacts have been identified from overlying Wallarah Seam workings as part of the geotechnical assessment for MWS5, NPA (Strata2, 2020) and Northeast and North Headings (Mine Advice,2025).

3.1.6 Consideration of other features

Thin beds of claystone in the Fassifern Seam floor have been attributed to increases in floor heave under higher pillars loads associated with the extraction of multiple panels. The potential for increased subsidence effects associated with softening and lateral squeezing of the claystone has been noted and accounted for in the updated analyses prepared as part of this EP.

The limited final pillar stresses and high Stability Factors associated with the S2/S3, S3/S4, S4/S5 panel chain pillars and NPA barrier pillars are not anticipated to have any adverse or irregular subsidence effects (Strata2 2020, Byrnes geotechnical 2024).

For the Northeast and North Headings, average pillar stresses are well within proven levels whereby *en masse* failure of the coal/claystone sequence beneath pillars in the Fassifern Seam is not a credible possibility (Mine Advice, 2025).

3.2 Subsidence predictions

3.2.1 Overview

Subsidence magnitudes and impacts have previously been estimated as part of the preparation of the life of mine design for CVC, which included the MWS5 and NPA area covered by this EP (DGS 2015). The methodology used to predict subsidence was originally based on the results of the Australian Coal Industry's Research Program (ACARP) (Ditton and Frith 2003), *Review of industry subsidence data in relation to the influence of overburden lithology on subsidence and an initial assessment of a sub-surface fracturing model for groundwater analysis*, as well as a review of subsidence data from MW 1–9 at CVC and LW17–23 at MC. This information was re-analysed for the MW 1–12 exceedance investigation at CVC (DGS 2018a), leading to a revised subsidence assessment for the S1 and N1 Panels (DGS 2018b).

In assessing factors that could influence subsidence for MMS5 and NPA, a geotechnical mine design investigation (combining an assessment of pillar stability, surface subsidence and height of connective fracturing) has been completed (Strata2 2020). This document was used to inform the mine design and management plans (refer Chapter 4). This assessment builds on the previous learnings with respect to subsidence impacts from previous miniwall extraction at the mine. As part of the assessment, specific consideration was given to:

- depth of cover,
- rock head cover;
- panel width;
- chain pillar geometry;
- extraction height;
- spanning capabilities of the conglomerate-dominated overburden;
- floor properties (in particular weak and moisture sensitive claystone units);
- potential for additional long-term subsidence/creep;
- the location of the proposed extraction outside of both the high water mark subsidence barrier (HWMSB) and identified seagrass communities (Plan 2 of Appendix 14); and
- the location of the workings with regard to previous workings in the same seam.

Predicted subsidence effect parameters are summarised in Table 7.

Table 7 - Predicted Subsidence Effects (Strata2 2019, Byrnes Geotechnical 2024 and Mine Advice 2025)

Panel	Subsidence (m)	Angle of draw
MWS5	0.5m	<26.5°
NPA Update DCV-27 (Appendix 15.3)	0.236m Very unlikely	15.7°
Northeast and North Headings	0.192m	Likely/Worst Case 14 ° /23 °

3.2.2 Lake bed fracturing

Ditton (2015) indicated that, based on previous experience at nearby mines, it can be assumed that any surface cracking to the rock head below the lake bed sediments is likely to be minor for the predicted range of surface subsidence magnitudes. Tensile strains were predicted

to be up to 1.5 mm/m and maximum crack widths were estimated to be <20 mm at rock head. MSEC (2018) arrived at a similar conclusion, with fractures of ≤10 mm at the rock head extending to a depth of up to 3 m.

It is likely that any cracks that occur will be naturally 'filled' by lake bed sediments with no impact on the lake bed itself. The strains at the lake bed surface itself will also be more uniformly distributed and are therefore more likely to be absorbed by the plastic nature of the sediments.

3.2.3 Sub-surface fracturing

Two methods have been adopted for estimating the height of sub-surface fracturing, namely:

- a model developed by Ditton and Merrick (2014) that has been used successfully for all previous secondary extraction at CVC; and
- a model developed by SCT (2008) as part of an ACARP project investing aquifer inflow predictions above longwall panels.

3.2.3.1 Ditton and Merrick (2014)

The approach adopted by Ditton and Merrick (2014) builds on the work of Whittaker and Reddish (1989) and Forster (1995). The nomenclature of the sub-surface fracturing model is described in Figure 1. The predicted height of connective cracking is termed the "A Horizon" (Whittaker and Reddish) or "Fractured Zone" (Forster 1995).

The Ditton & Merrick (2014) model includes data from Forster (1995) and can be used to assess both sub-critical and supercritical panel geometries, whereas the original Forster (1995) work focussed on super-critical panels. DgS (2018b) back analysed sub-critical and supercritical behaviour relating to height of fracturing for previous MC and CVC panels and found these models to provide reliable height of fracturing predictions.

To obtain accurate rock head cover values, the mine conducted a detailed geophysical survey of lake bed sediment thickness over the northern mining domain in early 2018. This survey has shown that the sediment is often thicker than previously estimated, particularly in the central lake area.

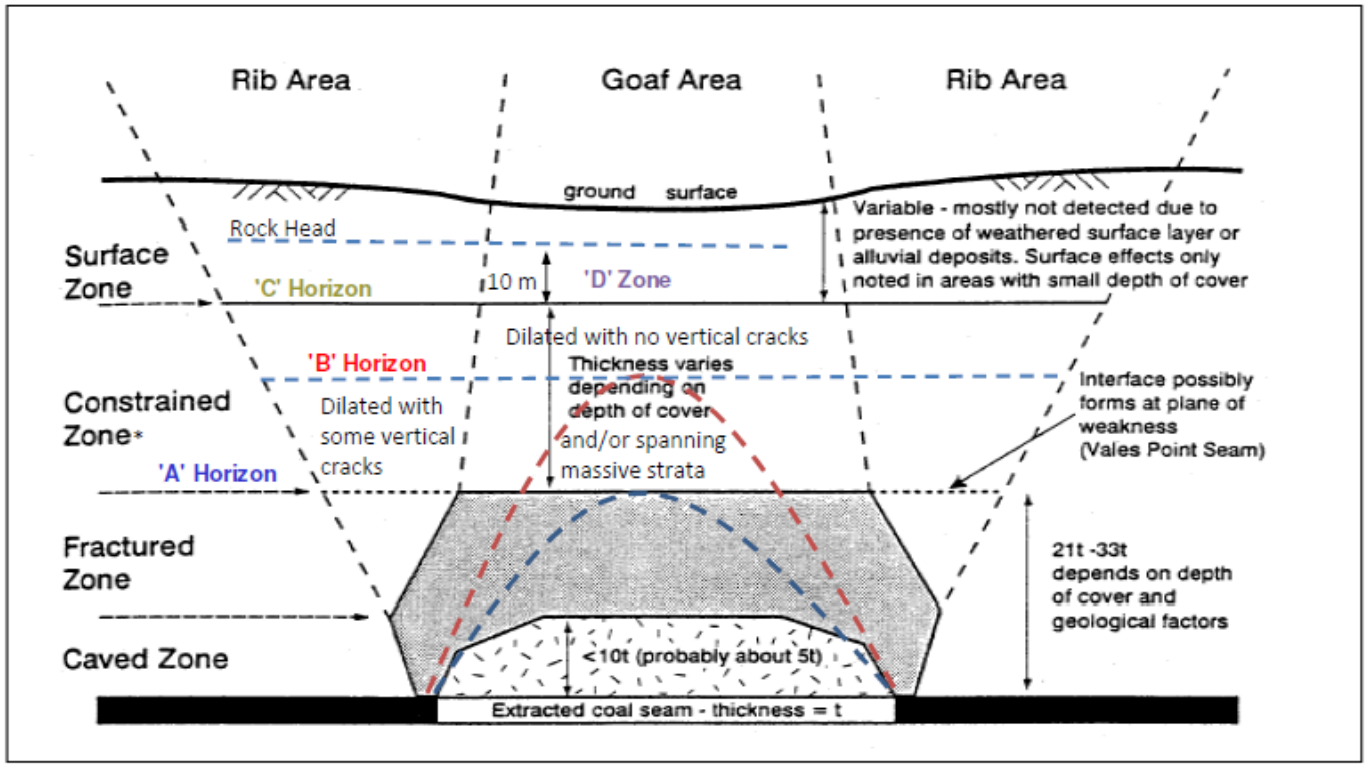
The predicted heights of fracturing above Miniwall S5 the Northern Pillar area is <81m and <74m respectively. The Ditton and Merrick (2014) model indicates that there is sufficient cover to meet a minimum constrained zoned thickness of 12T (Forster 1995). This is considered acceptable given the quality of the data, the absence of major geological structures and the sub-critical nature of the panels.

This is consistent with the successful application of the model in the MW1-12, CVB1, S1, N1, S2 and S3 areas, noting that MW 11 and 12 involve similar depths of cover and haven't experienced any signs of interconnectivity.

3.2.3.2 SCT (2008)

The approach adopted by SCT (2008) also builds on the work of Whittaker and Reddish (1989) as it links inflow experiences to subsidence and systematic tensile strains. Essentially, no issues are expected at strains of <4 mm/m and major difficulties are anticipated at strains of >10 mm/m (assuming a 'k' value of 0.6). These findings are consistent with those of Whittaker and Reddish (1989), as well as Wardell (1975).

Experience at CVC and MC is consistent with that from elsewhere, with no inflow issues at low strain values. The predicted subsidence and systematic strain values for the proposed MWS5 and NPA are at the low end of the database, such that no issues are anticipated.



Zones in the Overburden according to Forster (1995)

* - Constrained Zone generally means B-Zone, but may include C-Zone , depending on W/H ratio and geology

DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/1	
	Drawn:	S.Ditton			
	Date:	23.11.12	Title:	Schematic Model of Overburden Fracture Zones in **Forster, 1995** Model (based on Piezometric Data Above High Extraction Panels in the Newcastle Coalfield)	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 34.2

Figure 1 - Overburden fracture zones (Source: Ditton 2013)

3.2.3.3 Summary

The maintenance of a sub-critical panel geometry with subsidence at the low end of the historical range for miniwall operations at CVC results in acceptable outcomes in terms of the height of connective fracturing for the combined S2, S3, S4, S5 and NPA panels.

Northeast and North Headings continues this sub-critical panel geometry and predicted likely and even worst-case Angles of Draw (to 20 mm subsidence) as well as the maximum lateral extent of vertical abutment stress from lifted-off areas, are all contained within the footprint of the barrier pillar systems and therefore will not impact/re-activate existing subsidence above adjacent Miniwalls (Mine Advice, 2025).

3.2.4 Potential environmental consequences

Based on predicted maximum panel subsidence, tilt and strain values for Miniwall S5,NPA and Northeast and North Headings, potential subsidence-related impacts and their likely effect on nearby natural and man-made features have been considered, including:

- changes to the lake bed level;
- surface cracking beneath the lake bed;
- height of sub-surface fracturing above the panels (direct and indirect hydraulic connection zones);
- impacts on groundwater; and
- impacts on the foreshore of Lake Macquarie and surrounding natural and man-made features inclusive of public safe risks.

Extraction Plan Risk Assessment (Appendix 3) evaluated overall environmental risk (as it relates to subsidence impact) for MWS5 and NPA. From this and via application of mine design controls (refer Section 3.1) along with monitoring and response management systems (eg trigger action response plans (TARPs)), the risk of irregular subsidence impacting the foreshore or sensitive environmental features was considered highly unlikely.

Subsidence-related changes to the lake bed level and resultant impacts on benthic and seagrass communities and wave climate were assessed as part of the marine ecology assessments prepared by JSA Environmental in support of the CVC Mod 2 SEE (EMM 2015) and CVC Mine Extension Project EIS (EMM 2013).

As part of the previous Mod 2 Statement of Environment Effects environmental assessment, an aquatic biological survey was conducted, which included consideration of soft bottom benthic communities and seagrass mapping. Ground truthing of the seagrass beds since the original mapping has been utilised along with additional mapping data and satellite imagery to provide the most accurate location of seagrass beds at the time of this EP and inform the location of protection barrier offsets for mine design.

Considering the survey results, the proposed mine plan and the modelled subsidence predictions, JSA Environmental concluded as part of previous assessments that there would be no more than minor impacts on benthic communities and negligible impacts on seagrass levels as a result of proposed mining. This has been supported through the results of ongoing monitoring activities.

Given the additional mine plan controls that have been implemented since the time of the marine ecology assessments, these impacts are not expected to increase. In addition, bathymetric surveys have been increased to six monthly intervals to validate and update predictions and control effectiveness (including survey prior to any secondary extraction at CVC). The results of the bathymetric surveys will be used to confirm predicted subsidence levels and mapping of seagrass levels and benthic communities will be ongoing throughout the period of extraction within Miniwall S5, NPA and Northeast and North Headings. These results will be used to confirm whether subsidence and associated impacts are maintained within predicted levels.

Leading wave climate experts from University of NSW's Water Research Laboratory concluded that the predicted subsidence will not affect the wave climate sufficiently to have adverse shoreline impacts.

In regard to surface cracking beneath the lake bed, the strains at the lake bed surface itself are expected to be more uniformly distributed and are therefore more likely to be absorbed by the plastic nature of the sediments. Any cracks are therefore likely to be naturally filled by lake sediments with no significant impact on the lake bed itself.

The predicted height of continuous and discontinuous fracturing above the proposed miniwall is below the logged rock head thickness above the panels and provides for sufficient constrained zone thickness at the adjusted extraction heights. As such, it is considered very unlikely that hydraulic connection between the lake and the mine workings will occur or that connection between mining-related fractures and the lake will cause significant impacts on the lake. Additional monitoring (including an extension of CVC's subsidence management TARP) will be put in place to monitor for early signs of unexpected subsidence.

In regard to surface features, namely the lake foreshore and features surrounding the foreshore, both the HWMSB and seagrass protection barrier have been applied as part of the mine design process.

Routine monitoring and TARPs will continue to be implemented to identify and respond to any unanticipated changes as a result of extraction in Miniwall S5, NPA and Northeast and North Headings, further adaptive management and contingency controls will be implemented as required.

Predicted subsidence and tilt for Miniwall S5 (Table 9) at the Pelican Rock Navigational marker are considered manageable and will be managed via the Subsidence Management TARP (Appendix 4).

Table 9 - Navigation marker predicted subsidence parameters

Navigational Marker	Vertical Subsidence Predictions	Tilt predictions
Pelican Rock (NLM045)	• 155mm	• <4mm/m
Sugar Bay Rock (NLM062)	• < 20mm	• Negligible
Fishery Point (NLM063)	• <20mm	• Negligible
Casuarina Point (NLM064)	• <20mm	• Negligible

3.3 Performance objectives

3.3.1 Development consent conditions

Condition 1, Schedule 4 of SSD-5465 states:

The Applicant must ensure that vertical subsidence within the High Water Mark Subsidence Barrier and within seagrass beds is limited to a maximum of 20 millimetres (mm). If at any stage predicted subsidence levels are exceeded within these areas, an ecological monitoring program shall be initiated to assess the impacts to ecological communities and threatened species and if appropriate, offsets are to be provided for any impacts detected.

At present there is no expectation that predicted subsidence levels will be exceeded based on actual subsidence monitoring and subsidence predictions. The adopted mine design has been developed with the aim of achieving no additional subsidence impact due to Fassifern Seam extraction within the high water mark or seagrass areas. Nonetheless, a Subsidence Management TARP will be implemented as outlined in

Section 3.4 to deal with unanticipated subsidence impacts in a proactive manner (in the unlikely event they occur).

Condition 2, Schedule 4 of SSD-5465 states:

> The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 6 to the satisfaction of the Planning Secretary.

Biodiversity	
Threatened species or endangered populations	*Negligible environmental consequences.*
Seagrass beds	*Negligible environmental consequences including:* • *negligible changes in size and distribution of seagrass beds;* • *negligible change in the function 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.*

> *Notes:*
>
> *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
>
> *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.*
>
> *The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.*

Fassifern Seam first workings in the Miniwall S5, NPA and Northeast and North Headings areas are not beneath any of the features listed in Table 6 of SSD-5465. Should a change to first workings necessitate this, the first workings will be designed to be long-term stable.

In the unlikely event that greater than negligible/minor impacts occur, the Subsidence Management TARP (Appendix 4) will be implemented. The TARP includes detailed performance indicators.

Condition 4 of Schedule 4 of SSD-5465 states:

> The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7, to the satisfaction of the Planning Secretary.

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 compensated.*
Public safety	
Public safety	*Negligible additional risk.*

Notes:

The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in measures in the Built Features Management Plans or Public Safety Management Plan (see Condition 7 below).

Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.

The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.

Requirement's regarding safety or serviceability do not preclude preventative actions or mitigation being taken prior to or during mining in order to achieve or maintain these outcomes.

Requirement's under this condition may be met by measures undertaken in accordance with the Coal Mine Subsidence Compensation Act 2017

MWS5, NPA and Northeast and North Headings are outside any zones that may affect the Trinity Point Marina Development and other built features.

In the unlikely event that greater than negligible/minor impacts occur, the Subsidence Management TARP (Appendix 4) will be implemented. The TARP includes detailed performance indicators.

3.3.2 Other regulatory requirements

Prior to commencement of secondary extraction activities within MWS5 ,NPA and/or Northeast and North Headings, a Secondary Extraction High Risk Activity Notification is required under Schedule 3, Part 3, Section 17 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022.

3.4 Subsidence management strategies and measures

3.4.1 Overview

The overall framework for subsidence monitoring and management of impacts is summarised in Figure 2.

Details of relevant triggers and performance indicators (including measured subsidence and inspections for environmental impact) are provided in relevant component plans. These management plans also include specific information regarding subsidence monitoring requirements (including baseline monitoring), remediation, adaptive management techniques and contingency plans. A summary is provided in the Subsidence Management TARP (Appendix 4), which aims to consolidate all subsidence management requirements into a central location, triggering a response or set of responses commensurate with the nature of the measurement or the impact that has been identified.

3.4.2 Mine design elements

Mine design parameters such as panel start and finish position, panel width, chain pillar width and barrier pillar width in conjunction with an assessment of overlying strata, depth of cover and depth of rock head all contribute to the management of vertical subsidence effect and impacts.

MWS5, NPA and Northeast and North Headings have been designed to ensure that no secondary extraction will occur within the HWMSB or seagrass protection barrier. This will help to avoid any potential significant impacts on the foreshore of Lake Macquarie or seagrass communities in shallow foreshore areas.

The outcomes of the updated subsidence predictions have further informed the mine design strategies to be undertaken as outlined in Section 3.1. Adaptive management recommendations have been applied to the final mine design.

3.4.3 Remediation strategies

Remediation strategies are incorporated into the Subsidence Management TARP (Appendix 4). These also follow the principles outlined in the Rehabilitation Management Plan (Appendix 12).

3.4.4 Adaptive management strategy

CVC's Subsidence Management TARP includes a series of triggers and responses when subsidence levels exceed those predicted.

The extensive mining history in and around CVC's operations has greatly improved the accuracy of CVC to predict subsidence levels and allowed CVC to develop mine design guidelines to protect against foreshore, seagrass and lake bed impacts.

Based on recent history at CVC (using similarly-designed miniwall panels), exceedances of predicted subsidence effects and impacts are unlikely. However, the routine collection of data such as regular bathymetric surveys, foreshore subsidence surveys, groundwater assessments, seagrass mapping and benthic community surveys will allow rapid and proactive verification of both initial and final subsidence effects and impacts such that adaptive measures (eg mine design changes, increased barrier pillars, widening of protection zones, etc) can be undertaken in a timely manner to mitigate against and minimise the impact of any unforeseen exceedances.



Figure 2 – Subsidence monitoring and management framework

4 Extraction Plan Guidelines and Component plans

4.1 Overview

The Draft *Guidelines for the Preparation of Extraction Plans* (DPE) specify that six component plans should be prepared as part of an EP.

The high-level structure for the extraction plan should be as key component plans/programs (in bold) listed in the draft Guidelines and include the following:

- **Water Management Plan** (Appendix 5);
- **Land Management Plan** (Omitted as not required in CVC consent and Extraction area is located under Lake Macquarie);
- **Biodiversity Management Plan** (Appendix 6)
- **Benthic Communities Management Plan (Appendix 7)**
- **Seagrass Management Plan (Appendix 8);**
- **Heritage Management Plan** (Appendix 9);
- **Built Features Management Plan** (Appendix 10)
- **Public Safety Management Plan** (Appendix 11)
- **Rehabilitation Management Plan** (Appendix 12)
- **Subsidence Monitoring Program** (Appendix 13)

Implementation:

- **Graphical Plans** (Appendix 14); and

Attachments:

- Extraction Plan Risk Assessment (Appendix 3)
- Subsidence Prediction Report (Appendix 15)

As MWS5, NPA and Northeast and North Headings are located beneath Lake Macquarie there are management plans specific to the Lake Macquarie marine environment (Benthic Communities Management Plan and Seagrass Management Plan).

Management of impacts identified via the Subsidence Monitoring Program (Chapter 5) are commensurate with the nature of the measurement or the identified impact. This EP relies on the aforementioned component plans to address these impacts to particular environmental or built features within the Miniwall S5 area.

A summary of the intent of each component plan and how it relates to Miniwall S5, NPA and Northeast and North Headings is provided below.

As part of Amendment 2 of the Extraction Plan, approved Management Plans that have been revised since the previous EP approval have been appended.

As part of Amendment 3 of the Extraction Plan, approved Management Plans that have been revised since the previous EP approval have been appended.

4.2 Water Management Plan

CVC's Water Management Plan (Appendix 5) which includes the updated Groundwater Management Plan considers the potential for extraction within Miniwall S5 to contribute to regional groundwater drawdown and a reduction of private water bore yields.

Due to the existing large extent of depressurisation from historical mining, impacts from mining within MWS5 are considered negligible. Nonetheless, controls have been adopted, which include:

- continuation of the groundwater monitoring program;
- faults or dykes within Miniwall S5 are to be assessed case-by-case as to whether an extraction barrier is required to prevent hydraulic connection; and
- where access is available, monitoring of bore yields, saturated thickness and quality (if mining-related impacts can be proven, an alternative water supply will be provided until the bore recovers).

The Groundwater Management Plan has been updated as part of this EP. Other potential water-related impact risks due to extraction are either not applicable due to the extraction being contained wholly below Lake Macquarie or not relevant due to no risk of impact.

4.3 Biodiversity Management Plan

CVC's Biodiversity Management Plan (Appendix 6) was reviewed and was most recently approved in 2023. Only the Benthic Communities Management Plan (BCMP) (Appendix 7) and Seagrass Management Plan (SMP)(Appendix 8) components are applicable to this EP. The Seagrass Management Plan also includes consideration of potential biodiversity impacts to sea turtles.

The BCMP and SMP have been reviewed and updated most recently approved in 2023 and 2024 respectively.

Bathymetric surveys and benthic and seagrass monitoring will be undertaken prior to and post extraction. Monitoring locations are tailored to confirm that negligible changes are being recorded as required by SSD-5465.

If impacts are identified that are outside CVC's approved performance criteria, DC will investigate and undertake an assessment of the impacts. If the impacts cannot be remediated, a suitable offset will be provided in accordance with Condition 3 of Schedule 4 of SSD-5465.

4.4 Heritage Management Plan

CVC's Heritage Management Plan was reviewed and a draft for consultation was provided to stakeholders on the 6 November 2020 (Appendix 9). The Heritage Management Plan includes location and consideration of potential impacts to indigenous and non-heritage items. As part of Amendment 1 of this EP, the most recently approved Heritage Management Plan has been included, approved in September 2023.

All mining activities within MWS5 and NPA will occur beneath Lake Macquarie and as such will have no predicted direct impact on heritage features.

4.5 Built Features Management Plan

CVC's Built Features Management Plan (Appendix 10) was reviewed and updated as a part of this EP. This management plan was submitted for consultation with the relevant stakeholders as required by SSD-5465. Survey monitoring will be undertaken as per the Subsidence Monitoring Program. There are no built features identified above MWS5 and NPA.

If impacts are identified that are outside CVC's approved performance criteria, DC will investigate and undertake an assessment of the impacts.

4.6 Public Safety Management Plan

All mining activities within MWS5, NPA and Northeast and North Headings will occur beneath Lake Macquarie and as such will have no direct impact on surface facilities and infrastructure.

One navigational marker (Plan 2 of Appendix 14) is predicted to have negligible subsidence impacts from MWS5. As noted previously, RMS has been consulted in relation to this and have concluded that no direct management will be required and the marker will be able to be monitored as a part of routine inspections.

All proposed secondary extraction is outside of the HWMSB and Seagrass Protection Barrier and as such, no adverse impacts are anticipated on the immediate foreshore of Lake Macquarie as a result of extraction in MWS5, NPA or Northeast and North Headings.

Based on CVC's approved mine design, mining is not expected to result in any noticeable impacts along foreshore areas. Despite this, CVC will monitor the foreshore zone for any sign of change and if impacts as a result of mining are observed, a review of public safety measures will be triggered via the Subsidence Management TARP (Appendix 4).

Actions will be implemented by DC to reduce the risk to the public in the unlikely circumstance that impacts are identified outside those predicted and approved.

No other immediate increase in public safety risks have been identified.

4.7 Rehabilitation Management Plan

All mining activities within MWS5,NPA and Northeast and North Headings will occur beneath Lake Macquarie and as such will have no direct impact on surface facilities and infrastructure.

See Appendix 12 for the CVC Rehabilitation Management Plan.

4.8 Risk assessment

A risk assessment was conducted on 27 August 2020 and prepared as part of this EP (Appendix 3).

Each of the component management plans prepared for this EP include consideration of risk management.

4.9 Compensation and offsets

Based on predicted impacts, no compensation and/or offset requirements are anticipated.

5 Subsidence monitoring program

5.1 Overview

A copy of the Subsidence Monitoring Program is appended to this EP (Appendix 13) and environmental monitoring programs are provided in each of the relevant component plans. The proposed shoreline subsidence monitoring locations are shown on Plan 7 of Appendix 14 Graphical Plans.

Subsidence management at CVC is achieved through a combination of mine design and continual monitoring of key subsidence-related effects and impacts via the Subsidence Management TARP (Appendix 4). Regular and routine monitoring of the foreshore, lake bed, seagrass communities and benthic communities provide a means to verify and validate that predicted subsidence levels are not being exceeded and that the resultant levels of subsidence are not resulting in excessive impacts beyond those predicted. The mine design can be adapted and refined (as required) if exceedances occur or are likely to occur.

Bathymetric surveys of the lake bed and surveys of the foreshore will be used to validate and confirm predicted vertical subsidence around MWS5,NPA and Northeast and North Headings. Ongoing environmental monitoring (benthic and seagrass community surveys) will ensure that resultant vertical subsidence levels are not resulting in greater impacts than predicted.

As Lake Macquarie lies above MWS5,NPA and Northeast and North Headings, measurement of sub-surface fracture heights above the proposed miniwall is not recommended due to risks associated with drilling from a barge and potential intersection with goafs from barge-mounted drilling rigs after mining a given panel. Monitoring of groundwater inflow rates will be utilised to provide an indirect measure of connectivity between the lake and mine workings.

Ongoing inspections, monitoring and mapping of the stability of underground workings will continue along with assessments of groundwater monitoring data. In particular, the presence of a fault, dyke or joint shear zone that may have the potential to cause a hydraulic connection between the fracture zones, resulting in abnormal inflows, will be assessed on a case-by-case basis.

As stated previously, any strains at the lake bed surface itself will likely be more uniformly distributed and are therefore more likely to be absorbed by the plastic nature of the sediments. Accordingly, no monitoring or remediation for the potential minor cracking will be required as may be undertaken for land based cracking.

5.2 Monitoring frequency and review

As described in the Subsidence Monitoring Program, subsidence monitoring will include a combination of bathymetric surveys and foreshore level monitoring. Subsidence monitoring frequencies are defined in Table 11 and will be established to:

- validate model outcomes;
- enable early detection of subsidence impacts over those predicted; and
- allow early application of containment, adaptive and contingency measures to prevent impacts outside approved (particularly any potential increased impacts to the foreshore).

6 Implementation

6.1 Incidents and non-compliances

6.1.1 Procedure for investigation of incidents

In accordance with Condition 7 of Schedule 6 of Development Consent SSD-5465, CVC will notify and other relevant agencies of any incident, non-compliance or exceedance of performance criteria associated with this EP immediately after CVC becomes aware of the incident.

Within 7 days of the date of the incident or non-compliance, CVC will provide a detailed report on the incident to the Secretary and other relevant agencies. The incident investigation will follow CVC's Incident Reporting and Investigation procedure.

6.1.2 Procedure for quality assurance and review

The results of monitoring undertaken as part of the implementation of this EP will be provided to CVC's CCC at each meeting (occur quarterly).

Regular review of the EP and component plans is required by the conditions in Schedule 6 of SSD-5465. CVC is required to review and, if necessary, revise, the EP and relevant strategies, plans and programs within three months of the submission of:

- an audit under Condition 9 of Schedule 6 of SSD-5465;
- an incident report under Condition 7 of Schedule 6 of SSD-5465;
- an annual review under Condition 4 of Schedule 6 of SSD-5465; or
- any modification to the conditions of SSD-5465.

Any revisions to this EP (including component plans) must be completed to the satisfaction of the Secretary.

Table 11: Subsidence monitoring frequency (Ref Subsidence Monitoring Program)

Monitoring type	Pre-extraction	During extraction	Post extraction
Bathymetric surveys	Single baseline survey prior to extraction.	End of panel survey for Miniwall S5. Six-monthly surveys over areas of pillar extraction unless TARP triggered, in accordance with SSD-5465 Statement of Commitments	Annual for 3 years unless TARP triggered.
Terrestrial based subsidence monitoring (foreshore)	Baseline survey prior to commencement of extraction.	End of panel survey for S5 Quarterly surveys during primary and secondary extraction over areas undermined unless TARP triggered.	6 monthly surveys for the first year after secondary extraction Annual for 3 years unless TARP triggered.

Terrestrial based subsidence monitoring (general)	Baseline survey prior to commencement of extraction	Quarterly surveys during primary extraction over areas undermined, unless TARP triggered	Annual for 5 years unless TARP triggered, unless TARP triggered
Remote Sensing LiDAR		As required	As required
Surface Visual Inspection		Monthly inspections during primary and secondary extraction over areas undermined, unless TARP triggered	None
Underground Geotechnical Inspection	Inspection prior to commencement of pillar extraction	Monthly inspections during secondary extraction panels. **NOTE: Only areas that remain safely accessible.**	6 monthly inspections for the first year after secondary extraction. Annual for 3 years unless TARP triggered. **NOTE: Only areas that remain safely accessible.**

6.1.3 Complaints

Complaints in relation to the management of subsidence will be managed using the established protocols in Delta Coal's *Environmental Management System*.

6.1.4 Regular reporting

Regular reporting will be undertaken in accordance with the conditions within SSD-5465 and the relevant component management plans. Reports will be provided to DPHI and relevant agencies and will be posted on DC's website and discussed at CCC meetings. The results of monitoring undertaken as part of the implementation of this EP will be provided to CVC's CCC at each meeting (occur quarterly).

6.1.5 Annual reporting

As per Condition 4 of Schedule 6 of SSD-5465, by the end of March each year (or other timing as may be agreed by the Secretary), DC will review environmental performance at CVC for the previous year and submit an annual review, including:

- a description of the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;
- a comprehensive review of the monitoring results (including subsidence) and complaints records of the development over the past calendar year, which includes a comparison of these results against the:
    - relevant statutory requirements, limits or performance measures/criteria;
    - requirements of any plan or program required under this consent (including this EP and the component plans);
    - monitoring results of previous years; and relevant predictions in the EIS;

- any non-compliance over the past calendar year and a description of what actions were (or are being) taken to ensure compliance;
- any trends in the monitoring data over the life of the development;
- any discrepancies between the predicted and actual impacts of the development (including with regards to subsidence) and an analysis of the potential cause of any significant discrepancies; and
- a description of what measures will be implemented over the coming year to improve the environmental performance of the development.

6.2 Document review

In addition to routine auditing and review of environmental management plans, environmental management systems at CVC will be independently reviewed every three years by external experts suitably qualified to undertake such a review.

Regular review of the EP and component plans is required by the conditions in Schedule 6 of SSD-5465. CVC is required to review and, if necessary, revise, the EP and relevant strategies, plans and programs within three months of the submission of:

- an audit under Condition 9 of Schedule 6 of SSD-5465;
- an incident report under Condition 7 of Schedule 6 of SSD-5465;
- an annual review under Condition 4 of Schedule 6 of SSD-5465; or
- any modification to the conditions of SSD-5465.

Any revisions to this EP (including component plans) must be completed to the satisfaction of the Secretary.

6.3 Responsibilities

The overall responsibility for the implementation of this extraction plan sits with the Manager of Mining Engineering; however, other DC employees will have responsibilities under this EP to ensure that it is effectively implemented (Table 12).

Table 12: Roles and responsibilities for the implementation of this EP

Role	Responsibilities
Mining Engineering Manager	- Ensure that adequate financial and personnel resources are made available for the implementation of the EP - Maintain overall responsibility for environmental compliance with Mining Lease, EPL, SSD-5465 and other mining approvals as they pertain to subsidence management - Ensure all operations are undertaken in accordance with this EP - Ensure all mining is undertaken in accordance with approved mine plans
Technical Services Manager	- Provide adequate resources for the activities required under this EP - Provide technical review and assistance during the development of the EP and appendices - Coordinate technical consultants used as part of this EP
Environment Compliance & Approvals Coordinator	- Coordinate and undertake all environmental monitoring required under this EP - Ensure all reporting and monitoring is completed to an appropriate standard and in a timely manner - Ensure any discrepancies between actual monitoring results and predicted outcomes are reported to appropriate stakeholders as soon as practicable - Manage the implementation of all environmental management plans under this EP - Be responsible for all environmental reports, management plans, community consultation and communication with stakeholders and regulatory authorities
Mine Surveyor	- Preparation of the Subsidence Monitoring Program - Coordinate and undertake all subsidence monitoring requirements - Maintain plans and records of all subsidence monitoring - Distribute survey data to relevant stakeholders within agreed timeframes - Report any discrepancies and/or exceedances of actual survey results from expected/predicted data to the Environment Compliance & Approvals Coordinator and Manager of Mining Engineering - Prepare all subsidence-related reporting to an appropriate standard
All employees and contractors	- Comply with the requirements of this EP

7 Document control

7.1 Records

Generally, the Environment Compliance & Approvals Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data and equipment calibration;
- environmental inspections and auditing results;
  environmental incident reports;
- complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of four years or as otherwise required under any legislation, licence, lease, permit or approval.

7.2 Document control

This document and all others associated with CVC's Environmental Management System shall be maintained in a document control system which is in compliance with CVC's Document Control Standard. Any proposed changes to this document will be via the Environment Compliance & Approvals Coordinator or Technical Services Manager.

Details on document revisions are provided in Table 13.

Table 13: Document revision details

Version	Date	Details of revision	Company	Reviewed by/ Authorised by
1	17/12/2020	Draft EP	Delta Coal	C. Armit
1.1	18/01/2020	Comments incorporated from stakeholders	Delta Coal	C. Armit
1.2	10/03/2021	EP updated with comments from DPIE Request for Information letter (05/03/21)	Delta Coal	C.Armit
1.3	27/05/2024	Amendment request. Plan reviewed to incorporate additional geotechnical and subsidence prediction assessment for minor modification of planned pillar extraction in the NPA.	Delta Coal	P van Rooyen
2	26/08/2024	Revision of Plans and document to reflect current mining status, addressing DPHI's RFI to Amendment 1 of the EP.	Delta Coal	L McWha.
3	07/05/2025	Revision of plans to incorporate double-sided lifting extraction methodology in remaining extraction areas in Northern Pillar Area.	Delta Coal	L McWha.
4	19/11/2025	Revision of plans to incorporate double-sided lifting extraction methodology in the Northeast and North Headings.	Delta Coal	N Birt

8 References

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  - 2018b*, Subsidence Impact Assessment of the Proposed Northern Area Miniwalls (S1 and N1) at Chain Valley Colliery,* (DGS CHV-002-11a). Report prepared by DGS for LakeCoal.

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  - 2014, *Chain Valley Colliery Modification 1 – Statement of Environmental Effects*. Report prepared by EMM for LakeCoal.
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- Mine Advice 2024, Assessment of Proposed Secondary Extraction, North Headings, NE Headings and Herringbone Mains, Fassifern Seam. Report No. Chain Valley 10/1.
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- Mine Advice 2025, Adequacy of Barrier Pillars Between Extracted Miniwalls (MW's 1 to 3, 6 to 12 and S2 to S5) and Proposed Double-Sided Lifting-Off in the Northeast and North Main Headings. Report No. Chain Valley 12/2.
- MSEC 2018, *Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Miniwalls S2 and S3 in Support of the Extraction Plan* (979 Rev. 2). Report prepared by MSEC for Lake Coal.

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9 Abbreviations

ACARP	Australian Coal Industry Research Program
CCC	Community Consultative Committee
CVC	Chain Valley Colliery
DC	Delta Coal
DPIE	NSW Department of Planning, Industry and Environment
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental impact statement
EMS	Environmental Management System
EP	extraction plan
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
MC	Mannering Colliery
Mining Act	NSW *Mining Act 1992*
POEO Act	NSW *Protection of the Environment Operations Act 1997*
ROM	run-of-mine
Secretary	Planning Secretary of DPIE (or nominee)
SEE	Statement of environmental effects
SSD	State significant development

Appendix 1 Consultation

Appendix 1.1 – MWS5 and NPA Extraction Plan (2021) Consultation

Chris Armit

From: Chris Armit
Sent: Thursday, 17 December 2020 3:15 PM
To: rog.hcc@environment.nsw.gov.au; Resources Regulator; Margaret MacDonald-Hill; scott.carter@dpi.nsw.gov.au; Geoffrey Keech; Melissa Sawatzki; Council@lakemac.nsw.gov.au; dpi.cabinet@dpi.nsw.gov.au; cassandra.mcnamara@dpi.nsw.gov.au; Matthew.Montgomery@finance.nsw.gov.au; Ray Ramage; dan.adams@planning.nsw.gov.au; Robert Gibson; Joanna Pajkowska; landuse.enquiries@industry.nsw.gov.au; water.referrals@dpi.nsw.gov.au; Mitchell Isaacs; Danielle.Allen@centralcoast.nsw.gov.au; Jenny Mewing; EPA RSD Hunter Region Mailbox; Steve Clair; HERITAGEMailbox@environment.nsw.gov.au
Cc: Tim Chisholm; Chris Nicholas; Dave McLean; David Hill; Melissa Anderson; Matthew Sprott
Subject: Miniwall 5S and Northern Pillar Area Extraction Plan draft for comment and associated MP status

Dear All,

The draft Miniwall 5S and Northern Pillar Area Extraction Plan document (as a word doc) has been uploaded onto the Delta Coal website (https://www.deltacoal.com.au/environment/chain-valley-colliery/ch) for your comment. After 14 January 2021 (i.e. 28 days) and the inclusion/consideration of your comments this Extraction Plan document will be uploaded onto the DPIE planning portal.
Also available in this part of the website is the Subsidence Prediction report for your review.

By way of an update the mine is continuing with secondary extraction beneath Lake Macquarie with current miniwall production being in MWS4 and are planning to commence mining in Miniwall 5S in April 2021. Bord and Pillar (Herringbone) commenced in August 2020 with Pillar Extraction planned in July 2021.

The associated management plan reviews have been and are being submitted to relevant stakeholders and comments are being received, thank you for your comments on these.

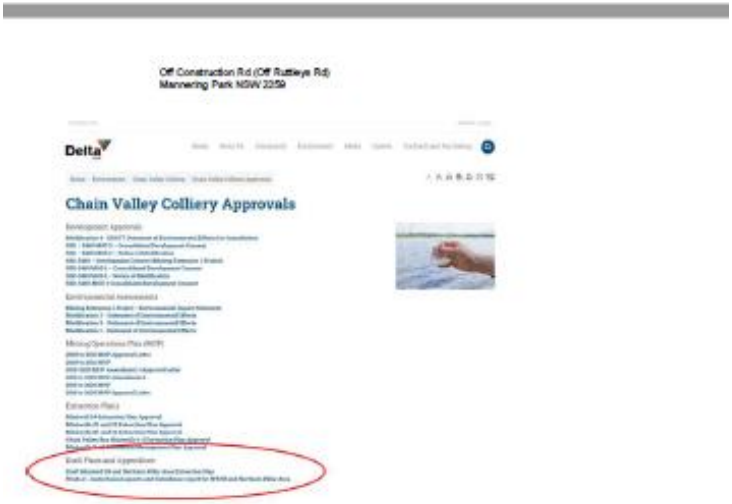
Associated Management Plan	Submitted to stakeholders
CVC Benthic Communities MP	November 2020
CVC Seagrass MP	November 2020
DC Heritage MP	November 2020
CVC Rehabilitation MP	December 2020
CVC Public Safety MP	December 2020
CVC Built Features MP	December 2020
CVC Water MP	December 2020

As always, happy to go through any comments you have in person or over the phone.

Thanks for your collective assistance over 2020 and look forward to working with you all again in 2021. Happy Holidays !

Regards,
Chris

Delta coal
Chris Armit
Approvals Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 203
Chain Valley Colliery



DPIE Request for Information Letter

Planning, Industry & Environment

Chris Armit
Approvals Coordinator
Chain Valley Colliery

Off Construction Rd (Off Ruttleys Rd)
MANNERING PARK, NSW, 2259

05/03/2021

Dear Mr Armit

Chain Valley Colliery
Extraction Plan – Miniwall S5 and Northern Pillar Area

I refer to the Extraction Plan dated January 2021 for Miniwall S5 and the Northern Pillar Area (NPA) at the Chain Valley Colliery, submitted in accordance with condition 7 of Schedule 4 of the Chain Valley Extension Project development consent (SSD 5465).

The Department has reviewed the Extraction Plan and identified several clarifications and minor matters that must be addressed by way of improvements to various parts of the Extraction Plan and its sub-plans (see Attachment A). The Department is satisfied that these matters can be addressed in a timely manner and would not materially change the ability of Delta Coal to effectively manage subsidence impacts.

In summary, the revised Extraction Plan should:

- include the detailed plans of existing and proposed first and second workings that clearly indicate the High Water Mark Subsidence Barrier (Plan 2) and show that all areas of proposed extraction are outside of the Seagrass Protection Barrier;
- where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls;
- include detailed performance indicators and contingencies for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent;
- include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP;
- include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments; and
- align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions.

The attached comments on the Extraction Plan and its sub-plans must be addressed to the satisfaction of the Secretary prior to the Department granting its final approval of the Extraction Plan. As noted above, the Department believes that they can be readily addressed in a timely manner. It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review.

If you require any more information, please contact James McDonough on 9585 6313.

Yours sincerely

DPIE Request for Information Letter - Response Summary Table

DPIE Review	Response
include the detailed plans of existing and proposed first and second workings that clearly indicate the High Water Mark Subsidence Barrier (Plan 2) and show that all areas of proposed extraction are outside of the Seagrass Protection Barrier	Plan 2 updated to include clear indication of the High Water Subsidence Barrier. All secondary workings extraction areas are located outside of Seagrass Protection Barrier.
where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls	Document updated for legacy miniwall naming (see tracked changes)
include detailed performance indicators and contingencies for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent	Subsidence Management TARP updated to include Threatened Species or Endangered Populations
include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP	Incident and non-compliance reporting timeframes included. Timeframes of contingency measures implementation added to the Subsidence Management TARP
include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments	See updates in section 2.5 Table 1 and Appendix 1 which includes specific stakeholder comment details and communications.
align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions	Consent references updated to changes in SSD5465 Modification 3 numbering and conditions.
It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review	A Microsoft Word document has been provided with tracked changes included at the start of the document change process. Plan 2 amendment and Subsidence Management TARP were not able to be tracked changed as they were drafted in software without the tracked changes option.

DPIE Request for Information Table – Attachment A Response Summary Table

Delta Coal – Chain Valley Colliery
Miniwall S5 and Northern Pillar Area Extraction Plan Review – March 2021

Extraction Plan, Schedule 4, Condition 7	Satisfactory (Yes/No)	Comment	Action Required	Delta Coal Response
The Applicant must prepare an Extraction Plan for all second workings on site, to the satisfaction of the Planning Secretary. Each Extraction Plan must:	No	The Extraction Plan (EP) is considered a well-structured and written document, which includes good quality figures. The EP includes clear summaries of subsidence predictions, impacts, monitoring, management and performance measures.	See actions in the rows below.	
(a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary;	Yes	Section 2.4 indicates that the EP has been prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Department of Planning, Industry and Environment (DPIE) (see letter dated 22/10/2020, provided as an attachment to the EP).	Nil	
(b) be approved by the Planning Secretary before the Applicant carries out any second workings covered by the plan;	N/a	N/a	N/a	
(c) include detailed plans of existing and proposed first and second workings and any associated surface development, including any applicable adaptive management measures;	No	Section 3.4 of the EP states that MWS5 and NPA has been designed to ensure that no secondary extraction will occur within the High Water Mark Subsidence Barrier (HWMSB) or Seagrass Protection Barrier (SPB). Plan 2 indicates there is a small area of proposed secondary extraction within the NPA, to the north-west of MWS5, that encroaches into the seagrass protection barrier. Further, the HWMSB is not clearly shown, despite being shown as a layer in the legend of this plan.	Update Plan 2 to show • all proposed secondary extraction occurring outside of the seagrass protection barrier; and • the HWMSB.	Plan 2 updated
(d) include detailed performance indicators for each of the performance measures in Tables 6 and 7;	No	Section 3.3 of the EP states that the Fassifern Seam first workings in the Miniwall S4 area are not beneath any of the features listed in Table 6 of SSD-5465. Should a change to first workings necessitate this, the first workings will be designed to be long-term stable. In the unlikely event that greater than negligible/minor impacts occur, the Subsidence Management TARP (Appendix 4) will be implemented. The TARP includes detailed performance indicators. The TARP does not include detailed performance indicators for Threatened Species or Endangered Populations (as listed in Table 6).	Update Section 3.3 of the EP to refer to Miniwall S5 and the NPA. Update the TARP to include detailed performance indicators for Threatened Species or Endangered Populations.	Section 3.3 updated Subsidence Management TARP updated
(e) provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this consent;	Yes	Long-term vertical subsidence is predicted to be 500 mm, compared to the approved limit for subsidence of 780 mm beneath the waters of Lake Macquarie. No impacts to sensitive environmental features or the built environment are predicted.	Nil	
(f) describe the measures that would be implemented to ensure compliance with the performance measures in Tables 6 and 7, and manage or remediate any impacts and/or environmental consequences;	Yes	The TARP does not include detailed performance indicators for Threatened Species or Endangered Populations (as listed in Table 6). It is therefore also lacking any description of the measures that would be implemented to ensure compliance with such indicators.	Update the TARP to include measures to ensure compliance with detailed performance indicators for Threatened Species or Endangered Populations.	Subsidence Management TARP updated for TS and Endangered populations
(g) include a Built Features Management Plan, which has been prepared in consultation with RR and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which • addresses in appropriate detail all items of public infrastructure and all classes of other built features; • has been prepared following appropriate consultation with the owner/s of potentially affected feature/s; • recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and;	No	The plan was submitted for consultation with the relevant stakeholders as required by the conditions of consent. However, consultation with the CCC is discussed in terms of the planned development of Miniwalls S2, S3 and S4. Further, no details of consultation are provided in Table 1.	Update Section 2.3 Consultation to refer to Miniwall S5 and the NPA and include within Table 1 the specific comments made by consultees and a summary of how they were addressed within the plan.	Evidence of CCC consultation of MWS5/NPA presentation provided in Appendix 1 Consultation Summary added to Table 1
(h) include a Benthic Communities Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on benthic communities, and which includes: • surveys of the lake bed to enable contours to be produced and changes in depth following subsidence to be accurately measured; • benthic species surveys within the area subject to second workings, as well as control sites outside the area subject to second workings (at similar depths) to establish baseline data on species number and composition within the communities;	No	The plan was submitted for consultation with the relevant stakeholders as required by the conditions of consent. Table 1 presents a summary of the consultation undertaken. It notes comments were made by LMCC and that Delta Coal (DC) updated Section 5.2 of the plan in response to those comments. There are no specific details on the comments made by LMCC or how they were addressed by updating Section 5.2.	Update Table 1 to include the specific comments made by LMCC and a summary of how they were addressed within the plan.	Evidence of LMCC consultation provided in Appendix 1 Consultation included in Appendix 1 Consultation Summary added to Table 1

Extraction Plan, Schedule 4, Condition 7	Satisfactory (Yes/No)	Comment	Action Required	Delta Coal Response
• a program of ongoing seasonal monitoring of benthic species in both control and impact sites; • development of a model to predict likely impact of increased depth and associated subsidence impacts and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities composition, incorporating the monitoring and survey data collected; and • updating the model every 2 years using the most recent monitoring and survey data;				
(i) include a Seagrass Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on seagrass beds, and which includes: • a program of ongoing monitoring of seagrasses in both control and impact sites; and • a program to predict and manage subsidence impacts and environmental consequences to seagrass beds to ensure the performance measures in Table 6 are met;	No	The plan was submitted for consultation with the relevant stakeholders as required by the conditions of consent. Table 1 presents a summary of the consultation undertaken. It notes comments were made by LMCC and that DC updated Section 4.3 of the plan in response to those comments. There are no specific details on the comments made by LMCC or how they were addressed by updating Section 4.3. Section 8.1 Review and improvement. The proposed timing of reviews and revisions to the plan set out in this section do not align with the wording in condition 5 of Schedule 6 of the conditions of consent.	Update Table 1 to include the specific comments made by LMCC and a summary of how they were addressed within the plan. Update Section 8.1 to align with the requirements of condition 5 of Schedule 6 of the conditions of consent.	Evidence of LMCC consultation provided in Appendix 1 Consultation Summary added to Table 1 Consultation included in Appendix 1
(j) include a Public Safety Management Plan, which has been prepared in consultation with RR, to ensure public safety;	No	The plan was submitted for consultation with RR as required by the conditions of consent. However, no details of consultation, including any comments received and changes made in response to those comments, are provided in the table in Appendix 1. Section 8.1 Review and improvement. The proposed timing of reviews and revisions to the plan set out in this section do not align with the wording in condition 5 of Schedule 6 of the conditions of consent.	Update the table in Appendix 1 to include the specific comments made by RR (if any) and a summary of how they were addressed within the plan. Update Section 8.1 to align with the requirements of condition 5 of Schedule 6 of the conditions of consent.	Evidence of Resource Regulator provided in Appendix 1 Consultation included in Appendix 1 Consultation Summary added to Table 1

Extraction Plan, Schedule 4, Condition 7	Satisfactory (Yes/No)	Comment	Action Required	Delta Coal Response
(k) include a Subsidence Monitoring Program which has been prepared in consultation with RR, 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; and • informs the contingency plan and adaptive management process;	No	The monitoring program was submitted for consultation with RR as required by the conditions of consent. However, no details of consultation, including any comments received and changes made in response to those comments, are provided in the document.	Update the program to include the specific comments made by RR (if any) and a summary of how they were addressed within the plan.	Evidence of RR consultation provided in Appendix 1
(l) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 6 and 7, or where any such exceedance appears likely;	No	The EP states that in the unlikely event that greater than negligible/minor impacts occur, the Subsidence Management TARP (Appendix 4) will be implemented. The TARP includes detailed performance indicators. However, the TARP does not include detailed performance indicators for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent. The contingency measures set out in the Subsidence Management TARP do not include timeframes for implementation. Further, under EP Appendix 2 Development Consent Requirements, the conditions set out in the table are out of date. The table has not been updated to include the most recent conditions of consent following the approval of Mod 3 in June 2020.	Update the TARP to include detailed performance indicators for Threatened Species or Endangered Populations. Update the Subsidence Management TARP to include timeframes for implementation of contingency measures. Update Appendix 2 to include the current conditions of consent.	Subsidence Management TARP updated for TS and Endangered populations Appendix 2 updated for current conditions of consent
(m) include appropriate revisions to the Rehabilitation Management Plan required under Condition 27 of Schedule 3; and	Yes	A rehabilitation management plan has been provided in Appendix 12. The applies to the surface operations at Chain Valley Colliery (CVC), including pit top facilities and lands where additional infrastructure may be constructed. As no infrastructure is being constructed as part of implementation of the EP, the Dept is satisfied that the RMP revisions are appropriate.	Nil	
(n) include a program to collect sufficient baseline data for future Extraction Plans.	Yes	The subsidence monitoring program includes a comprehensive baseline data monitoring program comprised of bathymetric surveys, fixed foreshore	Nil	

Extraction Plan, Schedule 4, Condition 7	Satisfactory (Yes/No)	Comment	Action Required
		monitoring surveys, seagrass monitoring and benthic community monitoring of areas within and outside the EP area.	
The Applicant must implement the Extraction Plan as approved by the Planning Secretary.	N/a	N/a	N/a
Schedule 4, Condition 8	**Satisfactory (Yes/No)**	Comment	**Action Required**
8. The Applicant must ensure that the management plans required under conditions 7(g)-(j) above include: (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this consent; and	Yes	The management plans required under conditions 7(g)-(j) have been developed with consideration of predicted subsidence impacts determined through the development of detailed subsidence predictions based on a detailed mine plan for MWS5 and the NPA. Impacts to built features and the natural environment are expected to be negligible.	Nil
(b) a detailed description of the measures that would be implemented to remediate predicted impacts.	Yes	Notwithstanding the comments above, the plans required under conditions 7(g)-(j) include a detailed and comprehensive description of the monitoring, mitigation and contingency measures proposed to manage or remediate potential impacts.	Nil
Evidence of consultation, Schedule 2, Condition 22	**Satisfactory (Yes/No)**	**Comment**	**Action Required**
22. Where conditions of this consent require consultation with an identified party, the Applicant must: (a) consult with the relevant party prior to submitting the subject document; (b) provide details of the consultation undertaken including: i. the outcome of that consultation, matters resolved and unresolved; and ii. details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.	No	Refer to the comments in the rows above regarding consultation with relevant parties. Further, consultation is documented in Section 2. 5 of the EP. Table 1 states that no comments were received from any consultees. However, in correspondence provided to the Department on 23/02/2021 (subsequent to lodgement of the EP for approval), Delta Coal indicated it had received four responses from agencies, as follows: • BCD indicated it had no comment • Transport for NSW indicated its satisfaction with the safety of the Pelican Rock Navigational Marker and provided feedback on the extra navigational markers, which were incorporated into the revised Built Features Management Plan. • LMCC provided minor comments on the MPs, which were incorporated by Delta Coal into revised versions of these MPs. • The Resource Regulator indicated it was satisfied with the resource recovery that was proposed and that a revision of the rehabilitation bond would be triggered by this Extraction Plan. Summaries of this correspondence have not been included within the EP.	Update the EP to include summaries of all correspondence on the EP, including details of the comments made and the actions taken by Delta Coal in response to those comments.

Delta Coal Response

Consultation Summary added to Table 1

Consultation evidence provided in Appendix 1

Transport for NSW – Maritime Consultation

CA Chris Armit Kumar Kuruppu; Lynda Hourigan; Melissa Anderson; Wayne Jones; Navigation Advice North; Chris Nicholas 01/02/

RE: Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - CVC Built Features Management Plan (SSD-5465-PA-38) (Central Coast,Lake Macquarie City)

Thanks heaps Kumar and Lynda for your input, appreciated.
Proposed responses below. I will include in the BFMP and provide the finalised MP when approved by DPIE.
regards,
Chris

From: Kumar Kuruppu <Kumar.Kuruppu2@transport.nsw.gov.au>
Sent: Monday, 1 February 2021 3:25 PM
To: Chris Armit <CArmit@deltacoal.com.au>
Cc: Melissa Anderson <Melissa.Anderson@planning.nsw.gov.au>; Wayne Jones <wayne.jones@planning.nsw.gov.au>; Navigation Advice North <navigationadvicenorth@rms.nsw.gov.au>
Subject: FW: Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - CVC Built Features Management Plan (SSD-5465-PA-38) (Central Coast,Lake Macquarie City)

Good afternoon Chris,
Please find Transport for NSW (TfNSW) Maritime advice below in relation to a post approval matter for the Chain Valley Extension Project- SSD-5465 referred to TfNSW by Department of Planning, Industry and Environment via Major Projects Portal.
A copy of this advice will also be uploaded to MP Portal.
Kind regards

Kumar Kuruppu
Development Services Case Officer
Development Services North
Regional and Outer Metropolitan
Transport for NSW

T 02 4908 7688
Level 8, 266 King Street Newcastle NSW 2300

NSW GOVERNMENT Transport for NSW

Use public transport... plan your trip at transportnsw.info

I acknowledge the traditional owners and custodians of the land in which I work and pay my respects to Elders past, present and future.

Text Below in Black is response from C Armit 1 February 2021 Email

From: Lynda Hourigan **On Behalf Of** Navigation Advice North
Sent: Monday, 1 February 2021 1:18 PM
To: Kumar Kuruppu <Kumar.Kuruppu2@transport.nsw.gov.au>; Navigation Advice North <navigationadvicenorth@rms.nsw.gov.au>
Cc: Mike Baldwin <Mike.Baldwin@transport.nsw.gov.au>; Brett Boehm <Brett.Boehm@transport.nsw.gov.au>; Chris Austen <Chris.Austen@transport.nsw.gov.au>; Peter Browne <Peter.Browne@transport.nsw.gov.au>; Nicole Waller <Nicole.Waller@transport.nsw.gov.au>; Lun Yeung <lun.yeung@transport.nsw.gov.au>; Sonia Mckay <Sonia.McKay@transport.nsw.gov.au>; Nathan Koch <Nathan.Koch@transport.nsw.gov.au>
Subject: RE: Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - CVC Built Features Management Plan (SSD-5465-PA-38) (Central Coast,Lake Macquarie City)

Hello Kumar

Thank you for your email requesting TfNSW Maritime's comment on the CVC Built Features Management Plan below.

Transport for NSW (TfNSW) Maritime is responsible for the ongoing maintenance of safe navigation throughout NSW under the Marine Safety Act 1998. As such, proposals like this are reviewed to ensure that any disruption to navigation for vessels is minimised as much as is practical.

The project documentation provided has been assessed as having minimal impact on the safety of navigation to vessels operating in this area and Maritime has no objections to the proposed works.

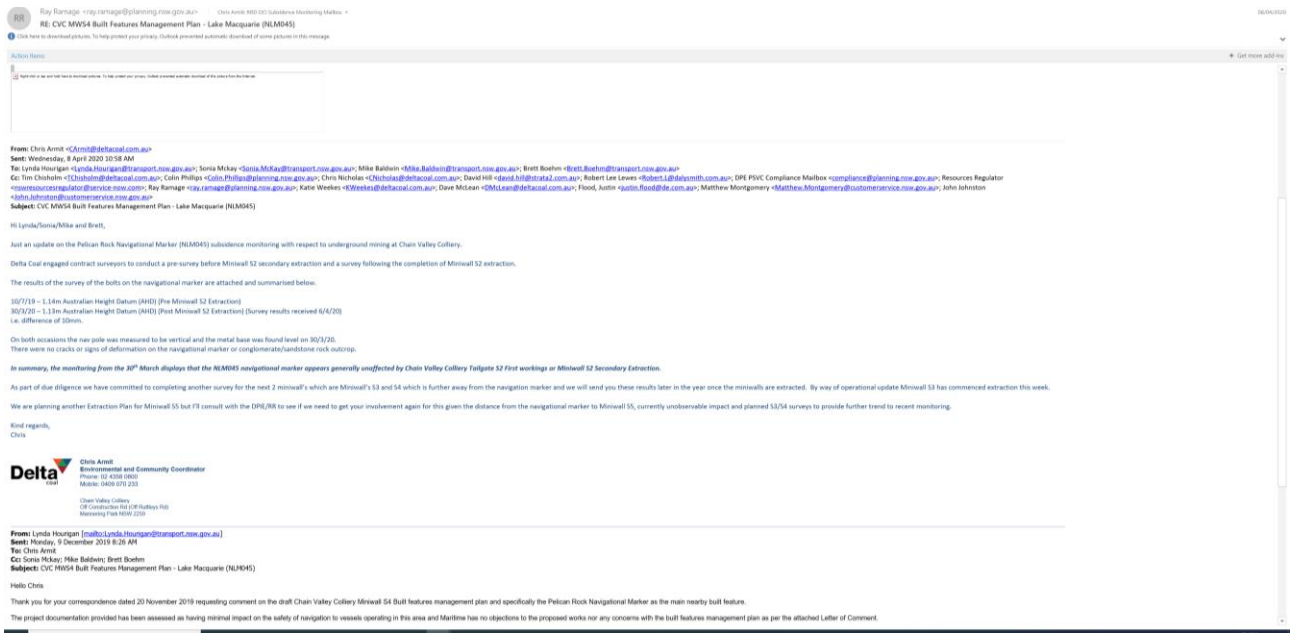
TfNSW Maritime advises the following matters need to be considered and addressed when preparing the REF and / or the Scope of Works for the Chain Valley Extension Project:

1. Any works impacting on navigation during the construction phase must seek TfNSW Maritime support 21 days prior to works commencing. A full scope of works including dates is to be provided to *navigationadvicenorth@rms.nsw.gov.au.* The extraction plan forms this scope of works.
2. All associated work boats to comply with the relevant NSW Marine Legislation for survey, registration and safety equipment, and comply with the Marine Safety (Domestic Commercial Vessels) National Law Act 2012. Noted – Mine Surveyor and survey contractors notified, will add to BFMP
3. Vessels must exhibit lights and shapes in accordance with International Regulations for Preventing Collisions at Sea. Noted – Mine Surveyor and survey contractors notified, will add to BFMP
4. ***"That If the subsidence was >500mm or the pylon ends up with more than 5° of lean on it, then there would need to be action taken."*** and NSW Maritime is to be notified immediately. Will include in BFMP and Subsidence TARP
5. For pelican rock NLM045, please confirm if this is an additional 155mm vertical subsidence to the 130mm already predicted for the mining of Miniwall S2-S4. NSW Maritime is seeking confirmation that the vertical subsidence is still within the limits allowing the project to go ahead without any action needed to be taken on NLM045. This is a total 155mm vertical subsidence, not additional. Navigational marker was already mined under in 2019, navigational marker NLM045 is located under a solid chain pillar, last subsidence measured was 30mm post Miniwall S3, no tilt change measured/vertical.
6. NSW Maritime acknowledges that the 4mm/m tilt on NLM045 is less than 0.25 degrees so this is not an issue and using this same criteria for NLM062 the 20mm movement and 0 tilt is also acceptable. Noted
7. NSW Maritime notes that NLM063 and NLM064 are both buoys so the tide has more impact on the Aid to Navigation height than the mining with the effect on the chain length and scope being almost undetectable. Therefore the subsidence values for these are also acceptable. Noted

Subsequently, NSW Maritime advises that "**There is no action required for these 4 navigation aids for the predicted subsidence and tilts and no further action required unless the subsidence and tilt exceed the values that have previously stipulated"** Will include consultation in the BFMP and provide an updated MP to reflect this.

For more information, please direct all correspondence to *navigationadvicenorth@rms.nsw.gov.au*.

Kind regards, Lynda Hourigan



Ray Ramage <ray.ramage@planning.nsw.gov.au>

RE: CVC MWS4 Built Features Management Plan - Lake Macquarie (NLM045)

From: Chris Armit <CArmit@deltacoal.com.au>
Sent: Wednesday, 8 April 2020 10:58 AM
To: Lynda Hourigan <Lynda.Hourigan@transport.nsw.gov.au>; Sonia Mckay <Sonia.McKay@transport.nsw.gov.au>; Mike Baldwin <Mike.Baldwin@transport.nsw.gov.au>; Brett Boehm <Brett.Boehm@transport.nsw.gov.au>
Cc: Tim Chisholm <TChisholm@deltacoal.com.au>; Colin Phillips <Colin.Phillips@planning.nsw.gov.au>; Chris Nicholas <CNicholas@deltacoal.com.au>; David Hill <david.hill@strata2.com.au>; Robert Lee Levers <Robert.L@dalysmith.com.au>; DPE PSVC Compliance Mailbox <compliance@planning.nsw.gov.au>; Resources Regulator <nswresourcesregulator@service-now.com>; Ray Ramage <ray.ramage@planning.nsw.gov.au>; Katie Weekes <KWeekes@deltacoal.com.au>; Dave McLean <DMcLean@deltacoal.com.au>; Flood, Justin <justin.flood@de.com.au>; Matthew Montgomery <Matthew.Montgomery@customerservice.nsw.gov.au>; John Johnston <John.Johnston@customerservice.nsw.gov.au>
Subject: CVC MWS4 Built Features Management Plan - Lake Macquarie (NLM045)

Hi Lynda/Sonia/Mike and Brett,

Just an update on the Pelican Rock Navigational Marker (NLM045) subsidence monitoring with respect to underground mining at Chain Valley Colliery.

Delta Coal engaged contract surveyors to conduct a pre-survey before Miniwall S2 secondary extraction and a survey following the completion of Miniwall S2 extraction.

The results of the survey of the bolts on the navigational marker are attached and summarised below.

10/7/19 – 1.14m Australian Height Datum (AHD) (Pre Miniwall S2 Extraction)
30/3/20 – 1.13m Australian Height Datum (AHD) (Post Miniwall S2 Extraction) (Survey results received 6/4/20)
i.e. difference of 10mm.

On both occasions the nav pole was measured to be vertical and the metal base was found level on 30/3/20.
There were no cracks or signs of deformation on the navigational marker or conglomerate/sandstone rock outcrop.

In summary, the monitoring from the 30th March displays that the NLM045 navigational marker appears generally unaffected by Chain Valley Colliery Tailgate S2 First workings or Miniwall S2 Secondary Extraction.

As part of due diligence we have committed to completing another survey for the next 2 miniwall's which are Miniwall's S3 and S4 which is further away from the navigation marker and we will send you these results later in the year once the miniwalls are extracted. By way of operational update Miniwall S3 has commenced extraction this week.

We are planning another Extraction Plan for Miniwall S5 but I'll consult with the DPIE/RR to see if we need to get your involvement again for this given the distance from the navigational marker to Miniwall S5, currently unobservable impact and planned S3/S4 surveys to provide further trend to recent monitoring.

Kind regards,
Chris

Delta coal
Chris Armit
Environmental and Community Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259

From: Lynda Hourigan [mailto:Lynda.Hourigan@transport.nsw.gov.au]
Sent: Monday, 9 December 2019 8:26 AM
To: Chris Armit
Cc: Sonia Mckay; Mike Baldwin; Brett Boehm
Subject: CVC MWS4 Built Features Management Plan - Lake Macquarie (NLM045)

Hello Chris

Thank you for your correspondence dated 20 November 2019 requesting comment on the draft Chain Valley Colliery Miniwall S4 Built features management plan and specifically the Pelican Rock Navigational Marker as the main nearby built feature.

The project documentation provided has been assessed as having minimal impact on the safety of navigation to vessels operating in this area and Maritime has no objections to the proposed works nor any concerns with the built features management plan as per the attached Letter of Comment.

EPA Consultation

DOC20/1053542

Major Projects
Planning and Assessment Division
Department of Planning, Industry and Environment
Locked Bag 5022
PARRAMATTA NSW 2124

No Comment to Planning Advice Requests – Draft Water Management Plan and Miniwall S5 and Northern Pillar Area Extraction Plan. Chain Valley Colliery Extension Project SSD – 5465 -Mod 4.

Dear Sir/Madam

Reference is made to your correspondence requesting input from the Environment Protection Authority (EPA) on the proposed Miniwall S5 and Northern pillar area extraction plan (Chain Valley Colliery Extention Project SSD-5465) (sent 17 December 2020) and the draft Chain Valley Colliery Water Management Plan (sent 18 December 2020).

The EPA encourages the development of such plans to ensure that proponents have determined how they will meet their statutory obligations and designated environmental objectives. However, as a regulatory authority, the EPA does not approve or endorse these documents as our role is to set environmental objectives for environmental management, not to be directly involved in the development of strategies to achieve those objectives.

The EPA has not reviewed the above documents.

In view of these factors, the EPA has no comments to provide on this project and no follow-up consultation is required.

If you have any questions about this request, please contact Steve Clair on (02) 49086850 or via email at steve.clair@epa.nsw.gov.au.

Yours sincerely

PETER JAMIESON
Unit Head – Regulatory Operations - Metropolitan North
Environment Protection Authority

cc: CAmit@deltacoal.com.au

Phone 131 555 | TTY 133 677 | Locked Bag 5022 | 4 Parramatta Square | info@epa.nsw.gov.au
Phone +61 2 9995 5555 (from outside NSW) | ABN 43 692 285 758 | Parramatta NSW 2124 Australia | 12 Darcy St, Parramatta NSW 2150 Australia | www.epa.nsw.gov.au

DPI - Fisheries Consultation

SC

Scott Carter <scott.carter@dpi.nsw.gov.au> Chris Armit 15/01/2021

RE: Miniwall S5 and Northern Pillar Area Extraction Plan draft for comment and associated MP status

You replied to this message on 15/01/2021 12:11 PM.
Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

Our Ref: C20/815

Chris

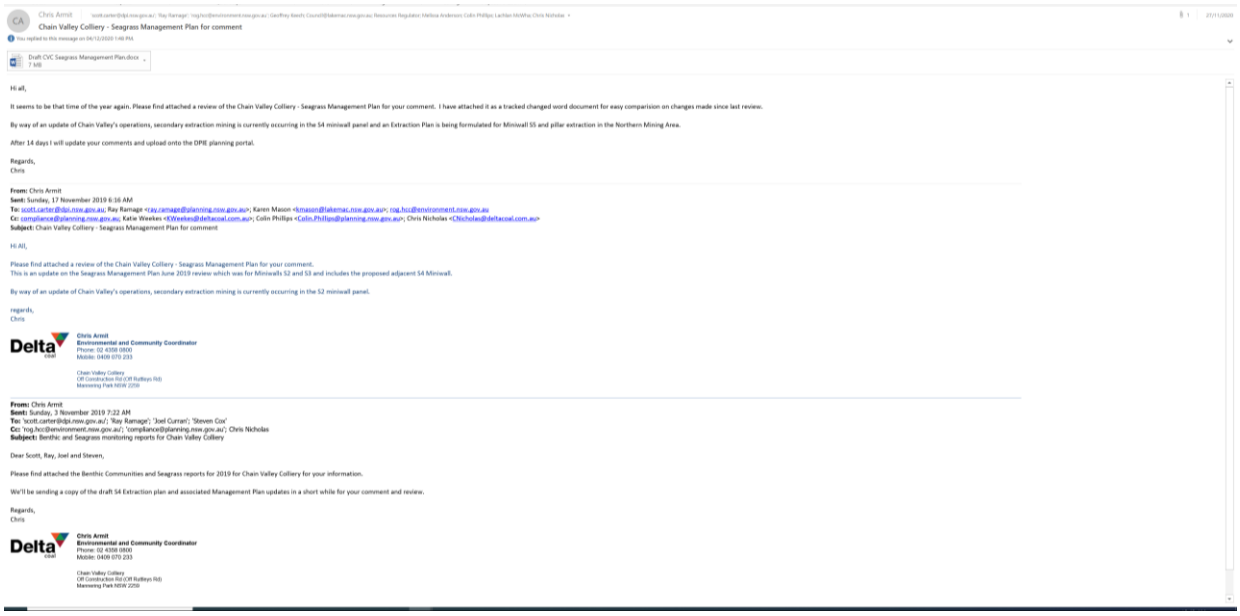
Apologies for late reply.

Based on the previous mining activities and the changes to the mining methods in the current proposal the Department has no objections to the works proceeding as described.

regards

Scott Carter
Senior Fisheries Manager Coastal Systems
NSW Department of Primary Industries | Fisheries
Port Stephens Fisheries Institute| Taylors Beach | NSW 2316
T: +61 2 4916 3931 | E: scott.carter@dpi.nsw.gov.au

ALL MAIL TO: DPI Fisheries, Attn: R. Philps,1243 Bruxner Hwy, Wollongbar NSW 2477



Chain Valley Colliery - Seagrass Management Plan for comment

Hi all,

It seems to be that time of the year again. Please find attached a review of the Chain Valley Colliery - Seagrass Management Plan for your comment. I have attached it as a tracked changed word document for easy comparison on changes made since last review.

By way of an update of Chain Valley's operations, secondary extraction mining is currently occurring in the S4 miniwall panel and an Extraction Plan is being formulated for Miniwall S5 and pillar extraction in the Northern Mining Area.

After 14 days I will update your comments and upload onto the DPIE planning portal.

Regards,
Chris

From: Chris Armit
Sent: Sunday, 17 November 2019 6:16 AM
To: scott.carter@dpi.nsw.gov.au; Ray Ramage; Karen Mason; rog.hcc@environment.nsw.gov.au
Cc: compliance@planning.nsw.gov.au; Katie Weekes; Colin Phillips; Chris Nicholas
Subject: Chain Valley Colliery - Seagrass Management Plan for comment

Hi All,

Please find attached a review of the Chain Valley Colliery - Seagrass Management Plan for your comment.
This is an update on the Seagrass Management Plan June 2019 review which was for Miniwalls S2 and S3 and includes the proposed adjacent S4 Miniwall.

By way of an update of Chain Valley's operations, secondary extraction mining is currently occurring in the S2 miniwall panel.

regards,
Chris

Chris Armit
Environmental and Community Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259

From: Chris Armit
Sent: Sunday, 3 November 2019 7:22 AM
To: 'scott.carter@dpi.nsw.gov.au'; 'Ray Ramage'; 'Joel Curran'; 'Steven Cox'
Cc: 'rog.hcc@environment.nsw.gov.au'; 'compliance@planning.nsw.gov.au'; Chris Nicholas
Subject: Benthic and Seagrass monitoring reports for Chain Valley Colliery

Dear Scott, Ray, Joel and Steven,

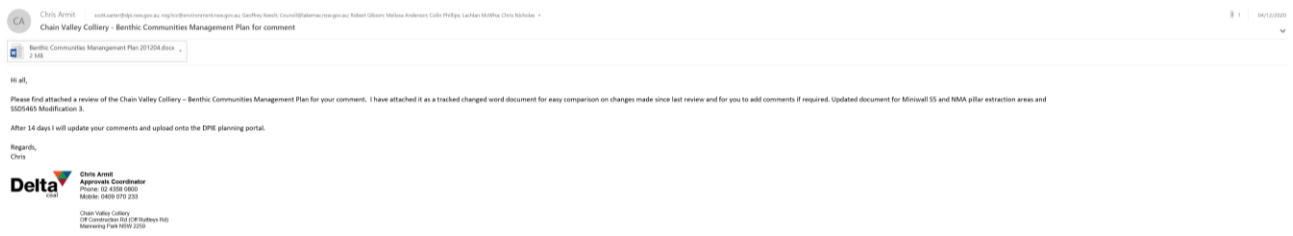
Please find attached the Benthic Communities and Seagrass reports for 2019 for Chain Valley Colliery for your information.

We'll be sending a copy of the draft S4 Extraction plan and associated Management Plan updates in a short while for your comment and review.

Regards,
Chris

Chris Armit
Environmental and Community Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259



Chain Valley Colliery - Benthic Communities Management Plan for comment

Hi all,

Please find attached a review of the Chain Valley Colliery – Benthic Communities Management Plan for your comment. I have attached it as a tracked changed word document for easy comparison on changes made since last review and for you to add comments if required. Updated document for Miniwall S5 and NMA pillar extraction areas and SSD5465 Modification 3.

After 14 days I will update your comments and upload onto the DPIE planning portal.

Regards,
Chris

Chris Armit
Approvals Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259

Resource Regulator Consultation

CA Chris Armit Resources Regulator; gang.li@planning.nsw.gov.au; alexander.tutt-branco@planning.nsw.gov.au; dan.adams@planning.nsw.gov.au; Melissa Anderson; Chris Nicholas; Tim Chisholm 01/01/2021

RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Hi Ray,

Thanks for your email re: BFMP. To answer your question, yes, we are currently seeking approval under a modification application (CVC MOD 4) to mine under the greater Morisset Peninsula.

However, Chain Valley Colliery already has approval under SSD 5465 to mine under a smaller section of Morisset Peninsula (see below Appendix 3 from SSD5465 – I've added a red box to outline the location of consent approval area.

Mining under Fishery Point has been referenced in the last MOP approval letter and is included in the current approved MOP plans (cc'ed Dan and Melissa, if you wish to consult with them on MOP/Consent approval from an internal regulator perspective).

The BFMP scope has been outlined in the draft for comment doc (see below excerpt). I'm compelled by the consent as part of the extraction plan application process to have a BFMP for secondary extraction (i.e. MWS5 and NMA Pillar extraction) but thought it good practice to include the first workings area under the Peninsula to get some buy in from the Resource Regulator given existing built features. If you don't deem this approach necessary, happy to remove mention of it from this BFMP. Let me know if you have any comments on the draft BFMP and can make appropriate amendments if necessary.

Cheers,
Chris

APPENDIX 3
DEVELOPMENT LAYOUT



1 Introduction

1.1 Purpose and Scope

The purpose of this Built Features Management Plan (BFMP) is to outline the process for management of built features within the subsidence affected zone associated with miniwall S5, pillar extraction area in the Northern Mining Area and first workings beneath Morisset Peninsula. The primary objectives of the document are to:

CA Chris Armit Resources Regulator; gang.li@planning.nsw.gov.au; alexander.tutt-branco@planning.nsw.gov.au; dan.adams@planning.nsw.gov.au; Melissa Anderson; Chris Nicholas; Tim Chisholm 01/01/2021

RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

From: Resources Regulator <nswresourcesregulator@service-now.com>
Sent: Monday, 21 December 2020 1:47 PM
To: Chris Armit <CArmit@deltacoal.com.au>
Cc: gang.li@planning.nsw.gov.au; alexander.tutt-branco@planning.nsw.gov.au
Subject: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Dear Chris,

Further to your submission of a Built Features Management Plan (BFMP), dated 17 December 2020, to the Resources Regulator (RR) I require some clarification.

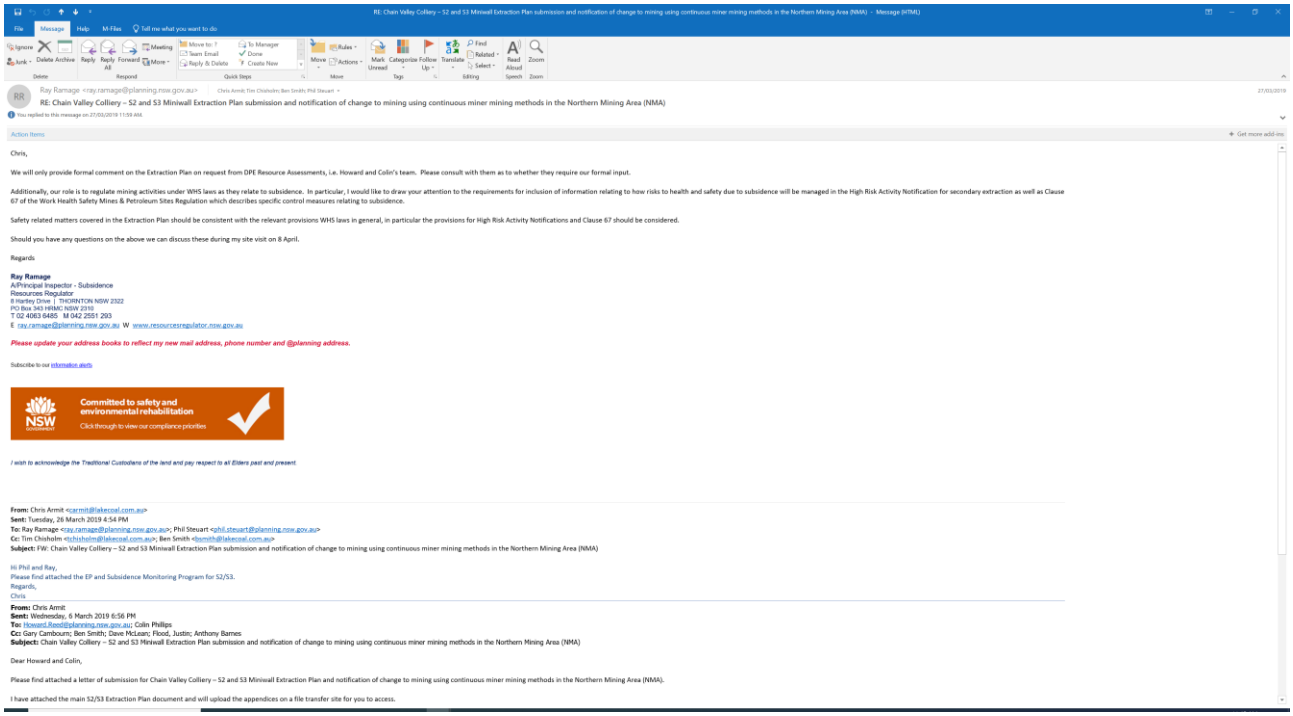
I understand that the BFMP has been submitted to RR for the purposes of consultation as required under Schedule 4, Condition 7(g) of SSD-5465.

The BFMP makes reference to Miniwall S5, first workings under Morriset Peninsula and the Northern Mining Area. It is also understood that the mine operator is currently seeking planning approval for mining in the Northern Mining Area including the suburbs of Brightwaters, Mirrabooka and Sunshine.

It is not clear to me whether Northern Mining Area subject of the BFMP has current planning approval and therefore it is not possible to provide comment in relation to that area. Can you please clarify the extents to which the BFMP applies and the status all relevant planning approvals.

Regards,

Ray Ramage
Senior Mine Safety Officer Subsidence
Subsidence Engineering | Resources Regulator
M 0422 551 293



RE: Chain Valley Colliery – S2 and S3 Miniwall Extraction Plan submission and notification of change to mining using continuous miner mining methods in the Northern Mining Area (NMA) - Message (HTML)

RE: Chain Valley Colliery – S2 and S3 Miniwall Extraction Plan submission and notification of change to mining using continuous miner mining methods in the Northern Mining Area (NMA)

Chris,

We will only provide formal comment on the Extraction Plan on request from DPE Resource Assessments, i.e. Howard and Colin's team. Please consult with them as to whether they require our formal input.

Additionally, our role is to regulate mining activities under WHS laws as they relate to subsidence. In particular, I would like to draw your attention to the requirements for inclusion of information relating to how risks to health and safety due to subsidence will be managed in the High Risk Activity Notification for secondary extraction as well as Clause 67 of the Work Health Safety Mines & Petroleum Sites Regulation which describes specific control measures relating to subsidence.

Safety related matters covered in the Extraction Plan should be consistent with the relevant provisions WHS laws in general, in particular the provisions for High Risk Activity Notifications and Clause 67 should be considered.

Should you have any questions on the above we can discuss these during my site visit on 8 April.

Regards

Ray Ramage
A/Principal Inspector - Subsidence
Resources Regulator
8 Hartley Drive | THORNTON NSW 2322
PO Box 343 HRMC NSW 2310
T 02 4063 6485 M 042 2551 293
E ray.ramage@planning.nsw.gov.au W www.resourcesregulator.nsw.gov.au

Please update your address books to reflect my new mail address, phone number and @planning address.

Subscribe to our information alerts

NSW GOVERNMENT Committed to safety and environmental rehabilitation
Click through to view our compliance priorities

I wish to acknowledge the Traditional Custodians of the land and pay respect to all Elders past and present.

From: Chris Armit <carmit@lakecoal.com.au>
Sent: Tuesday, 26 March 2019 4:54 PM
To: Ray Ramage <ray.ramage@planning.nsw.gov.au>; Phil Steuart <phil.steuart@planning.nsw.gov.au>
Cc: Tim Chisholm <tchisholm@lakecoal.com.au>; Ben Smith <bsmith@lakecoal.com.au>
Subject: FW: Chain Valley Colliery – S2 and S3 Miniwall Extraction Plan submission and notification of change to mining using continuous miner mining methods in the Northern Mining Area (NMA)

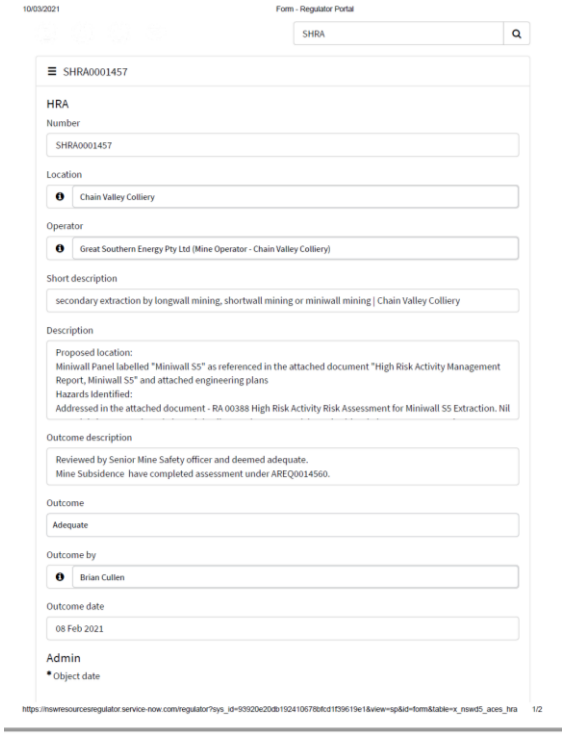
Hi Phil and Ray,
Please find attached the EP and Subsidence Monitoring Program for S2/S3.
Regards,
Chris

From: Chris Armit
Sent: Wednesday, 6 March 2019 6:56 PM
To: Howard.Reed@planning.nsw.gov.au; Colin Phillips
Cc: Gary Cambourn; Ben Smith; Dave McLean; Flood, Justin; Anthony Barnes
Subject: Chain Valley Colliery – S2 and S3 Miniwall Extraction Plan submission and notification of change to mining using continuous miner mining methods in the Northern Mining Area (NMA)

Dear Howard and Colin,

Please find attached a letter of submission for Chain Valley Colliery – S2 and S3 Miniwall Extraction Plan and notification of change to mining using continuous miner mining methods in the Northern Mining Area (NMA).

I have attached the main S2/S3 Extraction Plan document and will upload the appendices on a file transfer site for you to access.



10/03/2021 Form - Regulator Portal

SHRA

SHRA0001457

HRA

Number
SHRA0001457

Location
Chain Valley Colliery

Operator
Great Southern Energy Pty Ltd (Mine Operator - Chain Valley Colliery)

Short description
secondary extraction by longwall mining, shortwall mining or miniwall mining | Chain Valley Colliery

Description
Proposed location:
Miniwall Panel labelled "Miniwall S5" as referenced in the attached document "High Risk Activity Management Report, Miniwall S5" and attached engineering plans
Hazards Identified:
Addressed in the attached document - RA 00388 High Risk Activity Risk Assessment for Miniwall S5 Extraction. Nil

Outcome description
Reviewed by Senior Mine Safety officer and deemed adequate.
Mine Subsidence have completed assessment under AREQ0014560.

Outcome
Adequate

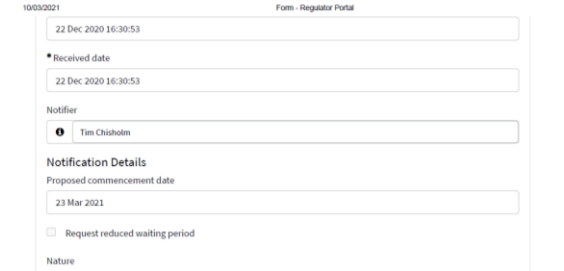
Outcome by
Brian Cullen

Outcome date
08 Feb 2021

Admin

*Object date

https://nswresourcesregulator.service-now.com/regulator?sys_id=93920e20db192410678bfcd1f59619e1&view=sp&id=form&table=x_nswd5_aces_hra 1/2



10/03/2021 Form - Regulator Portal

22 Dec 2020 16:30:53

*Received date
22 Dec 2020 16:30:53

Notifier
Tim Chisholm

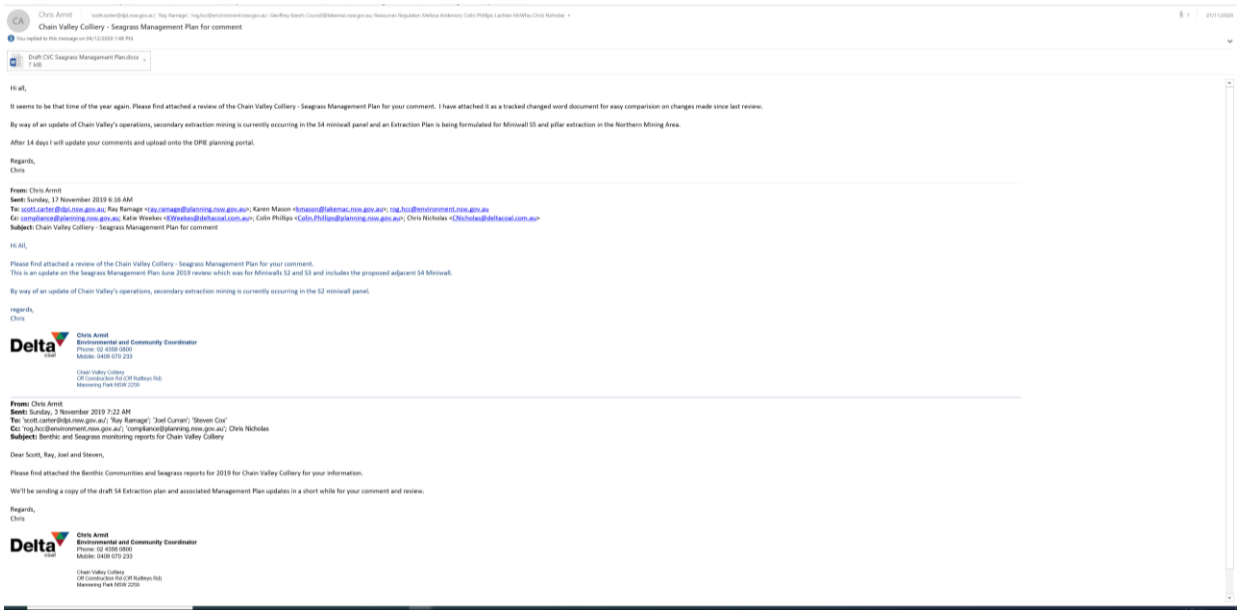
Notification Details

Proposed commencement date
23 Mar 2021

Request reduced waiting period

Nature

Lake Macquarie City Council Consultation



Chris Armit
Chain Valley Colliery - Seagrass Management Plan for comment

Draft CVC Seagrass Management Plan.docx
7 MB

Hi all,

It seems to be that time of the year again. Please find attached a review of the Chain Valley Colliery - Seagrass Management Plan for your comment. I have attached it as a tracked changed word document for easy comparison on changes made since last review.

By way of an update of Chain Valley's operations, secondary extraction mining is currently occurring in the S4 miniwall panel and an Extraction Plan is being formulated for Miniwall S5 and pillar extraction in the Northern Mining Area.

After 14 days I will update your comments and upload onto the DPIE planning portal.

Regards,
Chris

From: Chris Armit
Sent: Sunday, 17 November 2019 6:16 AM
To: scott.carter@dpi.nsw.gov.au; Ray Ramage <ray.ramage@planning.nsw.gov.au>; Karen Mason <kmason@lakemac.nsw.gov.au>; rog.hcc@environment.nsw.gov.au
Cc: compliance@planning.nsw.gov.au; Katie Weekes <KWeekes@deltacoal.com.au>; Colin Phillips <Colin.Phillips@planning.nsw.gov.au>; Chris Nicholas <CNicholas@deltacoal.com.au>
Subject: Chain Valley Colliery - Seagrass Management Plan for comment

Hi All,

Please find attached a review of the Chain Valley Colliery - Seagrass Management Plan for your comment.
This is an update on the Seagrass Management Plan June 2019 review which was for Miniwalls S2 and S3 and includes the proposed adjacent S4 Miniwall.

By way of an update of Chain Valley's operations, secondary extraction mining is currently occurring in the S2 miniwall panel.

regards,
Chris

Chris Armit
Environmental and Community Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259

From: Chris Armit
Sent: Sunday, 3 November 2019 7:22 AM
To: 'scott.carter@dpi.nsw.gov.au'; 'Ray Ramage'; 'Joel Curran'; 'Steven Cox'
Cc: 'rog.hcc@environment.nsw.gov.au'; 'compliance@planning.nsw.gov.au'; Chris Nicholas
Subject: Benthic and Seagrass monitoring reports for Chain Valley Colliery

Dear Scott, Ray, Joel and Steven,

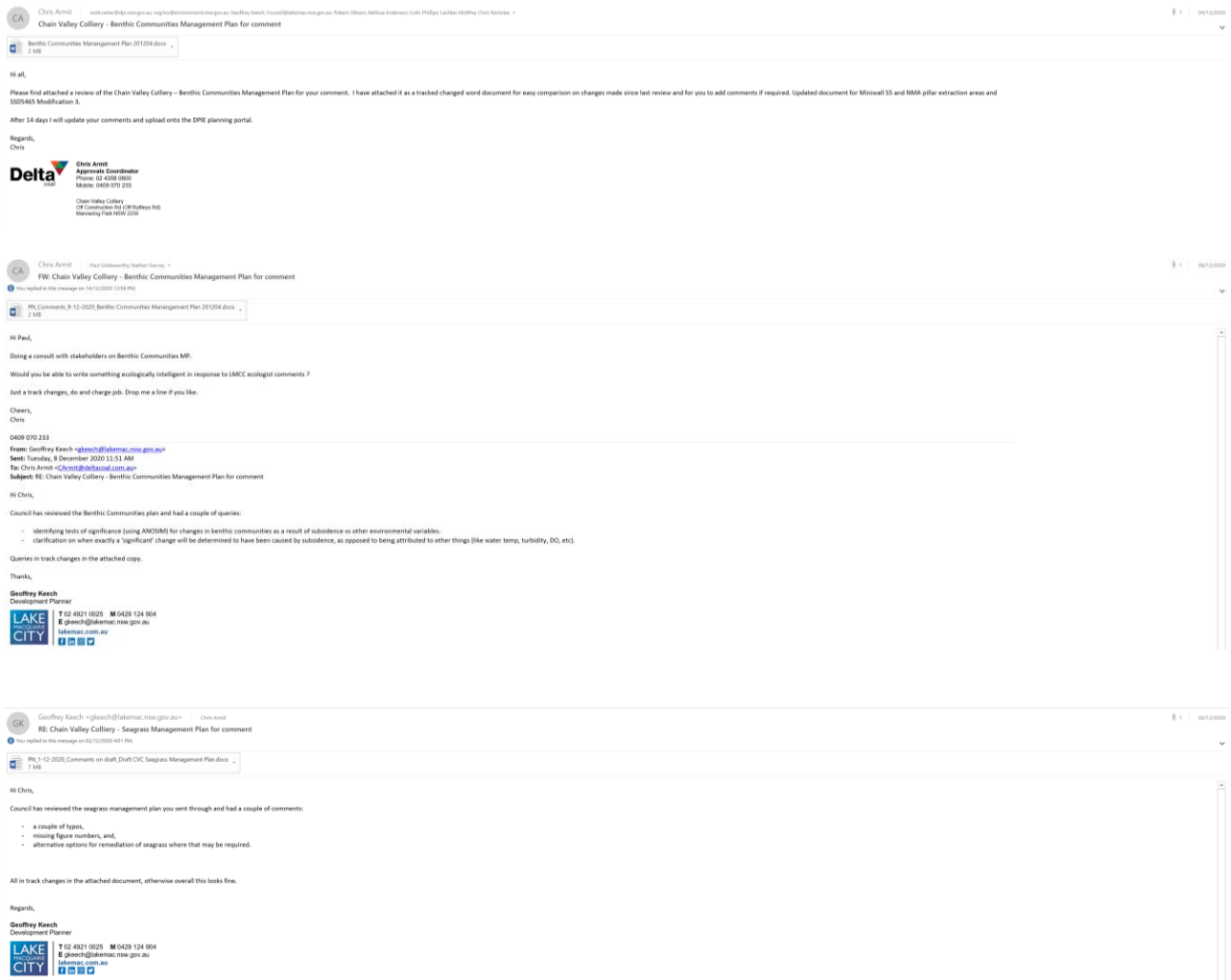
Please find attached the Benthic Communities and Seagrass reports for 2019 for Chain Valley Colliery for your information.

We'll be sending a copy of the draft S4 Extraction plan and associated Management Plan updates in a short while for your comment and review.

Regards,
Chris

Chris Armit
Environmental and Community Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259



Chris Armit
Chain Valley Colliery - Benthic Communities Management Plan for comment

Benthic Communities Management Plan 201204.docx
2 MB

Hi all,

Please find attached a review of the Chain Valley Colliery – Benthic Communities Management Plan for your comment. I have attached it as a tracked changed word document for easy comparison on changes made since last review and for you to add comments if required. Updated document for Miniwall S5 and NMA pillar extraction areas and SSD5465 Modification 3.

After 14 days I will update your comments and upload onto the DPIE planning portal.

Regards,
Chris

Chris Armit
Approvals Coordinator
Phone: 02 4358 0800
Mobile: 0409 070 233

Chain Valley Colliery
Off Construction Rd (Off Rutleys Rd)
Mannering Park NSW 2259

Chris Armit
FW: Chain Valley Colliery - Benthic Communities Management Plan for comment

PN_Comments_8-12-2020_Benthic Communities Management Plan 201204.docx
2 MB

Hi Paul,

Doing a consult with stakeholders on Benthic Communities MP.

Would you be able to write something ecologically intelligent in response to LMCC ecologist comments ?

Just a track changes, do and charge job. Drop me a line if you like.

Cheers,
Chris

0409 070 233

From: Geoffrey Keech <gkeech@lakemac.nsw.gov.au>
Sent: Tuesday, 8 December 2020 11:51 AM
To: Chris Armit <CArmit@deltacoal.com.au>
Subject: RE: Chain Valley Colliery - Benthic Communities Management Plan for comment

Hi Chris,

Council has reviewed the Benthic Communities plan and had a couple of queries:

- identifying tests of significance (using ANOSIM) for changes in benthic communities as a result of subsidence vs other environmental variables.
- clarification on when exactly a 'significant' change will be determined to have been caused by subsidence, as opposed to being attributed to other things (like water temp, turbidity, DO, etc).

Queries in track changes in the attached copy.

Thanks,

Geoffrey Keech
Development Planner
T 02 4921 0025 M 0429 124 904
E gkeech@lakemac.nsw.gov.au
lakemac.com.au

Geoffrey Keech <gkeech@lakemac.nsw.gov.au>
RE: Chain Valley Colliery - Seagrass Management Plan for comment

PN_1-12-2020_Comments on draft_Draft CVC Seagrass Management Plan.docx
7 MB

Hi Chris,

Council has reviewed the seagrass management plan you sent through and had a couple of comments:

- a couple of typos,
- missing figure numbers, and,
- alternative options for remediation of seagrass where that may be required.

All in track changes in the attached document, otherwise overall this looks fine.

Regards,

Geoffrey Keech
Development Planner
T 02 4921 0025 M 0429 124 904
E gkeech@lakemac.nsw.gov.au
lakemac.com.au

Appendix 1.2 – Amendment 1 Consultation

Department of Planning, Housing and Infrastructure – Approval

Department of Planning, Housing & Infrastructure

NSW GOVERNMENT

Our ref: SSD-5465-PA-142

Lachlan McWha
Environment and Approvals Coordinator
Chain Valley Colliery
Great Southern Energy Pty Ltd
PO Box 7115
Mannering Park, NSW, 2259

08/10/2024

Subject: Miniwal S5 and Northern Pillar Area Extraction Plan Amendment

Dear Mr McWha

I refer to your submission dated 6 June 2024, requesting approval for an amendment to the approved Extraction Plan for Miniwall S5 and the Northern Pillar Area at Chain Valley Colliery. The Department understands that the area of proposed secondary extraction would remain unchanged whilst the layout and orientation would be amended to avoid geological constraints and optimise the mine design.

The Department has carefully reviewed your request, including the accompanying subsidence predictions, and is satisfied that the amendment is necessary and would result in similar or reduced subsidence-related impacts when compared with those already approved.

Accordingly, as nominee of the Planning Secretary, I approve the Miniwall S5 and Northern Pillar Area Extraction Plan Amendment 1 (dated 26 August 2024).

You are reminded that if there are any inconsistencies between the Plan and the conditions of consent, the conditions prevail. Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact James McDonough on (02) 9585 6313.

Yours sincerely

JEvans

Jessie Evans
Director, Resource Assessments
Resource Assessments

As nominee of the Planning Secretary

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Locked Bag 5022, Parramatta NSW 2124

Resources Regulator

MINING, EXPLORATION & GEOSCIENCE
Department of Regional NSW

RDOC24/80693
21 June 2024

Pieter Van Rooyen
Technical Services Manager – Delta Coal
PVanRooyen@deltacoal.com.au
Via: Major Projects Portal

ADVICE RESPONSE: Chain Valley Extension Project – Extraction Plan amendment

Stage: Post Approval Assessment

Development Application: SSD-5465-PA-142

Dear Pieter,

I refer to your correspondence dated 6 June 2024 inviting the Department of Regional NSW – Mining, Exploration and Geoscience (MEG) to comment on the Chain Valley Extension Project - amendment request 'Miniwall S5 and NPA' Extraction Plan (EP), submitted by Great Southern Energy Pty Ltd trading as Delta Coal (the Proponent).

MEG has reviewed the information supplied and has no specific comments in relation to *Mining Act 1992* considerations and raises no issues regarding the EP amendment at this stage.

Please refer to NSW Resources Regulator advice in Attachment A.

For further advice on this matter, please contact Sarah Maiorana, Project Officer, Industry Advisory and Mining Concierge - Industry Development on 02 4063 6860 or mining.concierge@regional.nsw.gov.au.

Sincerely

Scott Anson
Manager Industry Advisory and Mining Concierge
Industry Development
Department of Regional NSW – Mining, Exploration and Geoscience

for

Tony Linnane
Executive Director Strategy, Performance and Industry Development
Department of Regional NSW – Mining, Exploration and Geoscience

516 High Street
Maitland NSW 2320

Email: Mining.Concierge@regional.nsw.gov.au
regional.nsw.gov.au/MEG

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Attachment A

Resources Regulator
Department of Regional NSW

Thursday, 20 June 2024

Pieter Van Rooyen
Delta Coal
Pvanrooyen@deltacoal.com.au

Via: Major Projects Portal

Dear Pieter,

I refer to your request of 30 May 2024 for advice regarding Chain Valley Extension Project (SSD-5465-PA-141). The Resources Regulator has reviewed the request and based on the review of the document, the Resources Regulator advises that it has no specific comments regarding mine safety or mine rehabilitation matters in relation to the proposals.

LIMITATIONS

The Extraction Plan is assessed and determined by Department of Planning and Environment (DPE) under the conditions of the development consent. The Resources Regulator provides advice to DPE to assist in the determination.

REGULATORY REQUIREMENTS IF APPROVED

The authorisation holder is required to comply with the rehabilitation commitments outlined in any approved Extraction Plan as regulated by the Resources Regulator under the conditions of the mining lease and the *Mining Act 1992*. Where subsidence impacts requiring rehabilitation occur, the area of impact will need to be identified in the Final Landform and Rehabilitation Plan and the progressive rehabilitation schedule will need to be identified as part of the Annual Forward Program and tracked in the Annual Rehabilitation Report as submitted to the Resources Regulator in accordance with Schedule 8A of the Mining Regulation.

The Resources Regulator may undertake assessments of the mine operators' proposed mining activities under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulation as well as other WHS regulatory obligations.

Subsidence associated with the proposed Extraction Plan will be regulated by under relevant provisions of WHS laws in particular Schedule 3, Section 17 of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*.

BACKGROUND

The NSW Resources Regulator is responsible for compliance and enforcement of the Extraction Plan is so far as it relates to requirements under the *Mining Act 1992* and Work Health and Safety legislation. This role principally relates to rehabilitation, workplace safety and public safety.

The Mining Act Inspectorate within the Resources Regulator undertake risk-based compliance and enforcement activities in relation to obligations under the *Mining Act 1992*. This includes undertaking assessment and compliance activities in relation to mine rehabilitation activities and determination of security deposits.

The Mine Safety Inspectorate within the Resources Regulator is responsible for ensuring the mine operators' compliance with the Work Health and Safety (WHS) legislation, in particular the effective management of risks associated with the principal hazards as specified in the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*.

CONTACT

Should you require any further information or clarification, please contact the Regulator on 1300 814 609 (Press Option 2 Press Option 5) or email nswresourcesregulator@service-now.com.

Yours sincerely,



Matthew Newton

Principal Inspector Environment & Rehabilitation

Resources Regulator

Appendix 1.3 – Amendment 2 Consultation

Department of Planning, Housing and Infrastructure – Approval

Department of Planning, Housing and Infrastructure

NSW GOVERNMENT

Our ref: Our ref: SSD-5465-PA-160

Lachlan McWha
Environment and Approvals Coordinator
Chain Valley Colliery
Great Southern Energy Pty Ltd
PO Box 7115
Mannering Park, NSW, 2259

10/06/2025

Subject: Chain Valley Miniwall S5 and Northern Pillar Area Extraction Plan Amendment #2 (June 2025)

Dear Mr McWha

I refer to your submission dated 8 May 2025, requesting approval for amendment #2 to the approved Extraction Plan for Miniwall S5 and the Northern Pillar Area (NPA) at Chain Valley Colliery.

The Department understands that Extraction Plan amendment #2 seeks to facilitate the utilisation of a double-sided lifting method of pillar extraction within the NPA, specifically in panels HBE1, so as to optimise coal recovery. The location of secondary extraction is unchanged from the updated areas approved in Amendment #1 of the Extraction Plan (dated October 2024). The proposed double-sided lifting would result in slightly greater subsidence (approximately 10 mm extra) than that predicted in Amendment #1, however remains compliant within the development consent (SSD-5145) subsidence limit of 780 mm. All other development consent criteria remain compliant (i.e. seagrass barrier and built-features criteria).

The Department has carefully reviewed your request, including the accompanying subsidence predictions, and is satisfied that the amendment is necessary.

Accordingly, as nominee of the Planning Secretary, I approve the Chain Valley Miniwall S5 and Northern Pillar Area Extraction Plan Amendment #2 (dated 7 May 2025).

You are reminded that if there are any inconsistencies between the Plan and the conditions of consent, the conditions prevail. Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Melissa Dunlop on 02 8229 2941 or melissa.dunlop@dpie.nsw.gov.au.

Yours sincerely



Jessie Evans
Director, Energy and Resource Assessments
As nominee of the Planning Secretary

Resources Regulator

NSW Resources

D25/32596
2 June 2025

Melissa Dunlop
Department of Planning, Housing and Infrastructure
melissa.dunlop@dpie.nsw.gov.au
Via: Major Projects Portal

ADVICE RESPONSE: Chain Valley Extension - Chain Valley Miniwall S5 and Northern Pillar Area Extraction Plan Amendment

Stage: Post Approval Assessment

Development Application: SSD-5465-PA-160

Dear Melissa,

I refer to your correspondence dated 19 May 2025 inviting the Department of Primary Industries and Regional Development - NSW Resources to review the information supplied and provide comments on Chain Valley Extension - Chain Valley Miniwall S5 and Northern Pillar Area Extraction Plan Amendment (the Project), submitted to Department of Planning, Housing and Infrastructure by Great Southern Energy Pty Ltd (the Proponent).

NSW Resources has reviewed the information supplied in relation to the Project and based on the review has no specific comments in relation to *Mining Act 1992* considerations and raises no issues regarding the Project at this stage.

Please refer to NSW Resources Regulator advice Attachment A.

For further advice on this matter, please contact Sarah Maiorana, Project Officer, Industry Advisory and Mining Concierge unit on 02 4063 6860 or mining.concierge@dpird.nsw.gov.au .

Sincerely

Scott Anson
Manager Industry Advisory and Mining Concierge
Industry Development

for

Tony Linnane
Executive Director Strategy, Performance and Industry Development
Department of Primary Industries and Regional Development - NSW Resources

Attachment A

Resources Regulator
Department of Primary Industries and Regional Development

Friday, 30 May 2025

Melissa Dunlop
Department Planning, Housing & Infrastructure
melissa.dunlop@dpie.nsw.gov.au

Via: Major Projects Portal

Dear Melissa,

I refer to your request of 19 May 2025 for advice regarding Chain Valley Extension and NPA Extraction Plan (SSD-5465-PA-160). Based on the review of the document, the Resources Regulator advises that it has no further comments.

LIMITATIONS

The Extraction Plan is assessed and determined by Department of Planning and Environment (DPE) under the conditions of the development consent. The Resources Regulator provides advice to DPE to assist in the determination.

REGULATORY REQUIREMENTS IF APPROVED

The authorisation holder is required to comply with the rehabilitation commitments outlined in any approved Extraction Plan as regulated by the Resources Regulator under the conditions of the mining lease and the *Mining Act 1992*. Where subsidence impacts requiring rehabilitation occur, the area of impact will need to be identified in the Final Landform and Rehabilitation Plan and the progressive rehabilitation schedule will need to be identified as part of the Annual Forward Program and tracked in the Annual Rehabilitation Report as submitted to the Resources Regulator in accordance with Schedule 8A of the Mining Regulation.

The Resources Regulator may undertake assessments of the mine operators' proposed mining activities under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and Regulation as well as other WHS regulatory obligations.

Subsidence associated with the proposed Extraction Plan will be regulated by under relevant provisions of WHS laws in particular Schedule 3, Section 17 of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*.

BACKGROUND

The NSW Resources Regulator is responsible for compliance and enforcement of the Extraction Plan is so far as it relates to requirements under the *Mining Act 1992* and Work Health and Safety legislation. This role principally relates to rehabilitation, workplace safety and public safety.

The Mining Act Inspectorate within the Resources Regulator undertake risk-based compliance and enforcement activities in relation to obligations under the *Mining Act 1992*. This includes undertaking assessment and compliance activities in relation to mine rehabilitation activities and determination of security deposits.

The Mine Safety Inspectorate within the Resources Regulator is responsible for ensuring the mine operators' compliance with the Work Health and Safety (WHS) legislation, in particular the effective management of risks associated with the principal hazards as specified in the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2022*.

CONTACT

Should you require any further information or clarification, please contact the Regulator on 1300 814 609 (Press Option 2 Press Option 5) or email nswresourcesregulator@service-now.com.

Yours sincerely,



Anthony Margetts

Chief Inspector of Mines

Resources Regulator

Appendix 2 Development consent requirements

Relevant sections of SSD-5465 that detail the requirements of the EP are reproduced in **Table A2** below along with identification of where the requirements are addressed in this document.

Table A2: Requirements from SSD-5465

Condition No.	Requirement	Relevant section of this document
	Schedule	
7	*The Applicant must prepare an Extraction Plan for all second workings on site, to the satisfaction of the Planning Secretary. Each Extraction Plan must:* *Be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary*	**This document** **Section 2.4**
	Be approved by the Secretary before the Applicant carries out any second workings covered by the plan	**Section 2.4** **Appendix 16**
	Include detailed plans of existing and proposed first and secondary workings and any associated surface development, including any applicable adaptive management measures	**Section 3.4**
	Include detailed performance indicators for each of the performance measures in Tables 6 and 7	**Sections 3.3 & 4.0**
	Provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this consent	**Section 2.5 and 3.2** **Appendix 12**
	Describe the measures that would be implemented to ensure compliance with the performance measures in Tables 8 and 9, and manage or remediate any impacts and/or environmental consequences	**Sections 3.4 & 4.0**
	Include a Built Features Management Plan, which has been prepared in consultation with RR and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which *Addresses in appropriate detail all items of public infrastructure and other public infrastructure and all classes of other built features* *Has been prepared following appropriate consultation with the owner/s of potentially affected feature/s* *Recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner*	**Section 4** **Appendix 10**
	Include a Benthic Communities Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on benthic communities, which includes: *Surveys of the lake bed to enable contours to be produced and changes in depth following subsidence to be accurately measured*	**Section 4.3** **Appendix 7**

	Benthic species surveys within the area subject to second workings, as well as control sites outside of the area subject to second workings (at similar depths) to establish baseline data on species number and composition within the communities *A program of ongoing seasonal monitoring of benthic species in both control and impact sites* *Development of a model to predict subsidence impact of increased depth and associated subsidence impacts and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities composition, incorporating the monitoring and survey data collected; and* *Updating the model every 2 years using the most recent monitoring and survey data*	
	Include a Seagrass Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on seagrass beds, and which includes: *A program of ongoing monitoring of seagrasses in both control and impact sites* *A program to predict and manage subsidence impacts and environmental consequences to seagrass beds to ensure the performance measures in Table 6 are met*	**Section 4.3** **Appendix 8**
	Include a Public Safety Management Plan, which has been prepared in consultation with RR, to ensure public safety	**Appendix 11**
	Include a Subsidence Monitoring Program which has been prepared in consultation with RR, 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*	**Section 5** **Appendix 13**
	Include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measures in Tables 6 and 7, or where any such exceedance appears likely	**Section 3.4.2** **Appendix 4**
	Include appropriate revisions to the Rehabilitation Management Plan required under Condition 27 of Schedule 3	**Appendix 12**
	Include a program to collect sufficient baseline data for future Extraction Plans	**Section 5**

Appendix 3 Extraction Plan Risk Assessment

WRAC Risk Assessment

Workplace Risk Assessment & Control

RA 00321 - Miniwall S5 Extraction, Northern Pillar Extraction Plan and Morisset Peninsula Subsidence Management Risk Assessment

Site: Chain Valley Colliery

Date: 29/04/2020 and 27/08/2020

No:	Draft - RA 00321 - Miniwall S5, Northern Pillar Extraction and Morisset Peninsula Extraction Plan Subsidence Management		
Topic	Miniwall S5 Extraction, Pillar Extraction in the Northern Pillar Area and Morisset Peninsula First workings Subsidence Management		
Venue	Chain Valley Colliery		
Requested by:	Chris Armit Environment and Community Coordinator	**Date:** 29/04/20 and 27/08/20	**Time allowed:** 4 hours
Facilitator	Chris Nicholas Technical Services Manager (29/4/2020) and Chris Armit (27/08/2020)		

Relevant Risk Assessment Documents/Procedures/Safety Alerts/Safety Bulletins

- Strata 2 (2020) S5 Subsidence Predictions report
- S4 Subsidence Predictions report
- S4 Extraction Plan Risk Assessment
- S2/S3 Subsidence Predictions report
- S2/S3 Extraction Plan Risk Assessment
- Strata 2 (2020) Northern Mining Area First workings

Persons participating in Risk Assessment

Name	Role	Years of Industry Experience	Signature
Chris Armit	Approvals Coordinator	20	
David Hill	Geotechnical Consultant	41	
Chris Nicholas	Technical Services Manager	15	
Tim Chisholm	Mine Surveyor	14	

Purpose

This risk assessment has been conducted to assess and document potential surface and sub-surface subsidence risks associated with mining of Northern Mining Domains (NMD) Miniwall S5 extraction, pillar extraction and first workings in and around the Morisset Peninsula.

Objectives and Scope

The objectives of this risk assessment are to:

- Identify hazards and assess the risk associated with environmental, public safety and surface built feature impacts from extraction.
- Ensure compliance with the WHS (Mines) Regulation 2014 Clause 67 Subsidence:

  (1) In complying with clause 9, the mine operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine.

  (2) Without limiting subclause (1), the mine operator must ensure that:

  (a) So far as is reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of any person at risk from subsidence, and

  (b) Monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features, and

  (c) Any investigation of subsidence and any interpretation of subsidence information is carried out only by a competent person, and

  (d) All subsidence monitoring data is provided to the regulator in the form and at the times required by the regulator, and

  (e) So far as reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence.
- Meet (where applicable) the standards for assessing and managing risks of subsidence as outlined in the “Managing Risks of Subsidence Guideline”, February 2017.
- Place a particular focus on recently updated subsidence predictions and recommendations for the area including a review of factors behind the exceedance of subsidence predictions over the MW 1 to 12 area.
- Identify the existing and potential controls to reduce the risk to a reasonable practicable level.

The scope of the risk assessment focuses on the extraction area defined by a 26.5 degree angle of draw from lakeside seagrass boundary projected to Fassifern seam or to the predicted 20mm subsidence contour of S5 (see **Figure 1 and Figure 2**). The level of monitoring required will be commensurate with the assessed level of risk (i.e. after controls are put in place) or potential consequence. The corresponding residual risk will determine if these controls are sufficiently acceptable.

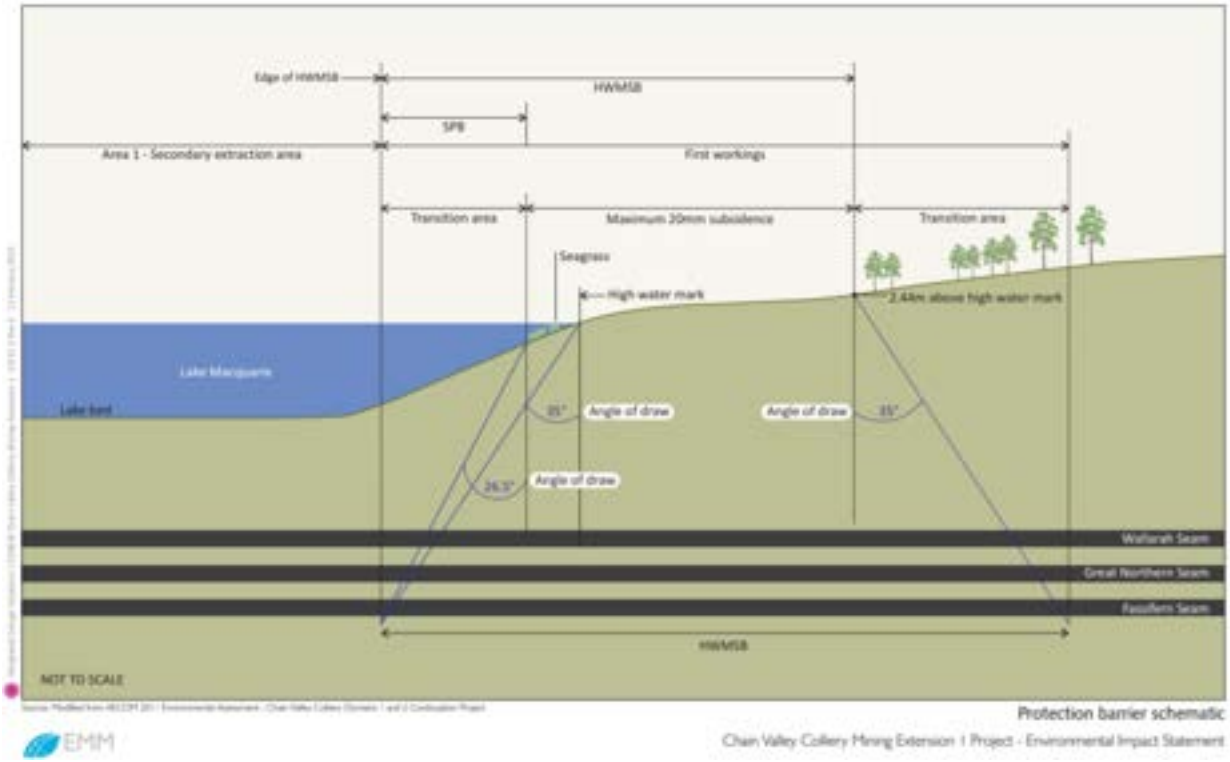


Figure 1- Protection barrier schematic from SSD 5465 Environmental Impact Statement

The list of surface and sub-surface features outlined in Appendix B of the 2003 NSW Department of Mineral Resources Guidelines for Application for Subsidence Management Approvals, along with items outlined in the 2017 Managing Risks of Subsidence Guideline, have been used as a starting reference list of features for assessment. All features on the list were assessed as to whether they exist within the defined extraction plan area. Where a feature is not noted in the WRAC assessment, it has not been identified within the area of interest.

APPENDIX 3
DEVELOPMENT LAYOUT

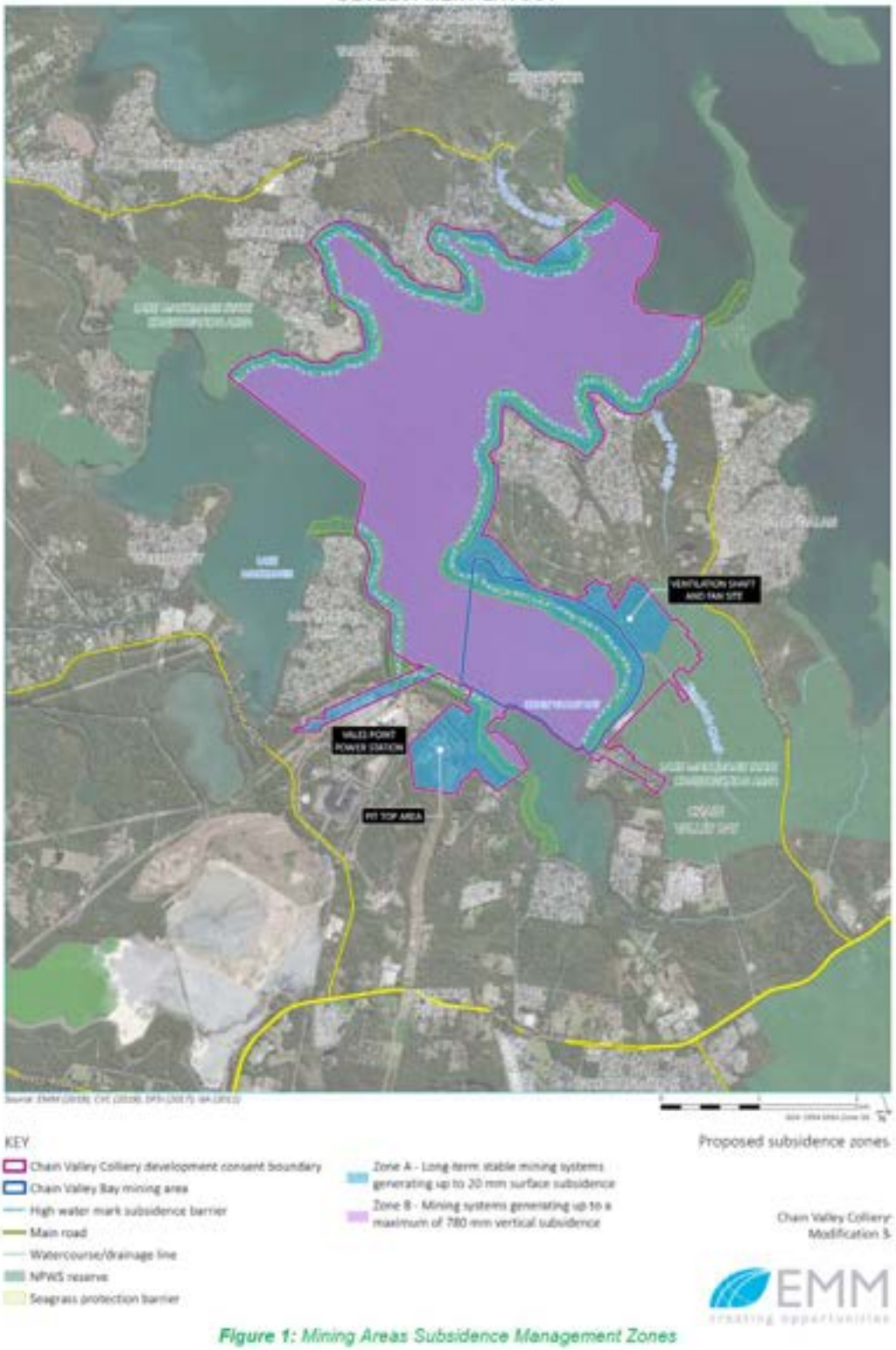


Figure 1: Mining Areas Subsidence Management Zones

Figure 2 – Figure 1 from CVC Consent (SSD 5465 Modification 3)

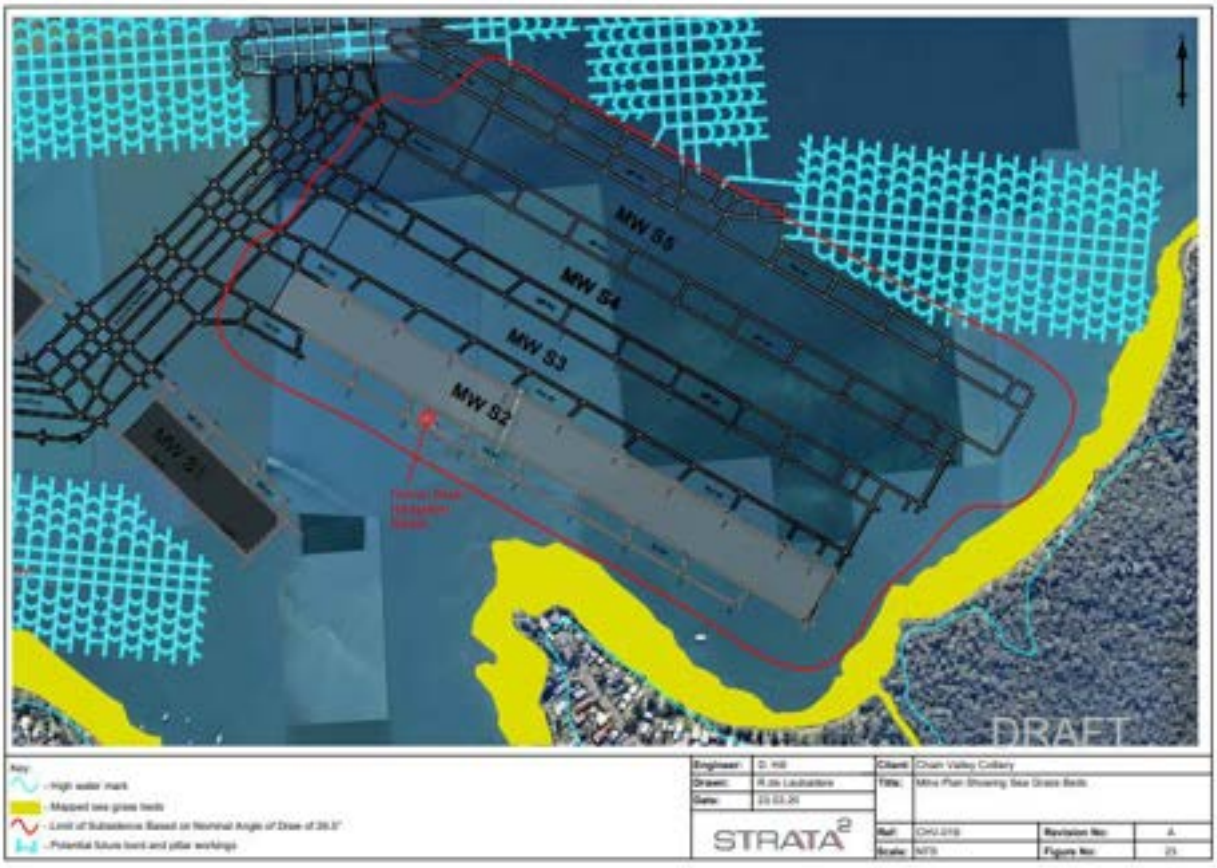


Figure 1- S2 to S5 Extraction Impact area due to Fassifern Miniwall Mining

Risk Assessment Process

1. Hazard identification
2. Identified hazards were evaluated with regard to consequence and then the Likelihood of that consequence outcome was assessed, assuming existing controls to be effectively implemented.
3. Risk rankings were derived.
4. Additional controls were proposed where possible for medium and high risks and the hazards were re-evaluated to arrive at the residual risk.
5. Likelihood and consequence were assessed in accordance AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines.
6. This risk assessment was conducted in general compliance with MDG1010 and MDG1014.
7. As low as reasonably practicable (ALARP) is determined from WHS Act 2011, Section 18.
8. Hazardous Manual Tasks should be identified and controlled to a reasonable practicable level of risk using the Risk Assessment Worksheet for Hazardous Manual Tasks Form and actions recorded in this risk assessment.
9. Actions and outcomes from the risk assessment are recorded with a due date of action completion and responsible person.
10. Risk Assessments are monitored and reviewed as detailed by the Delta Coal Site Work Health and Safety Management System.

Risk Assessment Checklist based on Hazard / Energy Types

Energy Type	POTENTIAL HAZARDS			
	To People	To Equipment	To Production	To The Environment
Electrical	• Electric Shock • Burns • Smoke Inhalation	• Unplanned movement • Fire • Circuit Damage	• Supply fails causing shutdown • Inadequate supply causing process slowdown	• Fire
Mechanical	• Crushed • Struck by Moving or Flying Objects • Caught Between Moving Objects	• Collision • Breakdown • Unplanned Movement • Breakages • Vibration	• Fails & Causes Shutdown • Slows Down Production	• Physical Damage • Fire
Chemical	• Burns • Skin Irritation • Ingestion • Inhalation (Toxic atmospheres) • Explosion (Mixing incompatible)	• Fire • Internal Damage • Corrosion	• Causes Delays or Shutdowns (Not enough, wrong type to much)	• Spillage (Water contamination, soil contamination, air pollution, vegetation destroyed)
Pressure (Fluids/Gases)	• Fluid Injection • Crush • Respiratory Problems	• Unplanned Movement • Poor Performance • Breakdown	• Equipment Failure Shutdown (No fluids or to much fluids, no gases or to much gases)	• Contamination (Dust, fuel/oil, dirty water0
Radiation	• Burns • Eye Damage (welding flash) • Internal problems		• Source fails (Causing delays or shutdown)	• Contamination
Thermal	• Burns • Heat Exhaustion • Frostbite	• Overheating • Freezing	• Shutdown (Overheating or freezing)	
Biochemical	• Sprains • Strains		• Slowdown due to loss of staff	
Noise/Vibration	• Hearing damage	• Mechanical damage	• Slowdown due to people not accessing area	• Community complaints
Biological	• Illness • Disease		• Shutdown due to lack of people	
Gravitational	• Falling from Heights • Objects falling on Personnel	• Rollover • Collapse • Failure • Damage from fall • Damage from objects falling	• Objects falling causing slowdown or shutdown	• Contamination

Risk Matrix

HIERARCHY OF CONTROL		LIKELIHOOD			
Elimination	Do we still have to do this?	A	Almost certain to happen	FREQUENCY	1 per week to 1 per month
Substitution	Is there another way or product?	B	Likely to happen at some point		1 per month to 1 per year
Redesign/Engineer	Can the equipment or process be modified?	C	Moderate, possible; heard of so it might happen		1 per year to 1 per 10 years
Isolation/Guarding	Will guarding or some type of barrier help?	D	Unlikely, not likely to happen		1 per 10 years to 1 per 100 years
Administration	Will a written procedure and/or training help?	E	Rare, practically impossible		Less than 1 per 100 years
PPE	Is personal protective equipment adequate?				

MAXIMUM REASONABLE CONSEQUENCE

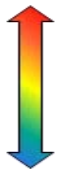
CONSEQUENCE	INJURY (I)	ENVIRONMENTAL (E)	LOSS (L)
1 - CRITICAL	Could kill, permanently disable	Regional environmental impact/ecosystem damage. Impact causing mine or business closure. E.g. Major release off site with long term detrimental effect	Could cause very major damage > $3M
2 - HIGH	Could cause serious injury (major LTI)	Substantial environmental damage which could result in major financial loss and/or prosecution. E.g Off-site release resulting in local ecosystem damage	Could cause major damage $500K - $3M
3 - MEDIUM	Could cause typical MTC/LTI	Substantial temporary or minor long term damage, release immediately contained with outside assistance eg. A minor water discharge or large hydrocarbon spill. Legal non-compliance.	Could cause moderate damage $100K - $500K
4 - LOW	Could cause first aid injury	Temporary or minor damage, non-compliance with internal environmental target, no legal breach, eg. Minor spill	Could cause damage $20K - $100K
5 - INSIGNIFICANT	Couldn't cause injury	No detrimental effect, low financial loss, negligible environmental impact	Couldn't cause damage, or <$20K damage

Risk Score Matrix

RISK SCORE	RISK	WHAT SHOULD I DO?
1 to 3	Critical	STOP WORK Immediate action required, inform senior management
4 to 10	High	Risk Assessment required. Action plan required, senior management attention needed
11 to 15	Medium	Specific monitoring of procedures required management responsibility must be specified
16 to 25	Low	Manage through routine procedures

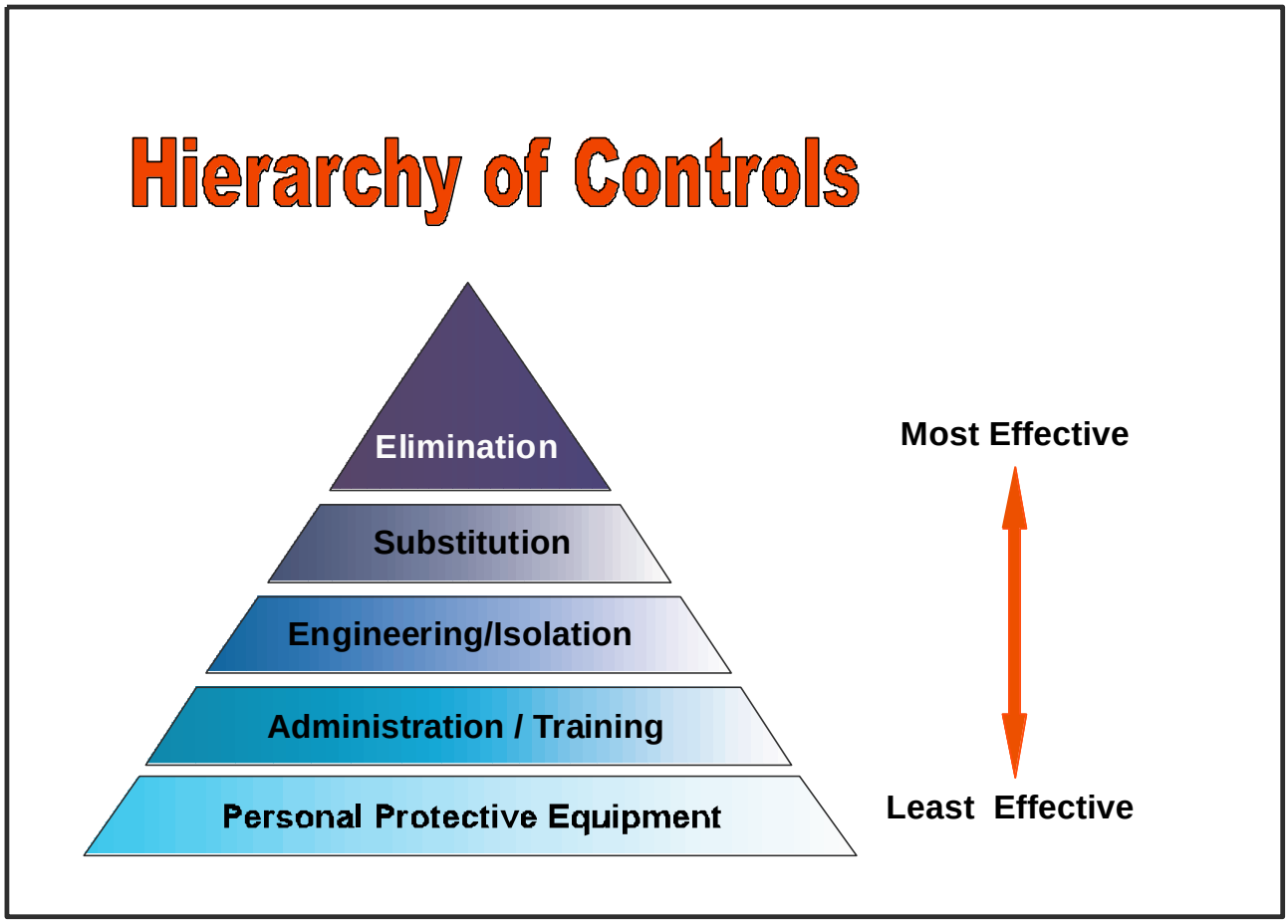
CONSEQUENCE	LIKELIHOOD: A- Certain	B - Likely	C - Moderate	D - Unlikely	E - Rare
1 - Critical	1	2	4	7	11
2 - High	3	5	8	12	16
3 - Medium	6	9	13	17	20
4 - Low	10	14	18	21	23
5 - Insignificant	15	19	22	24	25

Least Effective



Most Effective

Hierarchy of Controls (as per WHS Regulations 2011 Clause 36)



HIERARCHY OF CONTROLS 1-6 Descending Order (as per WHS Regulations 2011 Clause 36)	
Elimination	Remove the hazard from the workplace (Re-Design)
Substitution	Substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk. (Alternative product / plant)
Isolation	Isolating the hazard from any person exposed to it. Use barriers to shield or isolate the hazard (Guards on machines, enclosures for noises)
Engineering controls	Design & install equipment to counteract or lessen the hazard
Administrative controls	change to a system of work, a process or a procedure to lessen the hazard
Personal Protective Equipment	ensuring the provision and use of suitable personal protective equipment

Hazard Analysis and Risk Assessment

The risk management methodology as described in WHS Act 2011, WHS Regulations 2011, WHS Code of Practice WHS Act 2011, Section 274, Code of Practice –How to Manage Work, Health and Safety Risks 2011, MDG1010 and AS/NZS ISO 31000:2009 is used to identify the various processes and activities at Delta Coal sites.

Risk analyses shall be completed for each activity based on the following matrix. The subsequent risk ranking shall then determine the frequency of re-assessments.

Likelihood	Consequences
A. Almost certain to happen	1. Permanently disable.
B. Like to happen at some point	2. Could cause serious injury (Major LTI)
C. Moderate, possible, heard of so it might happen	3. Could cause Medical Treatment Case/ LTI
D. Unlikely, not likely to happen	4. Could cause First Aid Treatment
E. Rare, practically Impossible	5. Could not cause injury

Likelihood and Consequences are applicable to Table 1 below.

	LIKELIHOOD					
CONSEQUENCE		A – Certain	B – Likely	C – Moderate	D – Unlikely	E - Rare
	1 - Critical	1	2	4	7	11
	2 - High	3	5	8	12	16
	3 - Medium	6	9	13	17	20
	4 - Low	10	14	18	21	23
	5 - Insignificant	15	19	22	24	25

Facts

- Extraction is to occur in the Fassifern seam utilising miniwall extraction methods and solely beneath Lake Macquarie (ie outside the High Water Mark Subsidence Barrier and Seagrass Protection Barrier).
- S5 extraction depth of cover ranges between an effective depth of 162 to 171m. The panels are at $>35^0$ angle of draw to the foreshore.
- No extraction is planned within the High Water Mark Subsidence Barrier (HWMSB) and Seagrass Protection Barrier (SPB)
- The panel void width for Miniwall S5 is 97m, consistent with recent CVC practice.
- For the Miniwall S5 Twin heading gate roads with typically 110m long (centres) pillars. 5.4m wide by 3.2m high roadways.
- The S5 maingate and tailgate chain pillars are 32.6m and 40m in width respectively (solid) to limit (a) subsidence over S2 to S5 Panels and (b) abutment load transfer to future workings to the north.
- Seam thickness varies from 4.8m inbye to 5.0m outbye. The nominal extraction height will be 3.5m, leaving around 1m of top coal during extraction.
- Updated predictions for subsidence over the MW1 to 12 area of 720mm were exceeded in the MW7 to 10 area with up to 1100mm recorded (a further 150mm of creep movement could be expected). The subsidence model has since been reviewed and amended to align with this increase, and to gain an understanding of the potential mechanisms behind the increase. This model and information has been utilised to develop a mine plan and updated predictions for the NMD such that predicted subsidence is planned to remain within the approved 780mm for the domain allowing for anticipated longer term creep.
- A detailed subsidence assessment has been undertaken for miniwalls S2 and S3 by Mine Subsidence Engineering Consultants (MSEC). The assessment has indicated that the subsidence results over the miniwalls will result in approximately 290mm of vertical subsidence and 6mm/m tilt. Predicted vertical subsidence at the sea grass beds/moorings and jetties are predicted to be less than 20mm. The expected subsidence at Pelican rock is expected to be in the order of 90mm.

  Strata2 ground control consulting has undertaken a detailed subsidence assessment for miniwall S5. The assessment has indicated that the extraction of miniwall S5 will result in a maximum of approximately 0.3-0.4m of long-term vertical subsidence, strains of <2mm and tilts of <5 mm/m . Predicted vertical subsidence at the sea grass beds/moorings and jetties is less than 20mm. The expected long-term subsidence at Pelican Rock is expected to be in the order of 0.1-0.2m
- Strata2 ground control consulting has undertaken a detailed geotechnical design report for the miniwall layout which has formed the basis for the mine design used in the subsidence assessment.

- Delta Coal has successfully mined Miniwall S1, N1, S2 and S3 in the NMD with subsidence monitoring results at the foreshore well within predictions.
- Delta Coal has completed a rock head survey of the NMD which has formed the basis for the key assumptions used in the technical reports.
- S5 extraction depth of cover ranges between 162 and 171m. Caving is expected to extend up to 35m above the Fassifern Seam extraction horizon and the theoretical height of the total Fractured Zone is 93m. However, in practice, the Fractured zone is expected to terminate at the base of the Teralba Conglomerate, some 45m to 50m above the mining horizon.
- The location of the maximum predicted subsidence is beneath Lake Macquarie within the FAS working footprint (ie outside the foreshore and mapped seagrass areas) **Figure 2**.
- First workings under the Morisset peninsula to be designed in accordance with the geotechnical design to remain long term stable and negligible surface subsidence.

Assumptions

- Employees are trained and assessed in relevant contents of the Delta Coal site WHSMS as a minimum.
- Compliance with the Environmental Protection Act 1994, Environmental Planning and Assessment Act 1979, Work Health and Safety Act 2011 and Work Health and Safety Regulations 2011, Code of Practice –How to Manage Work, Health and Safety Risks 2011, AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Compliance with the Delta Coal Environmental Management System
- Compliance with the Work Health and Safety Act 2011 and Work Health and Safety Regulations 2011, Code of Practice –How to Manage Work, Health and Safety Risks 2011, AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Work Health and Safety Act (2013) and Regulations (2014) Mines and Petroleum sites.

Monitoring and Review

Delta Coal site monitoring and review processes should encompass all aspects of the risk management process for the purposes of:

- ensuring that controls are effective and efficient in both design and operation;
- obtaining further information to improve risk assessment;
- analyzing and learning lessons from events (including near-misses), changes, trends, successes and failures;

- Identifying emerging risks.

References

- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines
- MDG1010 – Risk Management Handbook for the Mining Industry
- MDG1014 - Guideline to reviewing a risk assessment of mine equipment and operations
- Work Health and Safety Act 2011
- Work Health and Safety Regulations 2011
- Codes of Practice –WHS Act 2011, Section 274.
- Work Health and Safety Mines Act 2013
- Work Health and Safety Mines Regulations 2014
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines
- MDG1010 – Risk Management Handbook for the Mining Industry
- MDG1014 - Guideline to reviewing a risk assessment of mine equipment and operations
- Environmental Protection Act 1994
- Environmental Planning and Assessment Act 1979
- DGS, 2017. Multi-Seam Mining Feasibility Study for the Proposed Miniwalls CVB to CVB4 at Chain Valley Colliery
- EMM, 2015. Chain Valley Colliery- Modification 2- SoEE
- EMM, 2013. Chain Valley Colliery Mining Extension project 1- EIS
- Lake Coal, 2013. Chain Valley Colliery Extraction Plan MW7 to MW12
- NSW DMR, 2003. Guideline for Applications for Subsidence Management Approvals
- NSW DRE Mine Safety, 2017. Guideline Managing Risk of Subsidence
- PHMP 00021- Mannering and Chain Valley Collieries Principal Hazard Management Plans
- Delta Coal Subsidence PHMP
- Miniwall S1/N1 Extraction Plan and associated Risk Assessment

- Miniwall S2/S3 Extraction Plan and associated Risk Assessment
- Miniwall S4 Extraction Plan and associated Risk Assessment
- DGS (2018). Updated Investigation Report into the Maximum Subsidence Prediction Exceedance over Miniwalls 1 to 12 at Chain Valley Colliery, Vales Point. Report No. CHV-002/10b to LakeCoal Pty. Ltd.
- MSEC (2018). Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Miniwalls S2 and S3 in Support of the Extraction Plan. Report No. MSEC 979 Rev 2.
- Strata2 (2019b). S4 Panel : Geotechnical Environment, Subsidence Estimates and Impacts. Report No. CHV-010-Rev0 to Chain Valley Colliery.
- Strata 2 (2019) Secondary Extraction of Herringbone Report No. CHV-015-Rev0Strata 2 (2020) Herringbone Pillar Layout – Design criteria for Negligible Surface Effects Report No. CHV-008-Rev 0
- Strata 2 (2020) Geotechnical Aspects of S5 Panel Design and Subsidence Report No. CHV-019-Rev0

Definitions

Hazard

Means a situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace. (reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

Hazardous Manual Task

Defined in the WHS Regulations 2011, means a task that requires a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any person, animal or thing involving one or more of the following:

- repetitive or sustained force
- high or sudden force
- repetitive movement
- sustained or awkward posture
- exposure to vibration.

Musculoskeletal disorder

Defined in the WHS Regulations 2011, means an injury to, or a disease of, the musculoskeletal system, whether occurring suddenly or over time. It does not include an injury caused by crushing, entrapment (such as fractures and dislocations) or cutting resulting from the mechanical operation of plant.

Risk Assessment

Risk management process applied to a scope of work, overall activities, equipment and machinery to determine how often specified events may occur and the magnitude of their consequence. When applied to a specific and sequential set of job steps/activities this may be referred to as a Job Safety Analysis.

Risk

Is the possibility that harm (death, injury or illness) might occur when exposed to a hazard. (Reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

Risk control

Means taking action to eliminate health and safety risks so far as is reasonably practicable, and if that is not possible, minimising the risks so far as is reasonably practicable. Eliminating a hazard will also eliminate any risks associated with that hazard. .(reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

WRAC

Workplace Risk Assessment & Control

Subsidence

Movement of the ground surface as a result of readjustments of the overburden due to collapse or failure of underground mine workings and/or compression of remnant pillars

Subsidence Effects
The term used to define the subsidence and differential subsidence parameters (i.e. subsidence, tilt, strain and horizontal displacement) that may or may not have an impact on natural or man-made surface and sub-surface features above a mining area

Subsidence Impacts
The impact that a subsidence effect has on natural or man-made surface and sub-surface features above a mining area

Tilt
The rate of change of subsidence between two points (A and B), measured at set distances apart (usually 10 m).

Strain
The change in horizontal distance between two points at the surface after mining, divided by the pre-mining distance between the points, may be tensile, compressive or shear.

Rock Head
The geological boundary in the overburden between competent rock and unconsolidated sediments and weathered rock

Abbreviations

ALARP	As low as reasonably practicable (ALARP) - determined from WHS Act 2011, Section 18.
CVC	Chain Valley Colliery
DISRD	Department of Industry, Skills and Regional Development
EMP	Environmental Management Plan
FOS	Factor of Safety
JSA	Job Safety Analysis
LTA	less than adequate
LAK	Delta Coal
MC	Mannering Colliery
MSD	Musculoskeletal Disorder
MSMFI	Multi-seam Mining Feasibility Investigation
PCP	Principle Control Plans

PMHMP	Principle Mining Hazard Management Plans
PPE	Personal protective Equipment
STD	Standard
STF	Slip/Trips/Falls
SMP	Safety Management Plan
SWP	Standard Work Procedure

Monitoring and Review

Delta Coal site monitoring and review processes should encompass all aspects of the risk management process for the purposes of:

- ensuring that controls are effective and efficient in both design and operation;
- obtaining further information to improve risk assessment;
- analyzing and learning lessons from events (including near-misses), changes, trends, successes and failures;
- Identifying emerging risks.

Risk Table

The hazards were analysed and risks derived. The existing control mechanisms were identified prior to establishment of risk. Proposed risk reductions were discussed and agreed and a residual risk determined based on implementation of existing and proposed risk reductions. Consequences assessed through this risk assessment were taken as the reasonable practicable level of risk considering Injury to Personnel as a primary consideration and Environmental Impact and Financial Loss as a secondary consideration as defined in the Risk Assessment Matrix.

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.	**Natural Features**													
1.1a	Groundwater	Loss of groundwater from aquifers due to subsidence induced fracturing impacts users or dependant ecosystems	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Strata2 Mine Design Report • Existing extraction has already influenced groundwater levels (minimal further impact predicted) • Ground water assessment (SEE) • GWMP • Operational water management TARP and underground water make monitoring.	E	D	3	17	Update the GWMP for S5 and Pillar Extraction Plan application				ALARP	Approvals Coordinator	30/11/20

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.1b		Abnormal groundwater inflow due to extraction of Miniwall panel	• Strata2 Mine Design Report • Documented experience indicates that dykes and normal faults with throws of up to 3m have no appreciable impact on subsidence development or overburden hydraulic conductivity • Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Existing extraction has already influenced groundwater levels (minimal further impact predicted) • Subsidence and Water Management TARP • Ground water assessment (SEE) • GWMP • Strata2 report on S2 water make • Water monitoring systems (WO and trending database)	L	D	3	17					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.1c		Impact on registered groundwater bores in proximity to extraction effects their ongoing use (GW24575)	• Mining underneath saline Lake Macquarie. Previously no groundwater users identified • Minimal impact based on assessment and existing mining (SEE) • Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing)	E	D	4	18	As part of GWMP identify potential bores to be affected by MWS5. Check groundwater bores register and monitor SWL where access is granted Provide alternative water supply until impacted bore recovers where proven to be related to mining impact or as required by the secretary	D	5	22	LOW	Approvals Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.2a	Sea/Lake	Increased lakebed cracking resulting in impacts outside predictions	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Geological mapping of known structures incorporated into the mine design and assessed. • Detailed subsidence assessment by Strata 2. Predictions are significantly less than the EA approved limits. • Thickening of Teralba Conglomerate reduces fracture heights • Extensive subsidence model including bathymetric survey • Subsidence monitoring program • No previous evidence of significant irregularities around geological structures in previous MW areas • Subsidence PHMP and associated TARP	E	D	3	17	Undertake remediation of any mining affected sections in consultation with relevant authorities/landowners.				ALARP	Approvals Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.3a	Shoreline	Increased flooding risk due to subsidence	• HWMSB/Mine Design Report • Subsidence assessment (<20mm predicted) • Subsidence monitoring program	E	E	2	16					ALARP		
1.3b		Foreshore ecology impacted by increased flooding or erosion	• HWMSB/Seagrass Protection Barrier Mine Design • Subsidence assessment (<20mm predicted) • Subsidence monitoring program including 6 monthly bathymetric surveys • Biodiversity management plan	E	E	3	20	Undertake remediation of any mining affected sections of foreshore in consultation with relevant authorities/landowners.				ALARP	Approvals Coordinator	If triggered
1.3c		Changes in lakebed depth and wave climate result in increased erosion	• HWMSB/Mine Design • Low wave height environment (SEE) • Subsidence assessment (<0.4m vertical subsidence predicted) • Subsidence monitoring program	E	E	4	23					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.4	Ecosystems (Seagrass)	Increased depth from subsidence reduces presence/health of seagrass beds	• Seagrass mapping (no threatened species identified in extraction plan area) • Seagrass Management Plan and monitoring program • SPB/Mine design report • Subsidence assessment (<20mm predicted) • Subsidence monitoring program	E	D	4	21	Undertake remediation of any mining affected sections of seagrass in consultation with relevant authorities/landowners. Rehabilitation Management Plan				ALARP	E&C Compliance Coordinator	If triggered
1.5	Ecosystems (Benthic Communities)	Increased depth from subsidence reduces colony numbers/health	• Benthic communities monitoring surveys • Benthic Communities Management Plan • Subsidence assessment (<0.4m predicted for S5) • Subsidence monitoring program • Predictive modelling and assessment	E	D	4	21	Undertake remediation of any mining affected sections of seagrass in consultation with relevant authorities/landowners.				ALARP	E&C Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.6	Threatened and Protected Species (Loggerhead and Green Turtles)	Increased depth from subsidence results in reduction in food source (seagrass)	• Annual Seagrass mapping • SPB/Mine Design Report • Subsidence Assessment (<20mm Predicted) for first workings • Mobile and no impact predicted to food source	E	E	5	25	Review Subsidence trigger levels in the Seagrass Management plan and the Subsidence Monitoring TARP with regards to survey tolerance (meaningful survey limits) and corresponding seagrass health				ALARP	EC Coordinator	30/06/2020
1.7	Cliff/Steep Slope	Horizontal movements of cliff face results in rock failure	• Sub critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Subsidence assessment (Strata2) • Subsidence monitoring program • HWMSB/Mine Design • Miniwall S5 footprint contained to areas under Lake Macquarie • Pillar extraction to remain under Lake Macquarie Seagrass and Highwater Subsidence Mining barriers	E	E	5	25					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.8	Rock outcrops within lake (Pelican Rock)	Change in depth results in public safety risk	• Subsidence assessment (<0.2m long term predicted) • No direct secondary extraction undermining of the outcrop or marker • Subsidence monitoring program updated to include Pelican Rock Navigational Marker • Built Features Management and RMS Consultation	I	E	2	16	Update Built features management plan and consult with stakeholders				ALARP	EC Coordinator	30/6/20
2. Public Utilities														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
2.2	Services	Services not identified within impact area during original SEE impacted by subsidence	• Dial before you dig has confirmed no services located within subsidence affectation area (>20mm). All services located landward from high water mark. • Seagrass and Highwater Subsidence Mining barriers • Miniwall S5 footprint contained to areas under Lake Macquarie Pillar extraction to remain under Lake Macquarie	L	E	3	20					ALARP		
3. Public Amenities														
	Nil		• Miniwall S5 footprint contained to areas under Lake Macquarie • Pillar extraction to remain under Lake Macquarie • Seagrass and Highwater Subsidence Mining barriers											
4. Farm Land and Facilities														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
	Nil		• Miniwall S5 and Pillar Extractionfootprint contained to areas under Lake Macquarie • Seagrass and Highwater Subsidence Mining barriers • Long term stable pillar design for First Workings under land											
5. Industrial, Commercial and Business Establishments														
	Nil		• Miniwall S5 and Pillar Extractionfootprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land Seagrass and Highwater Subsidence Mining barriers											
6. Areas of Archaeological and/or Heritage Significance														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
6.1	AHIMS sites (adjacent extraction plan area)	Arch sites near foreshore impacted by flooding or erosion increases due to subsidence	• Locations identified (approx.) via AHIMS register • Conservation Risk Assessment covers for Miniwall S5 subsidence monitoring • Heritage Management Plan • HWMSB (no impact predicted) • Subsidence assessment (<20mm) • Subsidence monitoring program Consultation with the RAPs	E	E	4	23					ALARP	EC Coordinator	1/9/2020
7. Items of Architectural Significance														
	Nil		• Miniwall S5 and Pillar Extraction footprint contained to areas under Lake Macquarie Long term stable pillar design for First Workings under land											
8. Permanent Survey Control Marks														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
8.1	State Survey Marks/Permanent Survey Marks	Survey marks near foreshore effected by horizontal/vertical movement	• HWMSB/Mine Design • Subsidence assessment Miniwall S5 and Pillar Extraction footprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land	E	D	4	21	Review Built Features Management Plan to include Trig station adjacent MW S5 Subsidence monitoring program to include Trig station adjacent MW S5				ALARP	EC Coordinator Mine Surveyor	30/6/20 30/6/20
9. Residential Establishments														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
	Nil		• Miniwall S5 and Northern Pillar Extraction footprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land • Authority to Mine system and survey control					Subsidence Monitoring Program						
10. Other identified items requiring particular assessment														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.1a	Public Safety	Shallow water buoy (or other markers including sailing markers) within extraction plan area impacted due to subsidence resulting public safety risk	• Strata2 Subsidence assessment • Marker locations visually assessed and mapped and within seagrass area. • RMS consulted as part of previous S4 Extraction Plan. • Keep CCC informed of actions taken in relation to public safety risks • PMHMP Subsidence	I	D	3	17	Review the presence and potential impacts to shallow water buoys in Extraction area				ALARP	Mine Surveyor	01/06/20
10.1b		Jetties within extraction plan area impacted due to subsidence	• Subsidence assessment (<20mm predicted) due to mine design principles • Consultation program / community notifications • Visual assessment undertaken Subsidence monitoring program	E	D	4	21	Consultation with affected landholders - send out notification letters				ALARP	Mine Surveyor	30/09/20

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.1c		Moorings within extraction plan area impacted due to subsidence	• Limited moorings adjacent the EP area • Strata2 S5 Subsidence assessment • Majority of moorings within seagrass boundary (<20mm subsidence). Negligible change • Subsidence monitoring program	E	D	4	21	Check if there are any moorings in Extraction area				ALARP	Mine Surveyor	30/6/20
10.2	Consultation	LTA community, stakeholder or agency consultation results in concerns over impact	• CCC meetings • Delta Coal Website • Regular meetings with relevant authorities. Consultation with DPIE has occurred. • Extraction Plan Guidelines •	E	C	4	18	Review notification requirements for secondary extraction for affected stakeholders Landowner notifications to be sent out.				ALARP	Mine Surveyor	

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.3a	Subsidence Impact (general)	Subsidence predictions exceeded results in increased impact/community concern/ breach of conditions	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) including proximity of mine workings to surface constraints • Strata 2 Subsidence Assessment • Subsidence monitoring program	E	D	3	17	Update subsidence monitoring program to include MWS5	E	3	20	Low	Mine Surveyor	30/06/20

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.3b	Subsidence Impact (general)	Known or unknown geological structures in the workings increases subsidence impact	• Geological database and mapping from old and existing workings • Strata2 Mine Design Report • Known major structures incorporated into the updated geological and subsidence model • Strata Failure Management Plan • All pillars squat pillars thus confinement not reduced by structures • Subsidence monitoring to date has not indicated significant variation in areas of geological structure • Subsidence monitoring program	E	D	3	17					ALARP		

10.3c	Subsidence Impacts (Height of Fracturing)	Height of fracturing exceeds predictions leading to impacts on groundwater/ingress into mine workings due to direct hydraulic connectivity with the Lake.	• Sub-critical mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • PMHMP Subsidence • Lake Bed rock head survey undertaken and used to inform Mine Design and Subsidence Assessment report. • Bathymetric survey undertaken at the end of S2 March 2020. • Constrained zone thickness is greater than or equal to 12T • Strata2 Mine Design Report • Experience from inbye end of Miniwall 12 at Chain Valley at similar rock head thickness did not result in increased water make or signs of direct connectivity at higher levels of subsidence • Strata2 Subsidence Assessment Report • No overlying workings in the NMD • Geological mapping and site model • Subsidence monitoring program	E	D	3	17					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
			• Ground water assessment (SEE) • GWMP • Operational water management TARP											

Actions

No	Clause(s) No from RA Tables	Action	Person responsible for Action	Action timeframe	Comments	Database Action No	Responsible Person signature
1.	1.1.a	Update the GWMP for S5 Extraction Plan application Check groundwater bores register Provide alternative water supply until impacted bore recovers where proven to be related to mining impact or as required by the secretary	C Armit	30/6/2020			
2	1.1.c	Undertake remediation of Miniwall S5 mining affected areas as required in consultation with relevant authorities/landowners.	C Armit	If triggered			
3	1.3b, 1.4, 1.5, 1.8	Undertake remediation of any mining affected sections of foreshore in consultation with relevant authorities/landowners.	C Armit	If triggered			
4	1.6	Review Subsidence trigger levels in the Seagrass Management plan and the Subsidence Monitoring TARP with regards to survey tolerance (meaningful survey limits) and corresponding seagrass health.	C Armit	30.06.2020			
5	1.8	Update Built features management plan and consult with stakeholders (add trig station and pelican rock nav marker update in subsidence predictions)	C Armit	30.06.2020			

6	6.1	Review previous Archaeological surveys and requirement for further surveys for subsidence monitoring	C Armit	1.09.2020			
7	10.1a, 10.1c	Check if there are any moorings, shallow water buoys infrastructure in Extraction area	T Chisholm	30.06.2020			
8	10.2	Review notification requirements for secondary extraction for affected stakeholders	T Chisholm	30.09.2020			
9	10.3.a	Update Subsidence monitoring program and to include Trig station adjacent MW S5 Extend foreshore monitoring where access is granted Organise appropriate land access to conduct monitoring	T Chisholm	30.06.2020			



_____

[Chris Armit] **[Signature]** **[29/08/20]**

_____ _____

(Dave McLean) **[Signature]** **[Date]**

MDG 1014 Review Checklist

RISK ASSESSMENT REVIEW CHECKLIST

Risk Assessment Title: MINIWALL S5 and NORTHERN PILLAR EXTRACTION PLAN ***Date:*** 27/08/20

Site: CHAIN VALLEY COLLIERY

1. Report

[Circle or Highlight Yes or No for the following]

1.1	Is there a description of the operation or equipment being assessed?	Yes / No
1.2	Is there a summary of the strategic, corporate and risk management context?	Yes / No
1.3	Is there a list of the people involved in the risk identification step, together with their organizational roles and experience relevant to the risk assessment topic?	Yes / No
1.4	Is there an adequately detailed outline of the approach used to identify the risks?	Yes / No
1.5	Is there an outline of the method used for assessing the likelihood and consequences of the risks?	Yes / No
1.6	Is there, discussion of the basis for defining either the safety standard to be achieved, or the level of risk management expenditure?	Yes / No
1.7	Is there a list of the main actions to be taken to reduce risks and to manage risks?	Yes / No
1.8	Is there a timetable for implementing the main actions?	Yes / No
1.9	Does the report specify a requirement for a working audit requirement after completion of all stages?	Yes / No

2. Process

	How do you rate the following? [Circle or Highlight Poor to Very Good]	Poor/Very Good
2.1	The range of expertise of team which did the study.	**1 2 3 4 5**
2.2	The appropriateness of the degree of detail of the study.	**1 2 3 4 5**
2.3	The comprehensiveness of the systematic approach.	**1 2 3 4 5**
2.4	The identification of the key risk scenarios to be addressed.	**1 2 3 4 5**
2.5	The basis for deciding the required safety level or effort.	**1 2 3 4 5**
2.6	The method for assessing likelihood and consequences.	**1 2 3 4 5**
2.7	The thoroughness of consideration of planned risk reduction actions.	**1 2 3 4 5**
2.8	The thoroughness of consideration of existing or planned risk controls.	**1 2 3 4 5**
2.9	The objectivity and balance of the study (ie not unduly optimistic or pessimistic)	**1 2 3 4 5**

Signed: 

Position: Approvals Coordinator Date: 27/08/20

WRAC Risk Assessment

Workplace Risk Assessment & Control

RA 00321 - Miniwall S5 Extraction, Pillar Extraction Plan and Morisset Peninsula Subsidence Management Risk Assessment

Site: Chain Valley Colliery

Date: 29/04/2020 and 27/08/2020

No:	Draft - RA 00321 - Miniwall S5, Pillar Extraction and Morisset Peninsula Extraction Plan Subsidence Management		
Topic	Miniwall S5 Extraction, Pillar Extraction in the NMA and Morriset Peninsula First workings Subsidence Management		
Venue	Chain Valley Colliery		
Requested by:	Chris Armit Environment and Community Coordinator	**Date:** 29/04/2020 and 27/08/20	**Time allowed:** 4 hours
Facilitator	Chris Nicholas Technical Services Manager (29/4/2020) and Chris Armit (27/08/2020)		

Relevant Risk Assessment Documents/Procedures/Safety Alerts/Safety Bulletins

- Strata 2 (2020) S5 Subsidence Predictions report
- S4 Subsidence Predictions report
- S4 Extraction Plan Risk Assessment
- S2/S3 Subsidence Predictions report
- S2/S3 Extraction Plan Risk Assessment
- Strata 2 (2020) Northern Mining Area First workings

Persons participating in Risk Assessment

Name	Role	Years of Industry Experience	Signature
Chris Armit	Approvals Coordinator	20	
David Hill	Geotechnical Consultant	41	
Chris Nicholas	Technical Services Manager	15	
Tim Chisholm	Mine Surveyor	14	

Purpose

This risk assessment has been conducted to assess and document potential surface and sub-surface subsidence risks associated with mining of Northern Mining Domains (NMD) Miniwall S5 extraction, pillar extraction and first workings in the Morisset Peninsula.

Objectives and Scope

The objectives of this risk assessment are to:

- Identify hazards and assess the risk associated with environmental, public safety and surface built feature impacts from extraction.
- Ensure compliance with the WHS (Mines) Regulation 2014 Clause 67 Subsidence:

  (1) In complying with clause 9, the mine operator of an underground coal mine must manage risks to health and safety associated with subsidence at the mine.

  (2) Without limiting subclause (1), the mine operator must ensure that:

  (a) So far as is reasonably practicable, the rate, method, layout, schedule and sequence of mining operations do not put the health and safety of any person at risk from subsidence, and

  (b) Monitoring of subsidence is conducted, including monitoring of its effects on relevant surface and subsurface features, and

  (c) Any investigation of subsidence and any interpretation of subsidence information is carried out only by a competent person, and

  (d) All subsidence monitoring data is provided to the regulator in the form and at the times required by the regulator, and

  (e) So far as reasonably practicable, procedures are implemented for the effective consultation, co-operation and co-ordination of action with respect to subsidence between the mine operator and relevant persons conducting any business or undertaking that is, or is likely to be, affected by subsidence.
- Meet (where applicable) the standards for assessing and managing risks of subsidence as outlined in the “Managing Risks of Subsidence Guideline”, February 2017.
- Place a particular focus on recently updated subsidence predictions and recommendations for the area including a review of factors behind the exceedance of subsidence predictions over the MW 1 to 12 area.
- Identify the existing and potential controls to reduce the risk to a reasonable practicable level.

The scope of the risk assessment focuses on the extraction area defined by a 26.5 degree angle of draw from lakeside seagrass boundary projected to Fassifern seam or to the predicted 20mm subsidence contour of S5 (see **Figure 1 and Figure 2**). The level of monitoring required will be commensurate with the assessed level of risk (i.e. after controls are put in place) or potential consequence. The corresponding residual risk will determine if these controls are sufficiently acceptable.

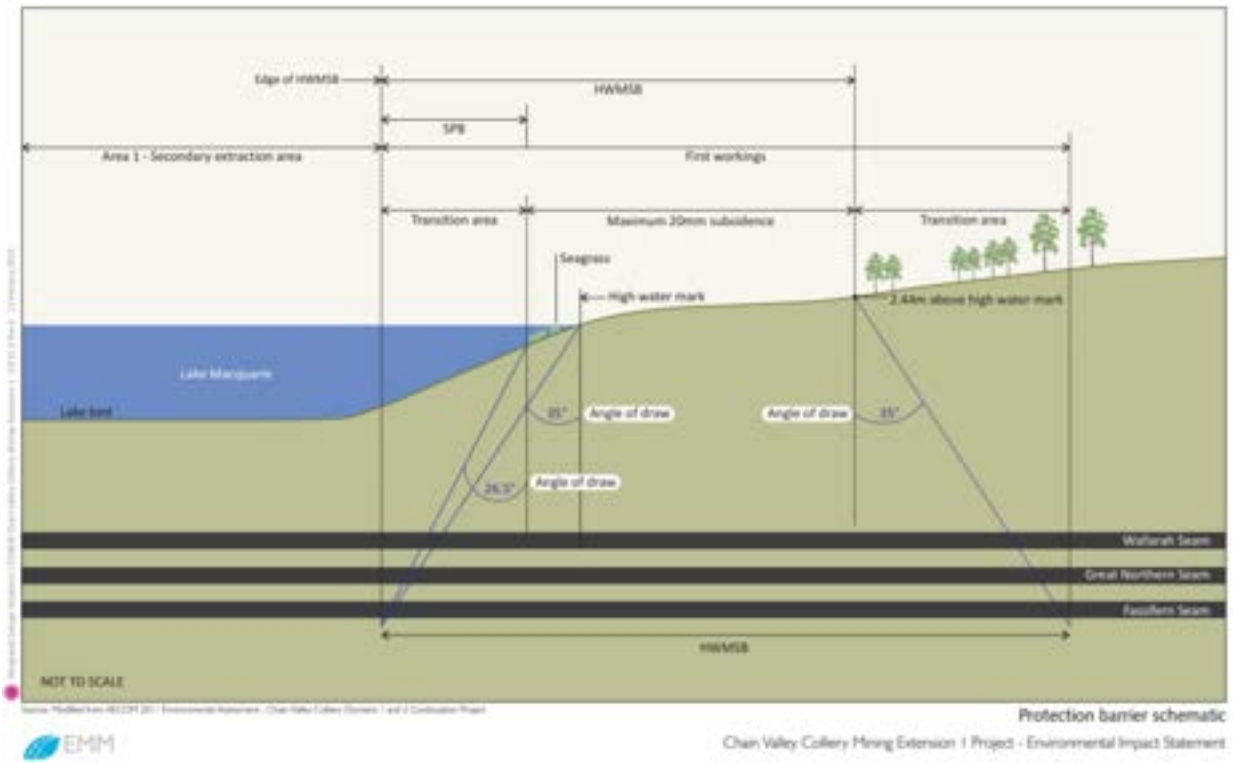


Figure 1- Protection barrier schematic from SSD 5465 Environmental Impact Statement

The list of surface and sub-surface features outlined in Appendix B of the 2003 NSW Department of Mineral Resources Guidelines for Application for Subsidence Management Approvals, along with items outlined in the 2017 Managing Risks of Subsidence Guideline, have been used as a starting reference list of features for assessment. All features on the list were assessed as to whether they exist within the defined extraction plan area. Where a feature is not noted in the WRAC assessment, it has not been identified within the area of interest.

APPENDIX 3
DEVELOPMENT LAYOUT

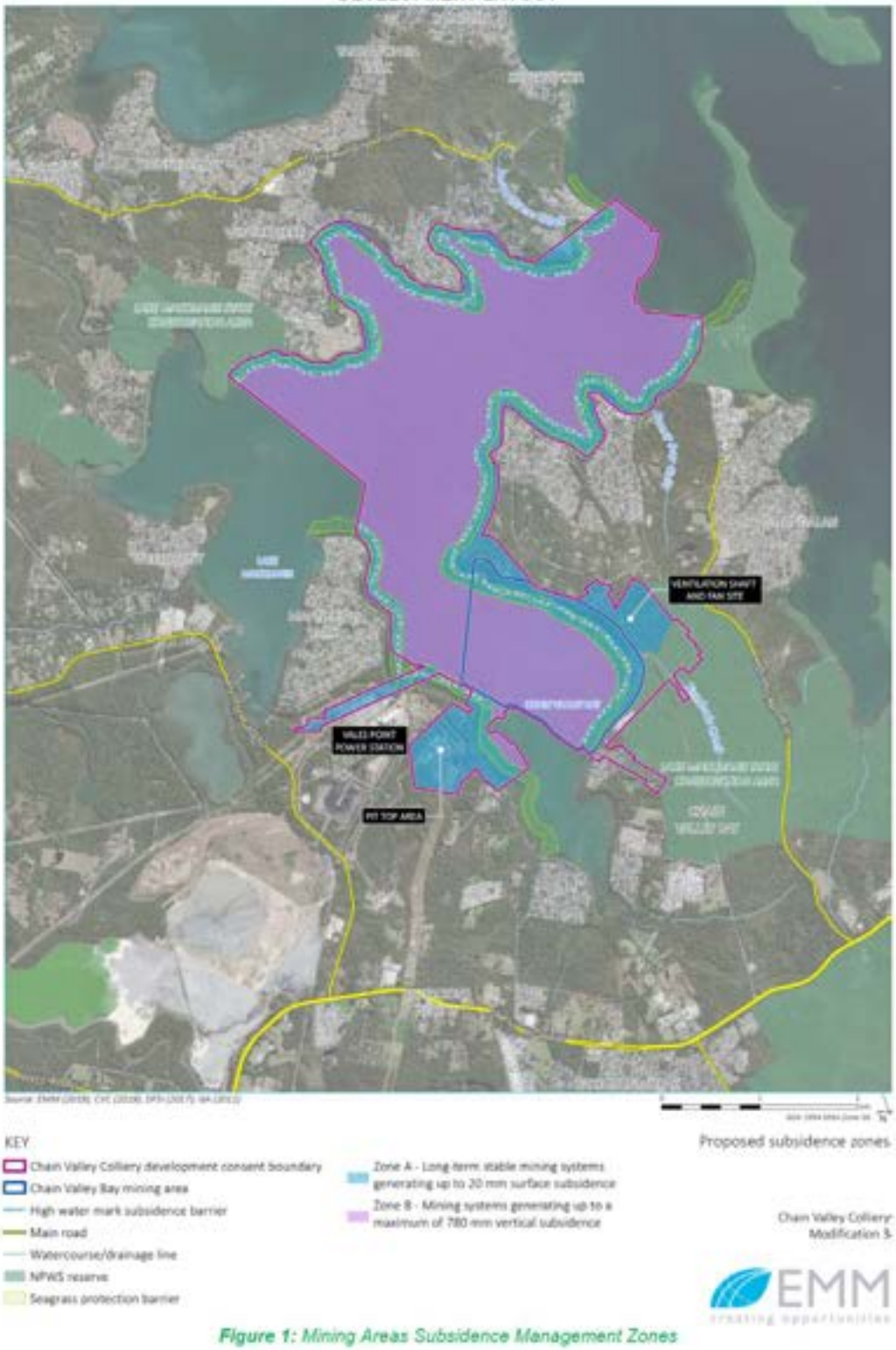


Figure 1: Mining Areas Subsidence Management Zones

Figure 2 – Figure 1 from CVC Consent (SSD 5465 Modification 3)

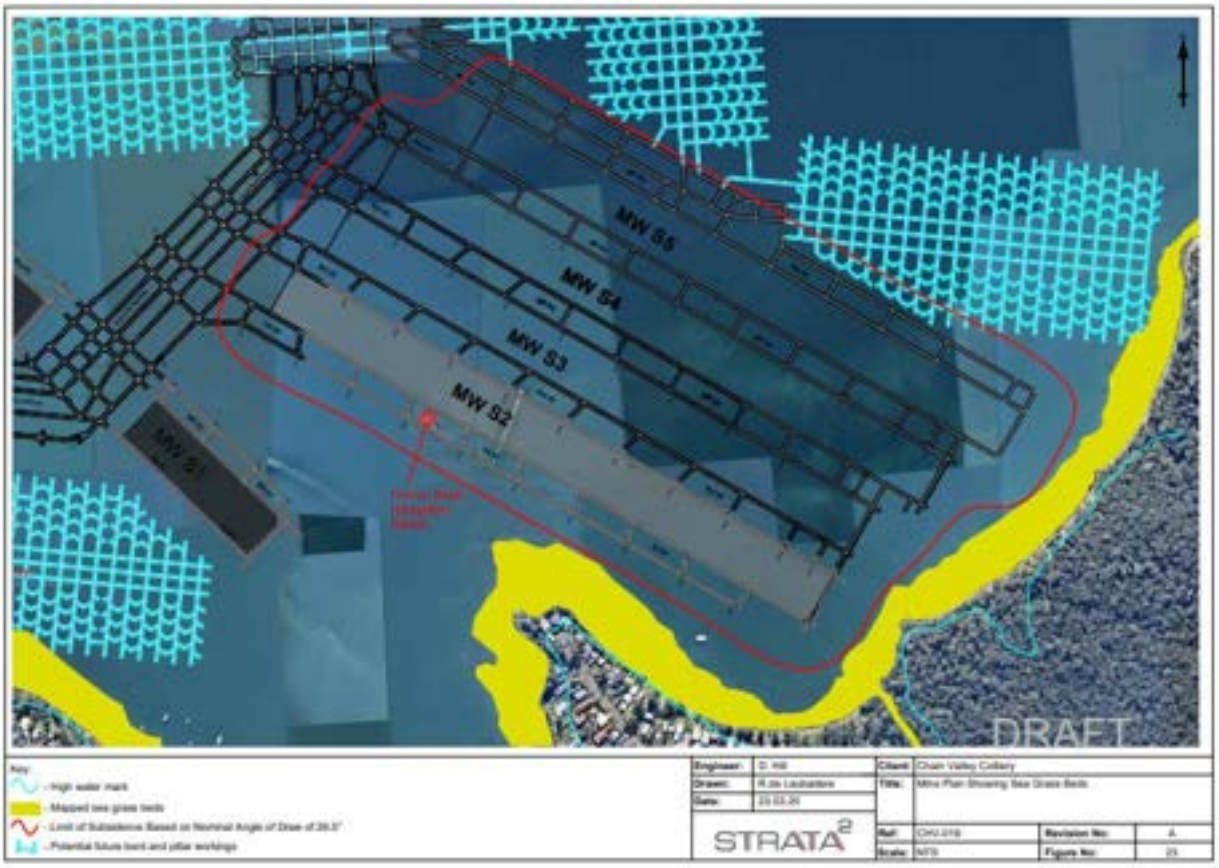


Figure 1- S2 to S5 Extraction Impact area due to Fassifern Miniwall Mining

Risk Assessment Process

1. Hazard identification
2. Identified hazards were evaluated with regard to consequence and then the Likelihood of that consequence outcome was assessed, assuming existing controls to be effectively implemented.
3. Risk rankings were derived.
4. Additional controls were proposed where possible for medium and high risks and the hazards were re-evaluated to arrive at the residual risk.
5. Likelihood and consequence were assessed in accordance AS/NZS ISO 31000:2009 Risk Management – Principles and guidelines.
6. This risk assessment was conducted in general compliance with MDG1010 and MDG1014.
7. As low as reasonably practicable (ALARP) is determined from WHS Act 2011, Section 18.
8. Hazardous Manual Tasks should be identified and controlled to a reasonable practicable level of risk using the Risk Assessment Worksheet for Hazardous Manual Tasks Form and actions recorded in this risk assessment.
9. Actions and outcomes from the risk assessment are recorded with a due date of action completion and responsible person.
10. Risk Assessments are monitored and reviewed as detailed by the Delta Coal Site Work Health and Safety Management System.

Risk Assessment Checklist based on Hazard / Energy Types

Energy Type	POTENTIAL HAZARDS			
	To People	To Equipment	To Production	To The Environment
Electrical	• Electric Shock • Burns • Smoke Inhalation	• Unplanned movement • Fire • Circuit Damage	• Supply fails causing shutdown • Inadequate supply causing process slowdown	• Fire
Mechanical	• Crushed • Struck by Moving or Flying Objects • Caught Between Moving Objects	• Collision • Breakdown • Unplanned Movement • Breakages • Vibration	• Fails & Causes Shutdown • Slows Down Production	• Physical Damage • Fire
Chemical	• Burns • Skin Irritation • Ingestion • Inhalation (Toxic atmospheres) • Explosion (Mixing incompatible)	• Fire • Internal Damage • Corrosion	• Causes Delays or Shutdowns (Not enough, wrong type to much)	• Spillage (Water contamination, soil contamination, air pollution, vegetation destroyed)
Pressure (Fluids/Gases)	• Fluid Injection • Crush • Respiratory Problems	• Unplanned Movement • Poor Performance • Breakdown	• Equipment Failure Shutdown (No fluids or to much fluids, no gases or to much gases)	• Contamination (Dust, fuel/oil, dirty water0
Radiation	• Burns • Eye Damage (welding flash) • Internal problems		• Source fails (Causing delays or shutdown)	• Contamination
Thermal	• Burns • Heat Exhaustion • Frostbite	• Overheating • Freezing	• Shutdown (Overheating or freezing)	
Biochemical	• Sprains • Strains		• Slowdown due to loss of staff	
Noise/Vibration	• Hearing damage	• Mechanical damage	• Slowdown due to people not accessing area	• Community complaints
Biological	• Illness • Disease		• Shutdown due to lack of people	
Gravitational	• Falling from Heights • Objects falling on Personnel	• Rollover • Collapse • Failure • Damage from fall • Damage from objects falling	• Objects falling causing slowdown or shutdown	• Contamination

Risk Matrix

Hierarchy of Control		LIKELIHOOD			
Elimination	Do we still have to do this?	A	Almost certain to happen	FREQUENCY	1 per week to 1 per month
Substitution	Is there another way or product?	B	Likely to happen at some point		1 per month to 1 per year
Redesign/Engineer	Can the equipment or process be modified?	C	Moderate, possible; heard of so it might happen		1 per year to 1 per 10 years
Isolation/Guarding	Will guarding or some type of barrier help?	D	Unlikely, not likely to happen		1 per 10 years to 1 per 100 years
Administration	Will a written procedure and/or training help?	E	Rare, practically impossible		Less than 1 per 100 years
PPE	Is personal protective equipment adequate?				

Maximum Reasonable Consequence

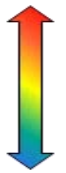
Consequence	Injury (I)	Environmental (E)	Loss (L)
1 - Critical	Could kill, permanently disable	Regional environmental impact/ecosystem damage. Impact causing mine or business closure. E.g. Major release off site with long term detrimental effect	Could cause very major damage > $3M
2 - High	Could cause serious injury (major LTI)	Substantial environmental damage which could result in major financial loss and/or prosecution. E.g Off-site release resulting in local ecosystem damage	Could cause major damage $500K - $3M
3 - Medium	Could cause typical MTC/LTI	Substantial temporary or minor long term damage, release immediately contained with outside assistance eg. A minor water discharge or large hydrocarbon spill. Legal non-compliance.	Could cause moderate damage $100K - $500K
4 - Low	Could cause first aid injury	Temporary or minor damage, non-compliance with internal environmental target, no legal breach, eg. Minor spill	Could cause damage $20K - $100K
5 - Insignificant	Couldn't cause injury	No detrimental effect, low financial loss, negligible environmental impact	Couldn't cause damage, or <$20K damage

Risk Score Matrix

Risk Score	Risk	What should I do?
1 to 3	Critical	STOP WORK Immediate action required, inform senior management
4 to 10	High	Risk Assessment required. Action plan required, senior management attention needed
11 to 15	Medium	Specific monitoring of procedures required management responsibility must be specified
16 to 25	Low	Manage through routine procedures

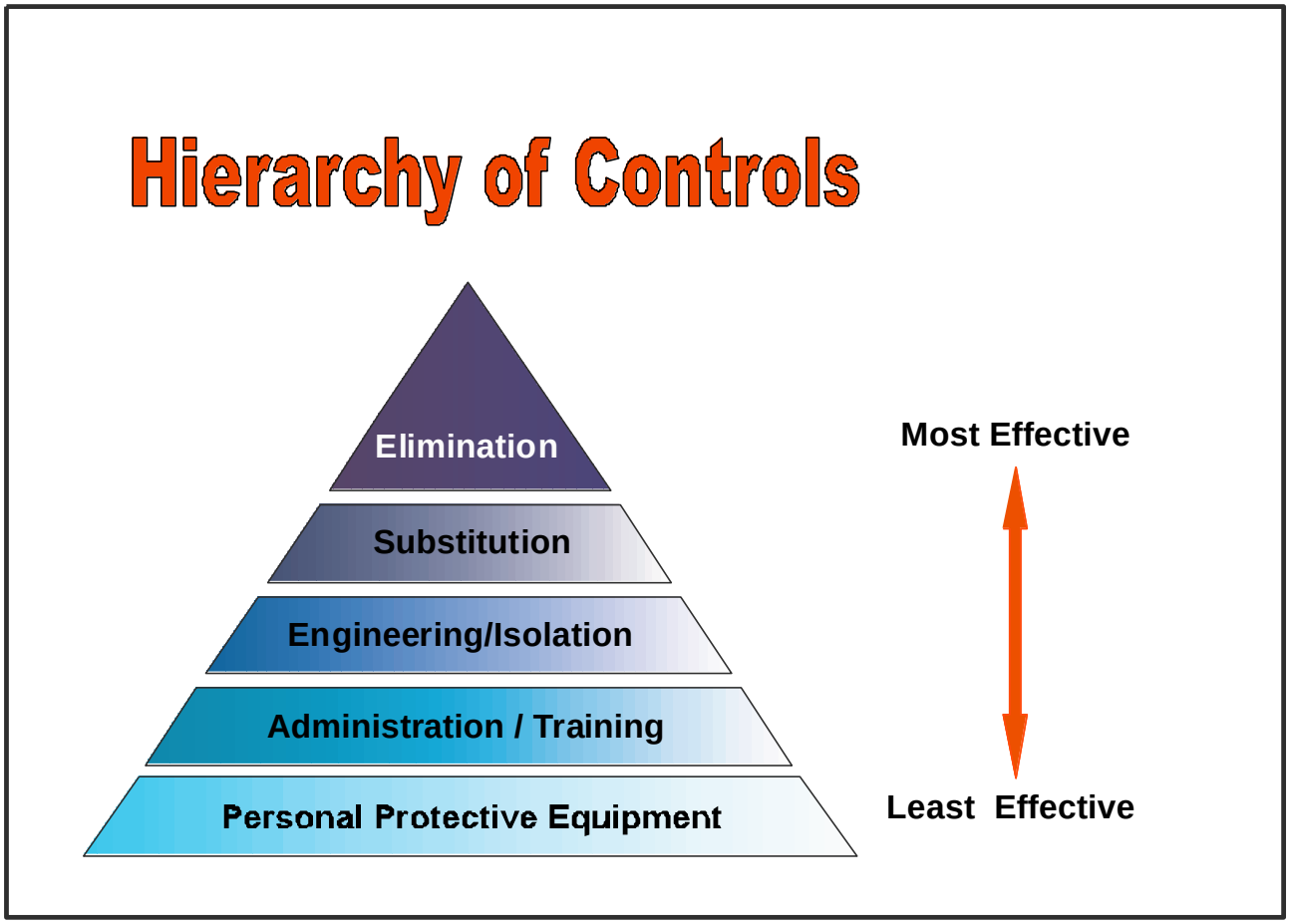
CONSEQUENCE	LIKELIHOOD					
		A- Certain	B - Likely	C - Moderate	D - Unlikely	E - Rare
	1 - Critical	1	2	4	7	11
	2 - High	3	5	8	12	16
	3 - Medium	6	9	13	17	20
	4 - Low	10	14	18	21	23
	5 - Insignificant	15	19	22	24	25

Least Effective



Most Effective

Hierarchy of Controls (as per WHS Regulations 2011 Clause 36)



HIERARCHY OF CONTROLS 1-6 Descending Order(as per WHS Regulations 2011 Clause 36)	
Elimination	Remove the hazard from the workplace (Re-Design)
Substitution	Substituting (wholly or partly) the hazard giving rise to the risk with something that gives rise to a lesser risk. (Alternative product / plant)
Isolation	Isolating the hazard from any person exposed to it. Use barriers to shield or isolate the hazard (Guards on machines, enclosures for noises)
Engineering controls	Design & install equipment to counteract or lessen the hazard
Administrative controls	change to a system of work, a process or a procedure to lessen the hazard
Personal Protective Equipment	ensuring the provision and use of suitable personal protective equipment

Hazard Analysis and Risk Assessment

The risk management methodology as described in WHS Act 2011, WHS Regulations 2011, WHS Code of Practice WHS Act 2011, Section 274, Code of Practice –How to Manage Work, Health and Safety Risks 2011, MDG1010 and AS/NZS ISO 31000:2009 is used to identify the various processes and activities at Delta Coal sites.

Risk analyses shall be completed for each activity based on the following matrix. The subsequent risk ranking shall then determine the frequency of re-assessments.

Likelihood	Consequences
A. Almost certain to happen	1. Permanently disable.
B. Like to happen at some point	2. Could cause serious injury (Major LTI)
C. Moderate, possible, heard of so it might happen	3. Could cause Medical Treatment Case/ LTI
D. Unlikely, not likely to happen	4. Could cause First Aid Treatment
E. Rare, practically Impossible	5. Could not cause injury

Likelihood and Consequences are applicable to Table 1 below.

		LIKELIHOOD				
CONSEQUENCE		A – Certain	B – Likely	C – Moderate	D – Unlikely	E - Rare
	1 - Critical	1	2	4	7	11
	2 - High	3	5	8	12	16
	3 - Medium	6	9	13	17	20
	4 - Low	10	14	18	21	23
	5 - Insignificant	15	19	22	24	25

Facts

- Extraction is to occur in the Fassifern seam utilising miniwall extraction methods and solely beneath Lake Macquarie (ie outside the High Water Mark Subsidence Barrier and Seagrass Protection Barrier).
- S5 extraction depth of cover ranges between an effective depth of 162 to 171m. The panels are at >35^0 angle of draw to the foreshore.
- No extraction is planned within the High Water Mark Subsidence Barrier (HWMSB) and Seagrass Protection Barrier (SPB)
- The panel void width for Miniwall S5 is 97m, consistent with recent CVC practice.
- The panel void width for Pillar Extraction is xxm, consistent with the Pillar extraction Strata 2 report
- For the Miniwall S5 Twin heading gate roads with typically 110m long (centres) pillars. 5.4m wide by 3.2m high roadways.
- The S5 maingate and tailgate chain pillars are 32.6m and 40m in width respectively (solid) to limit (a) subsidence over S2 to S5 Panels and (b) abutment load transfer to future workings to the north.
- Seam thickness varies from 4.8m inbye to 5.0m outbye. The nominal extraction height will be 3.5m, leaving around 1m of top coal during extraction.
- Updated predictions for subsidence over the MW1 to 12 area of 720mm were exceeded in the MW7 to 10 area with up to 1100mm recorded (a further 150mm of creep movement could be expected). The subsidence model has since been reviewed and amended to align with this increase, and to gain an understanding of the potential mechanisms behind the increase. This model and information has been utilised to develop a mine plan and updated predictions for the NMD such that predicted subsidence is planned to remain within the approved 780mm for the domain allowing for anticipated longer term creep.
- A detailed subsidence assessment has been undertaken for miniwalls S2 and S3 by Mine Subsidence Engineering Consultants (MSEC). The assessment has indicated that the subsidence results over the miniwalls will result in approximately 290mm of vertical subsidence and 6mm/m tilt. Predicted vertical subsidence at the sea grass beds/moorings and jetties are predicted to be less than 20mm. The expected subsidence at Pelican rock is expected to be in the order of 90mm.

  Strata2 ground control consulting has undertaken a detailed subsidence assessment for miniwall S5. The assessment has indicated that the extraction of miniwall S5 will result in a maximum of approximately 0.3-0.4m of long-term vertical subsidence, strains of <2mm and tilts of <5 mm/m . Predicted vertical subsidence at the sea grass beds/moorings and jetties is less than 20mm. The expected long-term subsidence at Pelican Rock is expected to be in the order of 0.1-0.2m

- Strata2 ground control consulting has undertaken a detailed geotechnical design report for the miniwall layout which has formed the basis for the mine design used in the subsidence assessment.
- Delta Coal has successfully mined Miniwall S1, N1, S2 and S3 in the NMD with subsidence monitoring results at the foreshore well within predictions.
- Delta Coal has completed a rock head survey of the NMD which has formed the basis for the key assumptions used in the technical reports.
- S5 extraction depth of cover ranges between 162 and 171m. Caving is expected to extend up to 35m above the Fassifern Seam extraction horizon and the theoretical height of the total Fractured Zone is 93m. However, in practice, the Fractured zone is expected to terminate at the base of the Teralba Conglomerate, some 45m to 50m above the mining horizon.
- The location of the maximum predicted subsidence is beneath Lake Macquarie within the FAS working footprint (ie outside the foreshore and mapped seagrass areas) **Figure 2**.
- First workings under the Morisset peninsula to be designed in accordance with the geotechnical design to remain long term stable and negligible surface subsidence.

Assumptions

- Employees are trained and assessed in relevant contents of the Delta Coal site WHSMS as a minimum.
- Compliance with the Environmental Protection Act 1994, Environmental Planning and Assessment Act 1979, Work Health and Safety Act 2011 and Work Health and Safety Regulations 2011, Code of Practice –How to Manage Work, Health and Safety Risks 2011, AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Compliance with the Delta Coal Environmental Management System
- Compliance with the Work Health and Safety Act 2011 and Work Health and Safety Regulations 2011, Code of Practice –How to Manage Work, Health and Safety Risks 2011, AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines.
- Work Health and Safety Act (2013) and Regulations (2014) Mines and Petroleum sites.

Monitoring and Review

Delta Coal site monitoring and review processes should encompass all aspects of the risk management process for the purposes of:

- ensuring that controls are effective and efficient in both design and operation;
- obtaining further information to improve risk assessment;

- analyzing and learning lessons from events (including near-misses), changes, trends, successes and failures;
- Identifying emerging risks.

References

- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines
- MDG1010 – Risk Management Handbook for the Mining Industry
- MDG1014 - Guideline to reviewing a risk assessment of mine equipment and operations
- Work Health and Safety Act 2011
- Work Health and Safety Regulations 2011
- Codes of Practice –WHS Act 2011, Section 274.
- Work Health and Safety Mines Act 2013
- Work Health and Safety Mines Regulations 2014
- AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines
- MDG1010 – Risk Management Handbook for the Mining Industry
- MDG1014 - Guideline to reviewing a risk assessment of mine equipment and operations
- Environmental Protection Act 1994
- Environmental Planning and Assessment Act 1979
- DGS, 2017. Multi-Seam Mining Feasibility Study for the Proposed Miniwalls CVB to CVB4 at Chain Valley Colliery
- EMM, 2015. Chain Valley Colliery- Modification 2- SoEE
- EMM, 2013. Chain Valley Colliery Mining Extension project 1- EIS
- Lake Coal, 2013. Chain Valley Colliery Extraction Plan MW7 to MW12
- NSW DMR, 2003. Guideline for Applications for Subsidence Management Approvals
- NSW DRE Mine Safety, 2017. Guideline Managing Risk of Subsidence
- PHMP 00021- Mannering and Chain Valley Collieries Principal Hazard Management Plans
- Delta Coal Subsidence PHMP

- Miniwall S1/N1 Extraction Plan and associated Risk Assessment
- Miniwall S2/S3 Extraction Plan and associated Risk Assessment
- Miniwall S4 Extraction Plan and associated Risk Assessment
- DGS (2018). Updated Investigation Report into the Maximum Subsidence Prediction Exceedance over Miniwalls 1 to 12 at Chain Valley Colliery, Vales Point. Report No. CHV-002/10b to LakeCoal Pty. Ltd.
- MSEC (2018). Subsidence Predictions and Impact Assessments for Natural and Built Features due to the Extraction of the Proposed Miniwalls S2 and S3 in Support of the Extraction Plan. Report No. MSEC 979 Rev 2.
- Strata2 (2019b). S4 Panel : Geotechnical Environment, Subsidence Estimates and Impacts. Report No. CHV-010-Rev0 to Chain Valley Colliery.
- Strata 2 (2019) Secondary Extraction of Herringbone Report No. CHV-015-Rev0Strata 2 (2020) Herringbone Pillar Layout – Design criteria for Negligible Surface Effects Report No. CHV-008-Rev 0
- Strata 2 (2020) Geotechnical Aspects of S5 Panel Design and Subsidence Report No. CHV-019-Rev0

Definitions

Hazard

Means a situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace. (reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

Hazardous Manual Task

Defined in the WHS Regulations 2011, means a task that requires a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any person, animal or thing involving one or more of the following:

- repetitive or sustained force
- high or sudden force
- repetitive movement
- sustained or awkward posture
- exposure to vibration.

Musculoskeletal disorder

Defined in the WHS Regulations 2011, means an injury to, or a disease of, the musculoskeletal system, whether occurring suddenly or over time. It does not include an injury caused by crushing, entrapment (such as fractures and dislocations) or cutting resulting from the mechanical operation of plant.

Risk Assessment

Risk management process applied to a scope of work, overall activities, equipment and machinery to determine how often specified events may occur and the magnitude of their consequence. When applied to a specific and sequential set of job steps/activities this may be referred to as a Job Safety Analysis.

Risk

Is the possibility that harm (death, injury or illness) might occur when exposed to a hazard. (Reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

Risk control

Means taking action to eliminate health and safety risks so far as is reasonably practicable, and if that is not possible, minimising the risks so far as is reasonably practicable. Eliminating a hazard will also eliminate any risks associated with that hazard. .(reference Code of Practice –How to Manage Work, Health and Safety Risks 2011)

WRAC

Workplace Risk Assessment & Control

Subsidence

Movement of the ground surface as a result of readjustments of the overburden due to collapse or failure of underground mine workings and/or compression of remnant pillars

Subsidence Effects
The term used to define the subsidence and differential subsidence parameters (i.e. subsidence, tilt, strain and horizontal displacement) that may or may not have an impact on natural or man-made surface and sub-surface features above a mining area

Subsidence Impacts
The impact that a subsidence effect has on natural or man-made surface and sub-surface features above a mining area

Tilt
The rate of change of subsidence between two points (A and B), measured at set distances apart (usually 10 m).

Strain
The change in horizontal distance between two points at the surface after mining, divided by the pre-mining distance between the points, may be tensile, compressive or shear.

Rock Head
The geological boundary in the overburden between competent rock and unconsolidated sediments and weathered rock

Abbreviations

ALARP	As low as reasonably practicable (ALARP) - determined from WHS Act 2011, Section 18.
CVC	Chain Valley Colliery
DISRD	Department of Industry, Skills and Regional Development
EMP	Environmental Management Plan
FOS	Factor of Safety
JSA	Job Safety Analysis
LTA	less than adequate
LAK	Delta Coal
MC	Mannering Colliery
MSD	Musculoskeletal Disorder
MSMFI	Multi-seam Mining Feasibility Investigation
PCP	Principle Control Plans

PMHMP	Principle Mining Hazard Management Plans
PPE	Personal protective Equipment
STD	Standard
STF	Slip/Trips/Falls
SMP	Safety Management Plan
SWP	Standard Work Procedure

Monitoring and Review

Delta Coal site monitoring and review processes should encompass all aspects of the risk management process for the purposes of:

- ensuring that controls are effective and efficient in both design and operation;
- obtaining further information to improve risk assessment;
- analyzing and learning lessons from events (including near-misses), changes, trends, successes and failures;
- Identifying emerging risks.

Risk Table

The hazards were analysed and risks derived. The existing control mechanisms were identified prior to establishment of risk. Proposed risk reductions were discussed and agreed and a residual risk determined based on implementation of existing and proposed risk reductions. Consequences assessed through this risk assessment were taken as the reasonable practicable level of risk considering Injury to Personnel as a primary consideration and Environmental Impact and Financial Loss as a secondary consideration as defined in the Risk Assessment Matrix.

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.	**Natural Features**													
1.1a	Groundwater	Loss of groundwater from aquifers due to subsidence induced fracturing impacts users or dependant ecosystems	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Strata2 Mine Design Report • Existing extraction has already influenced groundwater levels (minimal further impact predicted) • Ground water assessment (SEE) • GWMP • Operational water management TARP and underground water make monitoring.	E	D	3	17	Update the GWMP for S5 and Pillar Extraction Plan application				ALARP	E&C Coordinator	30/11/20

1.1b		Abnormal groundwater inflow due to extraction of Miniwall panel	• Strata2 Mine Design Report • Documented experience indicates that dykes and normal faults with throws of up to 3m have no appreciable impact on subsidence development or overburden hydraulic conductivity • Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Existing extraction has already influenced groundwater levels (minimal further impact predicted) • Subsidence and Water Management TARP • Ground water assessment (SEE) • GWMP • Strata2 report on S2 water make • Water monitoring systems (WO and trending database)	L	D	3	17					ALARP		
1.1c		Impact on registered groundwater bores in proximity to extraction effects	• Mining underneath saline Lake Macquarie. Previously no groundwater users identified	E	D	4	18	As part of GWMP identify potential bores to be affected by MWS5.	D	5	22	LOW	Approvals Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
		their ongoing use (GW24575)	• Minimal impact based on assessment and existing mining (SEE) • Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing)					Check groundwater bores register and monitor SWL where access is granted Provide alternative water supply until impacted bore recovers where proven to be related to mining impact or as required by the secretary						

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.2a	Sea/Lake	Increased lakebed cracking resulting in impacts outside predictions	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Geological mapping of known structures incorporated into the mine design and assessed. • Detailed subsidence assessment by Strata 2. Predictions are significantly less than the EA approved limits. • Thickening of Teralba Conglomerate reduces fracture heights • Extensive subsidence model including bathymetric survey • Subsidence monitoring program • No previous evidence of significant irregularities around geological structures in previous MW areas • Subsidence PHMP and associated TARP	E	D	3	17	Undertake remediation of any mining affected sections in consultation with relevant authorities/landowners.				ALARP	Approvals Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.3a	Shoreline	Increased flooding risk due to subsidence	• HWMSB/Mine Design Report • Subsidence assessment (<20mm predicted) • Subsidence monitoring program	E	E	2	16					ALARP		
1.3b		Foreshore ecology impacted by increased flooding or erosion	• HWMSB/Seagrass Protection Barrier Mine Design • Subsidence assessment (<20mm predicted) • Subsidence monitoring program including 6 monthly bathymetric surveys • Biodiversity management plan	E	E	3	20	Undertake remediation of any mining affected sections of foreshore in consultation with relevant authorities/landowners.				ALARP	Approvals Coordinator	If triggered
1.3c		Changes in lakebed depth and wave climate result in increased erosion	• HWMSB/Mine Design • Low wave height environment (SEE) • Subsidence assessment (<0.4m vertical subsidence predicted) • Subsidence monitoring program	E	E	4	23					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.4	Ecosystems (Seagrass)	Increased depth from subsidence reduces presence/health of seagrass beds	• Seagrass mapping (no threatened species identified in extraction plan area) • Seagrass Management Plan and monitoring program • SPB/Mine design report • Subsidence assessment (<20mm predicted) • Subsidence monitoring program	E	D	4	21	Undertake remediation of any mining affected sections of seagrass in consultation with relevant authorities/landowners.				ALARP	E&C Coordinator	If triggered
1.5	Ecosystems (Benthic Communities)	Increased depth from subsidence reduces colony numbers/health	• Benthic communities monitoring surveys • Benthic Communities Management Plan • Subsidence assessment (<0.4m predicted for S5) • Subsidence monitoring program • Predictive modelling and assessment	E	D	4	21	Undertake remediation of any mining affected sections of seagrass in consultation with relevant authorities/landowners.				ALARP	E&C Coordinator	If triggered

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.6	Threatened and Protected Species (Loggerhead and Green Turtles)	Increased depth from subsidence results in reduction in food source (seagrass)	• Annual Seagrass mapping • SPB/Mine Design Report • Subsidence Assessment (<20mm Predicted) for first workings • Mobile and no impact predicted to food source	E	E	5	25	Review Subsidence trigger levels in the Seagrass Management plan and the Subsidence Monitoring TARP with regards to survey tolerance (meaningful survey limits) and corresponding seagrass health				ALARP	EC Coordinator	30/06/2020

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.7	Cliff/Steep Slope	Horizontal movements of cliff face results in rock failure	• Sub critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • Subsidence assessment (Strata2) • Subsidence monitoring program • HWMSB/Mine Design • Miniwall S5 footprint contained to areas under Lake Macquarie • Pillar extraction to remain under Lake Macquarie Seagrass and Highwater Subsidence Mining barriers •	E	E	5	25	Identify steep slopes in a figure in the geotechnical design and ensure its dealt with in geotechnical design and subsidence predictions document Add Steep slopes figure to the land management plan				ALARP	Approvals Coordinator	

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
1.8	Rock outcrops within lake (Pelican Rock)	Change in depth results in public safety risk	• Subsidence assessment (<0.2m long term predicted) • No direct secondary extraction undermining of the outcrop or marker • Subsidence monitoring program updated to include Pelican Rock Navigational Marker • Built Features Management and RMS Consultation	I	E	2	16	Update Built features management plan and consult with stakeholders				ALARP	EC Coordinator	30/6/20
2. Public Utilities														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
2.2	Services	Services not identified within impact area during original SEE impacted by subsidence	• Dial before you dig has confirmed no services located within subsidence affectation area (>20mm). All services located landward from high water mark. • Seagrass and Highwater Subsidence Mining barriers • Miniwall S5 footprint contained to areas under Lake Macquarie Pillar extraction to remain under Lake Macquarie	L	E	3	20					ALARP		
3. Public Amenities														
	Nil		• Miniwall S5 footprint contained to areas under Lake Macquarie • Pillar extraction to remain under Lake Macquarie • Seagrass and Highwater Subsidence Mining barriers											

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
4. Farm Land and Facilities														
	Nil		• Miniwall S5 and Pillar Extractionfootprint contained to areas under Lake Macquarie • Seagrass and Highwater Subsidence Mining barriers • Long term stable pillar design for First Workings under land											
5. Industrial, Commercial and Business Establishments														
	Nil		• Miniwall S5 and Pillar Extractionfootprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land Seagrass and Highwater Subsidence Mining barriers											
6. Areas of Archaeological and/or Heritage Significance														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
6.1	AHIMS sites (adjacent extraction plan area)	Arch sites near foreshore impacted by flooding or erosion increases due to subsidence	• Locations identified (approx.) via AHIMS register • Conservation Risk Assessment covers for Miniwall S5 subsidence monitoring • Heritage Management Plan • HWMSB (no impact predicted) • Subsidence assessment (<20mm) • Subsidence monitoring program Consultation with the RAPs	E	E	4	23					ALARP	EC Coordinator	1/9/2020
7. Items of Architectural Significance														
	Nil		• Miniwall S5 and Pillar Extraction footprint contained to areas under Lake Macquarie Long term stable pillar design for First Workings under land											
8. Permanent Survey Control Marks														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
8.1	State Survey Marks/Permanent Survey Marks	Survey marks near foreshore effected by horizontal/vertical movement	• HWMSB/Mine Design • Subsidence assessment Miniwall S5 and Pillar Extraction footprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land	E	D	4	21	Review Built Features Management Plan to include Trig station adjacent MW S5 Subsidence monitoring program to include Trig station adjacent MW S5				ALARP	EC Coordinator Mine Surveyor	30/6/20 30/6/20
9. Residential Establishments														

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
	Nil		• Miniwall S5 and Pillar Extractionfootprint contained to areas under Lake Macquarie • Long term stable pillar design for First Workings under land • Authority to Mine system and survey control					Subsidence Monitoring Program						

10. Other identified items requiring particular assessment

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.1a	Public Safety	Shallow water buoy (or other markers including sailing markers) within extraction plan area impacted due to subsidence resulting public safety risk	• Strata2 Subsidence assessment • Marker locations visually assessed and mapped and within seagrass area. • RMS consulted as part of previous S4 Extraction Plan. • Keep CCC informed of actions taken in relation to public safety risks • PMHMP Subsidence	I	D	3	17	Review the presence and potential impacts to shallow water buoys in Extraction area				ALARP	Mine Surveyor	01/06/20
10.1b		Jetties within extraction plan area impacted due to subsidence	• Subsidence assessment (<20mm predicted) due to mine design principles • Consultation program / community notifications • Visual assessment undertaken Subsidence monitoring program	E	D	4	21	Consultation with affected landholders - send out notification letters				ALARP	Mine Surveyor	30/09/20

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.1c		Moorings within extraction plan area impacted due to subsidence	• Limited moorings adjacent the EP area • Strata2 S5 Subsidence assessment • Majority of moorings within seagrass boundary (<20mm subsidence). Negligible change • Subsidence monitoring program	E	D	4	21	Check if there are any moorings in Extraction area				ALARP	Mine Surveyor	30/6/20
10.2	Consultation	LTA community, stakeholder or agency consultation results in concerns over impact	• CCC meetings • Delta Coal Website • Regular meetings with relevant authorities. Consultation with DPIE has occurred. • Extraction Plan Guidelines •	E	C	4	18	Review notification requirements for secondary extraction for affected stakeholders Landowner notifications to be sent out.				ALARP	Mine Surveyor	

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.3a	Subsidence Impact (general)	Subsidence predictions exceeded results in increased impact/community concern/ breach of conditions	• Sub-critical Mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) including proximity of mine workings to surface constraints • Strata 2 Subsidence Assessment • Subsidence monitoring program	E	D	3	17	Update subsidence monitoring program to include MWS5	E	3	20	Low	Mine Surveyor	30/06/20

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
10.3b	Subsidence Impact (general)	Known or unknown geological structures in the workings increases subsidence impact	• Geological database and mapping from old and existing workings • Strata2 Mine Design Report • Known major structures incorporated into the updated geological and subsidence model • Strata Failure Management Plan • All pillars squat pillars thus confinement not reduced by structures • Subsidence monitoring to date has not indicated significant variation in areas of geological structure • Subsidence monitoring program	E	D	3	17					ALARP		

10.3c	Subsidence Impacts (Height of Fracturing)	Height of fracturing exceeds predictions leading to impacts on groundwater/ingress into mine workings due to direct hydraulic connectivity with the Lake.	• Sub-critical mine design (panel width, chain pillar width and extraction height to limit height of hydraulic fracturing) • PMHMP Subsidence • Lake Bed rock head survey undertaken and used to inform Mine Design and Subsidence Assessment report. • Bathymetric survey undertaken at the end of S2 March 2020. • Constrained zone thickness is greater than or equal to 12T • Strata2 Mine Design Report • Experience from inbye end of Miniwall 12 at Chain Valley at similar rock head thickness did not result in increased water make or signs of direct connectivity at higher levels of subsidence • Strata2 Subsidence Assessment Report • No overlying workings in the NMD • Geological mapping and site model • Subsidence monitoring program	E	D	3	17					ALARP		

No	Activity	Potential Hazard	Existing Controls	Cons I,E,L	Likelihood	Consequence	Risk Rank	Proposed Controls	Likelihood	Consequence	Risk Rank	Risk Level	Responsible Person	Due Date
			• Ground water assessment (SEE) • GWMP • Operational water management TARP											

Actions

No	Clause(s) No from RA Tables	Action	Person responsible for Action	Action timeframe	Comments	Database Action No	Responsible Person signature
1.	1.1.a	Update the GWMP for S5 Extraction Plan application Check groundwater bores register Provide alternative water supply until impacted bore recovers where proven to be related to mining impact or as required by the secretary	C Armit	30/6/2020			
2	1.1.c	Undertake remediation of Miniwall S5 mining affected areas as required in consultation with relevant authorities/landowners.	C Armit	If triggered			
3	1.3b, 1.4, 1.5, 1.8	Undertake remediation of any mining affected sections of foreshore in consultation with relevant authorities/landowners.	C Armit	If triggered			
4	1.6	Review Subsidence trigger levels in the Seagrass Management plan and the Subsidence Monitoring TARP with regards to survey tolerance (meaningful survey limits) and corresponding seagrass health.	C Armit	30.06.2020			
5	1.8	Update Built features management plan and consult with stakeholders (add trig station and pelican rock nav marker update in subsidence predictions)	C Armit	30.06.2020			

6	6.1	Review previous Archaeological surveys and requirement for further surveys for subsidence monitoring	C Armit	1.09.2020			
7	10.1a, 10.1c	Check if there are any moorings, shallow water buoys infrastructure in Extraction area	T Chisholm	30.06.2020			
8	10.2	Review notification requirements for secondary extraction for affected stakeholders	T Chisholm	30.09.2020			
9	10.3.a	Update Subsidence monitoring program and to include Trig station adjacent MW S5 Extend foreshore monitoring where access is granted Organise appropriate land access to conduct monitoring	T Chisholm	30.06.2020			



_____

[Chris Armit] **[Signature]** **[29/04/20]**

_____ _____

(Dave McLean) **[Signature]** **[Date]**

MDG 1014 Review Checklist

RISK ASSESSMENT REVIEW CHECKLIST

Risk Assessment Title: MINIWALL S5 EXTRACTION PLAN ***Date:*** 29/04/20

Site: CHAIN VALLEY COLLIERY

1. Report

[Circle or Highlight Yes or No for the following]

1.1	Is there a description of the operation or equipment being assessed?	Yes / No
1.2	Is there a summary of the strategic, corporate and risk management context?	Yes / No
1.3	Is there a list of the people involved in the risk identification step, together with their organizational roles and experience relevant to the risk assessment topic?	Yes / No
1.4	Is there an adequately detailed outline of the approach used to identify the risks?	Yes / No
1.5	Is there an outline of the method used for assessing the likelihood and consequences of the risks?	Yes / No
1.6	Is there, discussion of the basis for defining either the safety standard to be achieved, or the level of risk management expenditure?	Yes / No
1.7	Is there a list of the main actions to be taken to reduce risks and to manage risks?	Yes / No
1.8	Is there a timetable for implementing the main actions?	Yes / No
1.9	Does the report specify a requirement for a working audit requirement after completion of all stages?	Yes / No

2. Process

	How do you rate the following? [Circle or Highlight Poor to Very Good]	Poor/Very Good
2.1	The range of expertise of team which did the study.	**1 2 3 4 5**
2.2	The appropriateness of the degree of detail of the study.	**1 2 3 4 5**
2.3	The comprehensiveness of the systematic approach.	**1 2 3 4 5**
2.4	The identification of the key risk scenarios to be addressed.	**1 2 3 4 5**
2.5	The basis for deciding the required safety level or effort.	**1 2 3 4 5**
2.6	The method for assessing likelihood and consequences.	**1 2 3 4 5**
2.7	The thoroughness of consideration of planned risk reduction actions.	**1 2 3 4 5**
2.8	The thoroughness of consideration of existing or planned risk controls.	**1 2 3 4 5**
2.9	The objectivity and balance of the study (ie not unduly optimistic or pessimistic)	**1 2 3 4 5**

Signed: 

Position: Environment and Community Coordinator Date: 29/04/20

Appendix 4 Subsidence Management Trigger Action Response Plan

Delta coal	**Trigger Action Response Plan TARP** **Delta Coal**	**Title:**	Chain Valley Colliery- Subsidence Management TARP
		No:	**TARP 00136 - NMA Subsidence Management TARP**

This TARP should be read in conjunction with the Chain Valley Colliery Subsidence Monitoring Program.

	TRIGGER	MONITORING REQUIREMENTS	CONTAINMENT / REMEDIATION MEASURES	ADAPTIVE MANAGEMENT MEASURES	CONTINGENCY PLANS
BATHYMETRIC SURVEY Subsidence	**NORMAL** Subsidence ≤ 500mm	As per Subsidence Monitoring Program			
	TRIGGER LEVEL 1 Subsidence > 500mm to ≤ 780mm	6 monthly surveys until subsidence stabilises		Review and update subsidence predictions, Identify controlling mechanisms, Review potential change in impact on natural and built features, and Update management plans if required	Review ability to limit further increases based on understood mechanisms. Including extraction heights, panel widths, panel recovery
	TRIGGER LEVEL 2 Subsidence >780mm	6 monthly surveys until subsidence stabilises, and	Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify RR, DECCW, and affected landholders or infrastructure owners. Review if increase is likely to create impact at foreshore/seagrass, or Exceed final subsidence prediction	Implement further controls on foreshore /seagrass as applicable from review , Review and update subsidence predictions, Review and update impact assessment on natural and built features.	Immediately review mine plan including panel width, pillar widths, extraction height and panel length, Consult with DPHI and RR, and Review and update Extraction Plan
FORESHORE SURVEYS Subsidence	**NORMAL** Subsidence ≤ 20mm	As per Subsidence Monitoring Program			
	TRIGGER LEVEL 1 Subsidence <20mm recorded movement with slow (3-5mm/month) creep	Validate increase with additional monthly survey/s then as per SM program		Review and update subsidence predictions, Identify controlling mechanisms, Review potential change in impact on natural and built features, and Update management plans if required	
	TRIGGER LEVEL 2 Subsidence >20mm recorded movement (associated with mining)	Implement Ecological Monitoring program for HWMSB exceedance, Increase frequency of subsidence monitoring until rates stabilises. Then as per SM program.	Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify RR, DECCW, and affected landholders or infrastructure owners. Cease extraction in panel in question until review conducted in consultation with DPHI and DRNSW.	Investigate cause of exceedance, Review and update subsidence predictions, Review and update impact assessment on natural and built features.	Provide offsets for any ecological communities or threatened species in the HWMSB if impacts detected, Review mine plan including panel width, pillar widths, extraction height in consultation with DPHI and RR, Review and update Extraction Plan

	TRIGGER	MONITORING REQUIREMENTS	CONTAINMENT / REMEDIATION MEASURES	ADAPTIVE MANAGEMENT MEASURES	CONTINGENCY PLANS
BUILT FEATURES	**NORMAL** No damage requiring remediation	Monitoring as per Subsidence Monitoring Program RMS routine monitoring navigation markers			
	TRIGGER LEVEL 1 Subsidence parameters exceeded such that Fassifern workings indicated to have potential impact on foreshore.	Monitoring as per Built Feature Management Plan	Review navigational marker freeboard and notify TfNSW if impacted, Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify RR, DECCW, and affected landholders or infrastructure owners.		Develop Built Feature Management Plan in conjunction with owner for built features surrounding potential impact area.
	TRIGGER LEVEL 2 Impact to built feature	Monitoring as per Built Feature Management Plan	**Cease extraction in panel in question until review conducted in consultation with DPHI and RR**, Assist owner with information to aid in Subsidence Advisory NSW claim in accordance with Built Feature Management Plan	Update impact assessment based on observed damage	Immediately review mine plan including panel width, pillar widths, Consult with DPHI and RR, Review and update Extraction Plan
PUBLIC SAFETY (Foreshore area and steep slopes)	**NORMAL** No impact				
	TRIGGER LEVEL 1 Subsidence parameters exceeded such that Fassifern workings indicated to have potential impact on foreshore.				
	TRIGGER LEVEL 2 Area around foreshore becomes unstable / shows signs of mining induced impact, Flooding or drainage impacts considered likely as result of Fassifern extraction.	Visual inspections frequency to be commensurate with level of risk (ie increase until controls put in place) Inspect foreshore in vicinity of other steep slopes and retaining walls for signs of movement. Implement TARP as required.	**Cease extraction in panel in question until review conducted in consultation with DPHI and RR**, Geotechnical Engineer to inspect area immediately, Implement temporary safety controls (barricades and signage available from mine site). Arrange for assistance and stay at site if immediate risk to public exists, Notify LMCC and TfNSW, DECCW , DPHI and RR.	Implement longer term safety controls.	Foreshore stabilisation of unsafe areas in consultation with LMCC and RR as soon as possible, Flooding and drainage rectification works in consultation with infrastructure owner as soon as possible.

	TRIGGER	MONITORING REQUIREMENTS	CONTAINMENT / REMEDIATION MEASURES	ADAPTIVE MANAGEMENT MEASURES	CONTINGENCY PLANS
BENTHIC COMMUNITIES	**NORMAL** ANOVA/ANOSIM >5%	As per Benthic Management Plan			
	TRIGGER LEVEL 1 ANOVA/ANOSIM level is approaching 5%	Liaise with monitoring consultant & undertake internal review to determine if impacts are related to mining, Arrange a peer review of the monitoring results and statistical analysis.			
	TRIGGER LEVEL 2 ANOVA/ANOSIM <5%	Undertake follow up monitoring at affected sites to obtain confirmation of impacts, Incident report to be completed and distributed to relevant agencies	Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify DPHI-Fisheries and LMCC.	Consult with relevant authorities about monitoring and management controls.	Consult with relevant authorities to identify if offsets are required and how these are to be implemented.
SEAGRASS	**NORMAL** Negligible impact.	As per Seagrass Management Plan			
	TRIGGER LEVEL 1 Approaching 20% decline in condition, Approaching 20mm of additional mine induced subsidence within mapped seagrass.	Liaise with monitoring consultant & undertake internal review to determine if impacts are related to mining.		Review if variation is within broader background variation range for the site.	
	TRIGGER LEVEL 2 >20% decline in conditions from year baseline survey >150mm of additional mine induced subsidence at survey location	Incident report to be completed and distributed to relevant agencies	Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify DPHI-Fisheries and LMCC.	Consult with relevant authorities about monitoring and management controls.	Consult with relevant authorities to identify if offsets are required and how these are to be implemented.

	TRIGGER	MONITORING REQUIREMENTS	CONTAINMENT / REMEDIATION MEASURES	ADAPTIVE MANAGEMENT MEASURES	CONTINGENCY PLANS
THREATENED SPECIES AND ENDANGERED POPULATIONS	**NORMAL** Negligible impact.	Monitoring as per Subsidence Monitoring Program, Benthic Communities Management Plan and Seagrass Management Plan			
	TRIGGER LEVEL 1 As per Seagrass and Benthic Community Management Plans Monitoring Level 1 triggers.	Liaise with monitoring consultant & undertake internal review to determine if impacts are related to mining and greater than negligible environmental consequences.		Review if variation is within broader background variation range for the site.	
	TRIGGER LEVEL 2 As per Seagrass and Benthic Community Management Plans Monitoring Level 2 triggers >780mm subsidence	Incident report to be completed and distributed to relevant agencies	Notify DPHI – immediately if incident or within 7 days if noncompliance, Notify DPHI-Fisheries and LMCC.	Initiate ecological monitoring program to assess the impacts to ecological communities and threatened species. Consult with relevant authorities about monitoring and management controls.	Consult with relevant authorities to identify if offsets are required and how these are to be implemented.
WATER INFLOW	Ongoing monitoring of water inflows and site water management through operational Water Management and Monitoring TARP process				

ROLES AND RESPONSIBILITIES:

As per various Management Plans, specifically:

Extraction Plan,

Subsidence Management Plan,

Subsidence monitoring program,

Benthic Management Plan,

Seagrass Management Plan,

As-built Management plan,

Public Safety Management Plan,

Water Management Plan, and

Biodiversity Management Plan

ABBREVIATIONS

DECCW – Department of Environment, Climate Change and Water

DPHI – Department of Planning, Housing and Infrastructure

DRNSW – Department of Regional NSW

ECC – Enviro Compliance Coordinator

LMCC – Lake Macquarie City Council

RR – NSW Resources Regulator

TfNSW – Transport for NSW

Appendix 5 Water Management Plan

Delta coal

Environmental Management System

Chain Valley Colliery

Water Management Plan

Reviewed	Lachlan McWha – Delta Coal
Authorised by:	Lachlan McWha – Delta Coal Environmental Compliance & Approvals Coordinator
Date:	16 January 2024

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1 Introduction

1.1 Purpose

The Water Management Plan (WMP) addresses the requirements for Development Consent SSD-5465 as modified (MOD 4) and EPL 1770.

The purpose of the WMP is to:

- guide the management of surface and groundwater resources throughout the operational life of the mine;
- address the relevant conditions of the development consent;
- meet the requirements of EPL 1770, including Pollution Reduction Programs (PRP's) that have been implemented on site;
- address the relevant commitments made within the Surface Water Assessment (SWA) (GSSE, 2013) and Environmental Impact Statement (EIS) (EMM, 2013); and
- address legislative requirements and guidelines relevant to the WMP.

The WMP incorporates the following components as required by SSD-5465:

- a Water Balance;
- a description of Surface Water Management;
- a Surface Water Monitoring Plan;
- a Ground Water Monitoring Plan; and
- a Water Management Review.

1.2 Background

Chain Valley Colliery (CVC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see **Figure 1**). The pit-top is located approximately 1 km south-east of the township of Mannering Park at the southern extent of Lake Macquarie.

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam, commenced with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963.

As of 1 April 2019, Great Southern Energy Pty Ltd (trading as Delta Coal, DC) own and operate the two underground coal mines, CVC and Mannering Colliery (MC). Mining is currently undertaken at CVC, with the coal being transported underground to MC where the coal is crushed and screened and sent directly to VPPS.

1.3 Operations

CVC is an underground coal mine which extracts coal through both first and secondary workings. ROM coal from both the first and second workings is transported out of the mine via a conveyor system to Mannering Colliery for processing.

The surface infrastructure comprises limited facilities at the 14 hectare pit top area adjacent to the Vales Point Power Station, off Construction Road at Mannering Park, and another 0.3 hectare area at the ventilation facility situated at Summerland Point. Both the pit top and ventilation facilities have remained largely unchanged since their establishment.

The above operations have potential impacts which were addressed in the SWA (GSSE, 2013). To address these, the SWA (GSSE, 2013) identified the following key objectives for surface water management at CVC:

- the prevention of the flow of pollutants into watercourses and the sedimentation on receiving waters, being Swindles Creek to the east of the pit top and Lake Macquarie;
- the control of discharges from the site to ensure that all discharges are within the water volume and quality criteria set out in EPL 1770;
- to minimise site potable water usage requirements and maximise runoff water reuse; and
- to ensure there is sufficient water available to meet Chain Valley Colliery's water requirements.

1.4 Consultation

The original WMP (GSSE, 2012) was prepared in consultation with the former NSW Office of Water (NOW), DTIRIS (Division of Resources & Energy (DRE)) and Wyong Shire Council. The previous WMP (GSSE, 2012) was submitted on the 23 August 2012 and approved by the Director-General on the 6 November 2012.

The 2015 revision of the WMP was prepared in consultation with the (former) NOW and the Environment Protection Authority (EPA) and incorporates outcomes of correspondence with EPA in relation to the variation of the EPL. Comments on the WMP were received from NOW on the 5 December 2014 and requested a change to the groundwater drawdown trigger to 2m over a 2-month period, which is consistent with the minimal impact considerations of the NSW Aquifer Interference Policy, this change has been made within the Groundwater Management Plan (**Appendix 1**).

Comments were also sought from the EPA and subsequently requested via email in December 2014. On the 12 June 2015 the EPA responded stating that "The Environment Protection Authority ("EPA") encourages the development of such plans to ensure that proponents have met their statutory obligations and designated environmental objectives. However, EPA does not review these documents as our role is to set environmental objectives for environmental / conservation management, not to be directly involved in the development of strategies to achieve those objectives.

In accordance with Schedule 3, Condition 18 of development consent SSD-5465 the December 2019 WMP review was prepared by suitably qualified and experienced persons, Sally Callander (EMM Consulting), Andrew Dawkins (Geoterra) and Chris Armit (EMM Consulting), whose appointment has been endorsed by the Planning Secretary.

A draft revision of the WMP was provided to DPIE - Water, EPA and DPIE on 26 November 2019 and a further review was provided in May 2020 associated with the Miniwall S4 Extraction Plan.

A review has been undertaken:

- after the approval of SSD5465 Mod 3 (approved in June 2020);
- for the submission of the Miniwall S5 and Northern Pillar area extraction plan (December 2020) with an updated Groundwater Management Plan; and
- Following the approval of SSD5465 Mod 4 (approved August 2021) references to Development Consent SSD-5465 were made to the document. The SEE prepared to accommodate Mod 4 to SSD-5465, there were no changes to extraction rates or surface infrastructure, or intensification of activities proposed by the modification and, therefore, water resources will not be impacted. Considering consultation with stakeholders on the WMP was undertaken for the Miniwall S5 and Northern Pillar area extraction plan (December 2020) further consultation was not undertaken beyond Planning Secretary approval.
- Following the completion of the 2022 Independent Environmental Audit.

A summary of the comments received and amendments subsequently made to the document (V7) prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 2**. The groundwater management plan section of this plan was approved by DPE on the 6 April 2021 as part of the Miniwall S5 and Northern Pillar Area extraction plan **(Appendix 1)**.

Table 1: Consultation Summary

Stakeholder	Comments	Response/Action
NSW EPA	*The EPA has reviewed the Site Water Management Plan (SWMP) and has no specific comments to make on its content. The EPA considers that the SWMP is broadly consistent with the current requirements of EPL 1770.*	Nil

Stakeholder	Comments	Response/Action
DCCEEW – Water Group	*Include a summary of maximum predicted groundwater take currently and ongoing to demonstrate sufficient entitlement is held.*	Addressed in Section 3.2. with information from Chain Valley Colliery's most recent Groundwater Impact Assessment.



Figure 1: Regional Context

2 Summary of the Statutory Approval Requirements

2.1 Key Legislation, Policy and Guidelines

A number of legislative requirements, government policies and guidelines relating to water management are applicable and have been addressed in detail within the SWA (GSSE, 2013). The key items of legislation and the relevant approval documents to this WMP are:

- *Water Act 1912 and Water Management Act 2000* - LakeCoal applied for a 4,443 ML/year groundwater license on the 5th October 2011 under the *Water Act, 1912* to pump water from the underground workings to the sedimentation and pollution control ponds at the pit top. The license (WAL41508) was subsequently granted on the 12 March 2013;
- *Protection of the Environment Operations Act 1997* (POEO Act) - Chain Valley Colliery has an existing EPL 1770 under the POEO Act for the discharge of water from site;
- *Environmental Planning and Assessment Act 1979* (EP&A Act) - On 23rd December 2013 development consent SSD-5465 was issued for the *Chain Valley Extension Project*, which has been modified twice by approval on the 27 November 2014 and 16 December 2015; and
- *Mining Act 1992* – Delta Coal holds numerous mining authorities under the Mining Act 1992, a list of all leases held is contained within the Environmental Management Strategy (OMP-D-16374), the most relevant for the WMP is Mining Purposes Lease 1349 as it pertains to the surface facilities area.

The relevant aspects of these approval documents are addressed further below.

Key policies and guidelines which are relevant to the preparation and implementation of this WMP include:

- ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines;
- Department of Environment and Conservation (DEC), Approved Methods for the Sampling and Analysis of Water Pollutants in NSW, March 2004;
- Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008;
- NSW Water Quality and River Flow Objectives, September 1999;
- NSW State Rivers and Estuaries Policy, 1993;
- NSW Groundwater Quality Protection Policy, adopted in 1998;
- The NSW State Groundwater Dependent Ecosystems Policy, adopted in 2002;
- NSW Groundwater Quantity Management Policy;
- Australian Government, Charter: National Water Quality Management Strategy, 2018;
- Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), National Guidelines for Sewerage Systems - Effluent Management, 1997; and
- NSW Department of Environment and Conservation (DEC), Environmental Guidelines: Use of Effluent by Irrigation, 2004.'

2.2 Development Consent (SSD-5465)

This plan has been prepared in accordance with Schedule 3, Condition 21 of SSD-5465, which states the requirements of the WMP and what it must address. Surface and groundwater related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 3**.

In accordance with Schedule 2, Conditions 2 and 2A, in addition to carrying out the works in accordance with the conditions of SSD-5465, DC will also carry out works generally in accordance with the Environmental Impact Statement (EIS), Statement of Environmental Effects (SEE) (Mod 1), SEE (Mod 2), SEE (Mod 3), SEE (Mod 4) Project Layout Plans and Statement of Commitments.

2.3 Mining Leases

MPL 1349, is the most relevant lease to this WMP as MPL 1349 relates to the surface facilities. MPL 1349 contains the following provision with respect to surface water management.

> *2. The proponent shall implement all practical measures to prevent and/or minimise any harm to the environment that may result from the construction, operation or rehabilitation of the development.*
>
> *18. Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosion, unless otherwise authorised by a relevant approval, and in accordance with an accepted Mining Operations Plan. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwater and perform any instructions given by the Director-General in this regard.*

2.4 Environmental Protection License (EPL 1770)

CVC operates under EPL 1770 issued by the Environment Protection Authority (EPA) under the POEO Act. The EPL has been modified a number of times, most recently in August 2022 for the transfer from Lake Coal Pty Ltd to Great Southern Energy Pty Ltd (trading as Delta Coal). Water related requirements of the EPL, including specific requirements that are to be addressed in this management plan and section references within the WMP are detailed in **Appendix 3**.

2.5 Maximum Harvestable Right Dam Capacity

Under the NSW *Water Management Act 2000*, landholders are permitted to capture, store and use a portion of the rainfall runoff on their property. The right to harvest rainfall is determined by geographic location and is typically 10% of the total rainfall runoff for the property and storage is calculated under the Maximum Harvestable Right Dam Capacity (MHRDC) provision. Dams that exceed this capacity or are greater than a certain size must be licenced.

Where dams are used to control pollution or effluent, there are exemptions to the licencing requirements. This is the case for the pollution control dams at CVC where the dams are exempt from the MHRDC calculation.

3 Water Balance

A comprehensive site water balance has been prepared for the site and is described in detail within the SWA (GSSE, 2013). This section of the WMP provides a summary of the water balance to enable the key inputs and outputs to be understood along with the water balance results. It also describes the implications of the proposed changes to site water management described in **Section 4.4**.

For more detailed information on the site water balance refer to the SWA (GSSE, 2013).

3.1 Water Balance Model

A detailed 'daily time-step' water balance model was used to represent the Chain Valley Colliery water balance using GoldSim Version 10.50 (GoldSim Technology Group LLC). This software is a graphical, object-oriented system simulation software for completing either static or dynamic systems. GoldSim is commonly used to undertake 'daily time step' water balance simulations for coal mines within NSW due its enhanced modelling capability and flexibility compared to spreadsheet models that have predominately been used in the past. The Chain Valley Colliery water cycle, as simplified and modelled in GoldSim is shown in the schematic water flow diagram as shown on **Figure 2**.

3.2 Data (Model Inputs and Outputs)

3.2.1 Rainfall Runoff

The dataset developed for the water balance used information from the Wyee and Norah Head weather stations. There are other stations in the general vicinity, however these stations were selected due to their proximity to the CVC and length and completeness of the data, which together, provide over 100 years of rainfall data.

The pit top area was segregated into four distinct catchments which were further broken up into eight sub-catchments for the purpose of the CVC water balance.

The daily step GoldSim model was used to estimate the surface water runoff from different sub catchments at the pit top area. The runoff coefficients adopted are considered conservative but reflect the large impermeable area in the catchment which includes laydown areas, compacted roads and coal stockpile areas. The free water surfaces of the pollution control dams and the roofed areas were modelled as completely impervious areas, capturing all precipitation.

Catchment areas as modelled within the GoldSim model are provided in **Table 2**.

Table 2: Pit Top Catchment Areas

Major Catchment Name	Sub-Catchment Name	Catchment Area (ha)
Carpark (Catchment 1)	Carpark (not modelled)	NA
Storage Yard (Catchment 2)	Oil Water Separator	0.15
	Workshop (Roof)	0.24
	Old Bath House (Roof)	0.11
	Pit Top Storage Yard	3.03
Stockpile (Catchment 3)	CHP Stockpile	5.34
Pollution Control Dams (Catchment 4)	Dams D1 to D6	0.41
	Dams D7 to D13	1.97
Total catchment reporting to pollution control dams		**11.25**

(excluding carpark)	

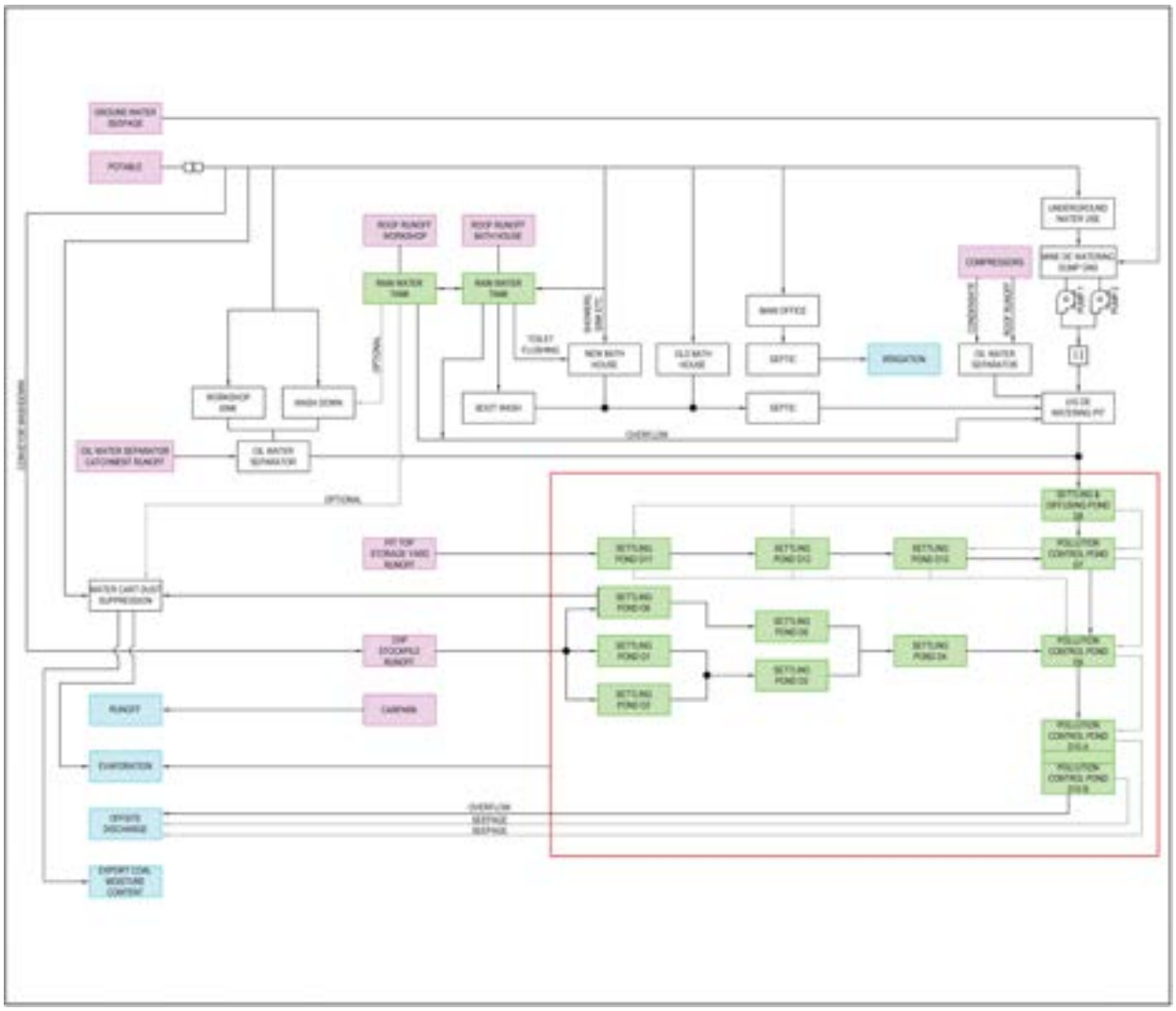


Figure 2: GoldSim schematic water flow diagram

3.2.2 Evaporation

Evaporation data was obtained from the Peats Ridge weather station on Waratah Road (station number 61351), approximately 33km south-west of the site. This was the closest meteorological weather station to the CVC with over 25 years of evaporation information. Evaporation data from this weather station was adjusted for the change in site conditions from the measuring site to the sedimentation dams by multiplying the average monthly rates by a pan coefficient of 0.7.

Evaporation from the pollution control dams was calculated using a daily step within the GoldSim model similar to the runoff model calculations. This model used the evaporation rate, modified by the pan coefficient, and the surface area of the dams, which was calculated using survey data.

3.2.3 Underground Water Extraction

The Groundwater Assessment (Geoterra, 2013) predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day. This estimated pumping rate is an average value and therefore pumped flow rates may exceed this value on occasions. It should be noted however, that this average

daily volume was calculated as an 'end of mining' estimate and can be considered a 'worst case' prediction of groundwater inflow rates. It is not expected to occur for the majority of the project life.

A groundwater impact assessment was completed in 2022 by GHD (GHD, 2022). The assessment predicted that peak groundwater inflow, in a life of mine scenario extending to 2029, was 7.6 ML/day, increasing from the daily average between January 2020 and April 2022 of 6.7 ML/day. The peak inflow under approved conditions was 2,774 ML/year, which was well within the 4,443 ML/year Water Access Licence 41508 limit.

Pump rate information indicates that the two existing underground dewatering pumps from the Great Northern Seam sump have a maximum pumping rate of 75 L/sec and 75 L/sec respectively. This equates to a total maximum pumping rate from underground of approximately 12.96 ML/day.

However, within the EIS (EMM, 2013) Chain Valley Colliery committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day (equivalent to the predicted average daily volume that will need to be pumped from the coal face during the later stages of the project). This limit remains in place, using the site Citect system to automatically stop the one of the underground pumps when 9.5 ML has been pumped and stopping the second pump if a total of 10.5 ML in any day has been pumped. The pumps are only able to be restarted the following day. This limit can however be temporarily disabled by authorised persons in the event of unacceptable risk (e.g. flooding and risk to employee health and safety), which was a requirement of the site risk assessment completed.

When not pumping, water accumulates underground in a number of storages that exist within both the Great Northern and Wallarah Seams, these are discussed in **Section 4.3**.

3.2.4 Pollution Control Dam Characteristics

Information pertaining to the GoldSim modelling of the sedimentation dams was obtained from survey data. This information is shown in **Table 3**. It should be noted that the volume of dam D6 was not available and was estimated based on a 1 m depth, the measured surface area and standard stage/storage relationships. Dams D1 to D6 and D7 to D13 were each modelled as single storages to simplify the water balance processes at the site.

Table 3: Pollution Control Dam Capacities (as modelled in GoldSim)

Dam	Volume (m^3)
D1	80
D2	51
D3	284
D4	547
D5	770
D6	568
Total dams D1 to D6	**2300**
D7	3856
D8	2933
D9	3796
D10	4802

D11	297
D12	229
D13	168
Total dams D7 to D13	**16081**

3.2.5 Loss of Water through Coal Export

During mining and conveying, the moisture content in the coal increases due to the use of water sprays at the coal face and at transfer points along the conveyor system. A review of the CVC coal analysis data indicates that the inherent (air dried) moisture content of the coal from underground is approximately 2.7%.

This same data indicates that the total moisture of the CVC coal that is exported is approximately 7.3%, which means that around 4.6% of this total moisture content is added to the coal prior to export. This equates to 69,000 tonnes of additional water at the current proposed rate of production of 1.5 Mtpa. Therefore, approximately 69.0 ML of water is exported from the CVC every year, or 188.9 kL/day.

3.2.6 Additional Data

A limited amount of water usage and flow monitoring data at CVC was available for the water balance investigation. However, where historic information was lacking, data and operational information was made available to best derive estimates of the respective water balance parameters (flow rates, water usage, etc.). Additional data, as used in the water balance model, is shown in **Table 4**, as well as comments/assumptions on how this data was derived.

Table 4: CVC Supplied and Derived Data

Parameter	Value	Comments/Assumptions
Potable Water: Underground (includes increase of 25% to account for any additional underground potable water demand)	140 ML/yr	Average of underground potable water from monitored water use with an additional 25% to account for increased potable water used underground.
Potable Water: Main Office	211 L/day	Includes shower, sink and toilet facilities. Shower (26 L/day): Assumes 9 L/min, 10 min/person, 2 showers per week. Toilet (154 L/day): Assumes 15 employees, employees at work 5 days/week, 6 L/toilet flush, average employee flushes 3 times/day (at work). Sink (31 L/day): Assumes 15 employees, 1.2 L/wash, employees at work 5 days/week, employees use sink 3 times/day.
Potable Water: Workshop	3724 L/day	Includes equipment washdown and sink use. Equipment Washdown (3712 L/day): Assumes 1-hour wash/day, 1.031 L/sec flow rate. Sink (12 L/day): Assumes 1.2 L/wash, 1 sink used 10 times per day.
Potable Water: Bath House 1	24 L/day	Includes sinks facilities. Sinks (24 L/day): Assumes 1.2 L/wash, 2 sinks each used 10 times per day.
Potable Water: Bath House 2 (Showers, Sink)	8519 L/day	Includes shower and sink facilities Shower (8190 L/day): Assumes 9L/min, 10 min/person, average of 91 shift ends / day

		(calculated from shift information provided by DC). Sink (329 L/day): Assumes 220 employees, 1.2 L/wash, employees at work 4 days/week, employees use sink 3 times/day.
Bath House 2 Toilet Flushing Demand	1097 L/day	Assumes 220 employees, employees at work 4 days/week, 4 L/toilet flush (reduced for urinals), average employee flushes 3 times/day (at work).
Potable Water: Bath House 3 (Showers, Sink)	8519 L/day	Includes shower and sink facilities Shower (8190 L/day): Assumes 9L/min, 10 min/person, average of 91 shift ends / day (calculated from shift information provided by DC). Sink (329 L/day): Assumes 220 employees, 1.2 L/wash, employees at work 4 days/week, employees use sink 3 times/day.
Bath House 3 Toilet Flushing Demand	1097 L/day	Assumes 220 employees, employees at work 4 days/week, 4 L/toilet flush (reduced for urinals), average employee flushes 3 times/day (at work).
Bootwash Water Demand	480 L/day	Assumes it is used 3 L/person/shift, average of 91 shift ends / day (calculated from shift information provided by DC).
Dust Suppression Demand	2-3 ML/yr	Calculated from available water cart records
Combined Rainwater Tank Capacity	30 kL	Estimated rainwater tank capacity.

3.3 Water Balance Results

3.3.1 Expected Discharge from Chain Valley Colliery

As noted in **Section 3.2.3**, DC limits the main underground pumps to a maximum pump out rate of 10.5 ML/day. As such, the GoldSim model was run (using a deterministic simulation) assuming that the pumps from the Great Northern Seam sump were constantly pumping at this 10.5 ML/day rate. This scenario assumes that adequate capacity is available in the underground workings to effectively store water during periods when the groundwater inflow rate exceeds the underground dewatering rate. This is further discussed in **Section 4.3**. It should be noted that assuming a constant underground pump rate of 10.5 ML/day is a 'worst case' scenario and is only predicted to occur, on occasions, near the end of the project life.

Key statistics from the GoldSim modelling, assuming a constant discharge from underground of 10.5 ML/day, include:

- daily average discharge through EPA Point 1 of 10.716 ML/day;
- maximum discharge through EPA Point 1 of 35.124 ML/day; and

- likelihood of EPA Point 1 volumetric limit exceedance on any given day of 4% (or approximately 15 times per year).

Further to modelled results actual surface water discharge averaged 6,234 kL per day in the 2023 calendar year.

3.3.2 Potable Water Use

The total amount of potable water used at the CVC was investigated in the GoldSim model, with and without the committed water savings measures (as described in **Sections 4.7**) in order to quantify how much potable water these measures are likely to save at the site. GoldSim modelling estimates that the potable water used in the pit top area will be reduced from 55.9 kL/day to 23.7 kL/day with an overall saving of 32.3 kL/day (11.8 ML/year) as a result of water saving measures being implemented.

This equates to an approximate reduction in total potable water of 8.9% (for current levels of potable water use) and 7.4% (allowing for a 25% increase in the underground potable water use as a result of the proposed future mining works).

3.4 Water Supply and Security

All water required for operational activity has historically been sourced from the single potable water supply connection from the Central Coast Council town-water system. This connection is considered a secure source of water as it is only a small portion of the total water consumed annually by the Central Coast and no viable alternative sources have been identified. Further discussion on water savings and alternative water supply is contained in **Section 4.7**.

No water is obtained from unregulated water sources listed in the *Water Sharing Plan for the Central Coast Unregulated Water Sources 2009*.

4 Surface Water Management

4.1 Overview of Water Management System

The water management at the CVC pit top is primarily focused on erosion and sediment control, however there are a number of water management components including the underground de-watering, oil water separator system, effluent management and the operation of the pollution control dams.

All water required for operational activity is sourced from the single potable water supply connection from the Central Coast Council town-water system. All excess water from the underground workings is pumped to the Great Northern Seam sump. This water is then pumped to the surface and discharged into the site's pollution control dams.

A combination of surface slope and earth diversion drains on the eastern and northern boundaries results in the majority of the site draining east towards the pollution control dams. A small catchment (i.e. carpark and access road) discharges off-site to the west and north. Other than the carpark catchment, the site's pollution control dams receive all rainfall runoff from the pit top and underground mine water, as well as workshop and wash down water after treatment by an oil separator. A system of 13 pollution control dams have been constructed from a mixture of earth, crushed rock, recycled brick and stone. The dams are interconnected through a series of overflow pipes and spillways which allows water to circulate through each dam before reaching the site discharge point. The dams provide improvement to the site wastewater and runoff quality prior to discharge to Lake Macquarie (via Swindles Creek).

4.2 Potable water

All water used for underground mining purposes by CVC is potable water and used in equipment, for cleaning, and dust control. To quantify the estimated volume of water consumed underground a flow/volume meter is installed on the underground water line.

Water is made available throughout the underground workings to satisfy statutory obligations for the production of underground coal. Water is consumed mainly by the following processes.

- when cutting coal at the coal face - to reduce respirable dust and propensity for frictional ignition of coal dust and methane gas;
- when transferring coal along the underground conveyor system and at transfer points - to reduce dust make;
- for use in cleaning;
- for use in equipment; and
- for emergency firefighting purposes.

Water used in the pit top operations is consumed by amenities, dust suppression and wash down.

4.3 Underground Water

In addition to the potable water, naturally saline groundwater migrates into the underground workings of the mine. This water is pumped to or collects in a sump within the Great Northern Seam, from there it is pumped to the pollution control dams on the surface. This water is not used for operational purposes due to its high salinity and subsequent potential effects on mine machinery and equipment.

As mentioned in **Section 3.2.3**, DC has limited the main underground pumps to a maximum pump out rate of 10.5 ML/day. To facilitate restrictions to pumping rates, underground water can be stored within both the Great Northern and Wallarah Seams. The underground storage volumes have been assessed and estimated at the following capacities:

- Great Northern Seam – North East Sump, ~ 100 ML;
- Great Northern Seam - Shaft Headings Sump, ~ 200 ML;
- Great Northern Seam - Sump Headings, ~ 5 ML; and

- Wallarah Seam – Wallarah Sump/Storage Location, 150 to 200 ML.

Details on groundwater management are contained in the Groundwater Management Plan (GwMP) (GeoTerra, 2019) which is in **Appendix 1**.

4.4 Surface Water Catchments and Controls

For the purpose of the WMP runoff from the pit top area is managed as 4 catchment areas including:

- Catchment 1 (Carpark) – carpark, office building and partial runoff from the workshop roof;
- Catchment 2 (Storage Yard) – rear storage yard and oil water separator;
- Catchment 3 (Stockpile) – stockpile, entry road and bathhouse form the third catchment; and
- Catchment 4 (Sedimentation Dams) – pollution control dams.

The above catchments and the major drainage structures are shown on **Figure 3.**

Delta Coal has developed a Trigger Action Response Plan (TARP) for the management of underground and surface water at Chain Valley Colliery, the TARP has been included in **Appendix 9**.

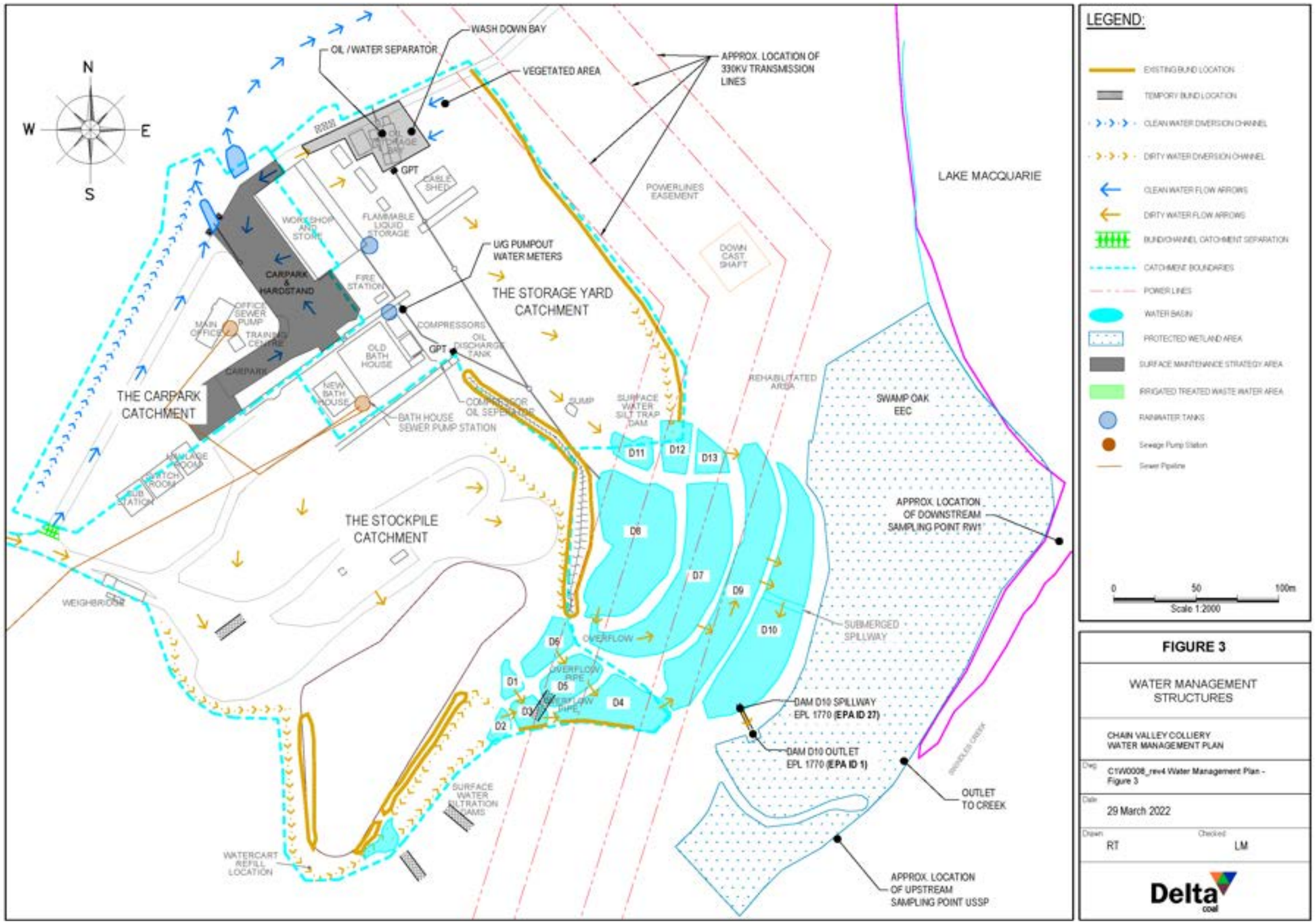


Figure 3: Water Management Structures

4.4.1 Catchment 1

Catchment 1 (carpark catchment) is a relatively clean catchment as a large portion of this area is vegetated, and there are areas of offices and sealed roads. However, the carpark is unsealed (gravel hardstand) and some sediments accumulate on the surface.

The key control methods implemented in Catchment 1 include:

- clean water diversion channel runs down the north-western perimeter of the pit top to divert any off-site run-on into the natural drainage channel. This is the only major clean water diversion channel required on-site with the remaining topography such that small bunds are sufficient to prevent overland flows entering the site;
- a concrete spoon drain at the intersection with the main site entry road directs dirty runoff from the entry road toward the weighbridge within the storage yard catchment and prevents it from entering this catchment;
- regular sweeping (utilising a street sweeper) of the sealed surface entry road sloping into the carpark to remove accumulated sediment;
- kerb and guttering on the access road provides the perimeter drainage directing runoff to the sediment treatment basins within this catchment; and
- utilisation of two small basins, the first is in line with main drainage outlet of the carpark and the second is beside the workshop adjacent to the carpark. Both basins allow coarse sediment to be removed prior to discharge into the natural drainage channel and are shown on **Figure 3**.

4.4.2 Catchment 2

Catchment 2 (storage yard catchment) includes the main storage yard, the majority of which is gravelled hardstand for equipment storage. This area also includes the vehicle wash down bay and bunded areas which drain to the oil water separator within this catchment.

The key control methods implemented in Catchment 2 include:

- there is no off-site water flowing into this catchment and subsequently clean water diversion is not required;
- an earth bund is installed along the eastern perimeter of the catchment which contains all dirty water runoff; and
- a large portion of this storage yard area drains south-east via overland flow into the pollution control dams D11, D12 and D13 which function as primary settling dams before discharging into the main mine water treatment system (i.e. dams D7 to D10);
- the remainder of the catchment (e.g. stormwater drains, workshop and treated water) enters various inlet pits and drains south-east via the pit and pipe network into the main mine water treatment system via dams D8; and
- an oil water separator to treat runoff from the bunded hydrocarbon storage areas and vehicle wash down bay (see **Section 4.10**).

4.4.3 Catchment 3

Catchment 3 (stockpile catchment) includes the main entry/haul road, weighbridge (no longer in use), coal handling (including ROM bin) and coal stockpiles (also no longer in use).

The key control methods implemented in Catchment 3 include:

- perimeter bunding along south-west perimeter to prevent clean water entering this area and dirty water leaving the site;
- bunding and surface grading around the water cart fill location to directed runoff to a stockpile catch drain;
- bunding and drainage around the weigh bridge to directed runoff to a stockpile catch drain;
- runoff is contained by two main stockpile catch drains that surround the stockpile. Runoff from this area contains a significant amount of coal fines and there are in-line sumps within the catch drains to trap coarse material before it enters the series of pollution control dams below the stockpile; and
- runoff from this catchment area reports to the pollution control dams D1 to D6 which function as primary settling dams before discharging into the main mine water treatment system (i.e. dams D7 to D10).

4.4.4 Catchment 4

This catchment contains all the pollution control dams (i.e. D1 to D13) which receive runoff from the storage yard area, the stockpile area, pumping of water from underground, and rainfall directly into the dams. The dams were constructed at a similar period to the mine commencement. In 2015, works were completed on the dam to formalise the spillway, and develop a gravity fed pipe discharging over coarse rip-rap to slow water flows and prevent erosion. The works completed in 2015 also included keying a 600mm wide trench into the final dam wall (D13) and backfilling with compacted low permeability clay, the dam wall remediation works were aimed at reducing the likelihood of seepage or dam wall failure of the final dam.

Since the discharge point of the final pollution control dam is gravity fed the retention time of the ponds is entirely dependent on flow rates into the catchment.

The management of this catchment is described in **Section 4.5**.

4.5 Management of Pollution Control Dams

Effective management of surface water runoff relies heavily on the use of pollution control dams for the detention of dirty water as well as mine water. All surface water runoff potentially containing sediment, septic treated bathhouse wastewater, treated water from the oil water separator and underground mine water is captured by the site's pollution control dams prior to discharge under EPL 1770. These dams have been constructed with a mixture of earth, crushed rock, crushed recycled brick and stone and are interconnected through a series of overflow pipes and spillways. The dams discharge through the LDP into native vegetation and flow to Swindles Creek prior to draining into Lake Macquarie on the western shoreline of Chain Valley Bay.

Water is directed through the treatment dams from a number of main inlet locations. Runoff from the stockpile area and the storage yard enters the pollution control dams as described above for those catchments. The underground mine water is pumped to a pit adjacent the compressor house and is combined with the septic treated wastewater from the bathhouse, the treated compressor condensate water and some surface runoff.

From this pit the water is piped to D8 for settling and diffusion. Water within D8 enters D7 via a spillway at the southern end of D8. However, due to the imperfect nature of the dam's construction an unknown amount of water diffuses through the dam wall. The water in D7 flows into D9 in a similar manner, in D9 the underground water is combined with the runoff from other areas on site. The primary spill from D9 to D10 is at the northern end of D9. Once in D10 the water flows over a shallow buffer spillway to the main discharge spillway and offsite at the LDP. A real time monitoring system on the final spillway was installed in February 2015, with monitoring data sent every 30 minutes via 3G to an online database where data can then be viewed or downloaded.

The dams provide improvement to the site wastewater and runoff quality through the settlement of fines and suspended solids and prevention of off-site discharge of hydrocarbon spills prior to discharge to Lake Macquarie. Based on the volume of the dams and the average daily discharge, the estimated residence time of the water in the pollution control dams is 1 – 2 days. The storage capacity of these dams is provided in **Section 3.2.4**.

4.6 Erosion and Sediment Control / Ground Disturbance

Erosion and sediment control are predominately managed through the implementation of the primary controls described above within the surface water management systems. In addition to these controls, temporary erosion and sediment controls are implemented for any construction disturbance that is not contained with the surface water management system. The primary objective is to ensure that appropriate procedures and programs of work are in place to meet the requirements of Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008).

4.6.1 Soils

CVC surface facilities are situated at the southern end of Lake Macquarie. This area is principally comprised of the Doyalson soil landscape with small parts on the Wyong soil landscape. The Doyalson soil landscape is characterised by gently undulating rises on Munmorah Conglomerate with broad crests, ridges and long gently inclined slopes.

Local relief is up to 30 metres and slope gradient is less than 10%. Doyalson soils are strongly acidic soils of low fertility with slight to high erodibility. The Wyong soil landscape is characterised by broad, poorly drained deltaic floodplains and alluvial flats of Quaternary sediments. Local relief is less than 10 metres and slope gradient is less than 3%. Wyong soils are strongly acidic, poorly drained, impermeable soils of very low fertility with saline subsoils.

There is also the potential for acid sulfate soils (ASS) to be present, with probability of occurrence increasing with proximity to the shoreline of Lake Macquarie (see **Section 4.8**).

4.6.2 Potential Impacts

As there is expected to be very little disturbance to ground surfaces and generally restricted to limited construction activities associated with the mines pit top, erosion impacts will be minimal. Construction activities would typically be in areas of relatively flat land at the pit top, with mitigation measures to be put in place to control mobilisation of disturbed soils at the time of, and immediately following, the construction activity.

The greatest potential for soil exposure and movement of soil would occur during any construction activities within areas outside of the pit top water management system (such as at the ventilation shaft site). Exposed soil may be mobilised, leading to erosion, fugitive dust emissions and potential sedimentation of Lake Macquarie. The following sections provide control measures to prevent adverse impacts on surrounding catchment areas and receiving waters.

4.6.3 Standard Erosion and Sediment Controls

Erosion and sediment controls are to be implemented across the CVC for all phases of the operation including construction, operation and maintenance activities to mitigate impacts on watercourses and the surrounding environment. Where activities are contained with the pit top surface water management system, erosion and sediment control will be achieved through the controls described in the previous section.

Where soil disturbance activities are outside of these controls, standard erosion and sediment control techniques and management principles are used in accordance with the requirements of Managing Urban Stormwater: Soils and Construction Vol. 1 and Vol. 2E - Mines and Quarries (referred to as the Blue Book in this Plan) (Landcom, 2004 and DECC, 2008).

For activities at CVC, a 'Permit to Clear or Disturb Land' is required prior to disturbance. This permit includes requirements to have water management and erosion controls in place prior to disturbance.

4.6.4 Construction Erosion Management Plan

Where soil disturbance activities are outside of the surface water management system, erosion and sedimentation shall be effectively controlled through the development of a Construction Erosion Management Plan (CEMP) prior to undertaking large scale disturbances (i.e. greater than 2,500 m^2). The CEMP shall be consistent with the Blue Book (Landcom, 2004 and DECC, 2008) and would include the following key principles:

- conducting best practice land clearing procedures for all proposed disturbance areas including:
    - coordinating construction activities to minimise exposure of disturbed soils to the elements; and
    - topsoil stripping procedures to reduce deterioration in topsoil quality and dust generation.
- appropriate storage of topsoil stockpiles in areas away from roadways and other drainage lines;
- appropriate design of access tracks;
- use of diversion structures to separate 'clean' water runoff from disturbed areas runoff, to minimise volumes of sediment-laden and mine water for management;
- ensuring sediment-laden runoff is treated via designated sediment control devices;
- topsoiling, reshaping and revegetation of disturbed areas as soon as possible following the completion of construction activities;
- temporary erosion and sediment controls to be in place prior to any construction activity outside of an existing dirty water management system; and
- implementing an effective maintenance program for the site.

The above principles are addressed in further detail in **Appendix 4**.

4.7 Water Savings

CVC seeks continual improvement in relation to water consumption, potential improvements in water efficiency, alternative water sources and options for recycling and reuse. The following measures are implemented on site:

- use of a road sweeper to clean roads (as opposed to more frequent washing of roads with a water cart);
- rainwater tank installed on the workshop;
- repair works to aging pipelines to reduce losses from leakage; and
- trial use of chemical dust suppressant to reduce water cart usage.

The primary use of potable water is to supply underground activities. The water storage within the dirty water dams is not suitable for supply to underground machinery.

4.8 Acid Sulfate Soils

ASS are naturally occurring coastal and near-coastal sediments and soils containing iron sulfides formed under anoxic conditions, where the sulfides are disturbed, oxidation occurs and a leachate of pure sulfuric acid is produced, causing significant environmental impacts particularly if drained to waterways. ASS are considered likely to be present in soil horizons less than 5 m AHD and coastal wetlands / swampy regions.

A review of the NSW SEED *Acid Sulfate Soils Risk* maps identifies that the CVC pit top facilities and immediate surrounds have a low probability / no known occurrence of ASS within underlying soils, however the Swamp Oak Floodplain EEC located adjacent the CVC pollution control dams extending up the Swindles Creek tributary and along the foreshore of Lake Macquarie are identified as having a high probability for the occurrence of ASS. The ASS maps reviewed of the CVC pit top locality have been provided in **Appendix 5**.

Where ASS are left undisturbed and in anoxic conditions there is minimal environmental risk. Avoiding disturbance of potential ASS is the preferred management method, however where unavoidable, any proposed disturbance (including potential dewatering) to potential acid sulfate soils will require an ASS assessment to be completed prior. The assessment is to be undertaken in accordance with the NSW Acid Sulfate Soils Management Advisory Committee (ASSMAC*), Acid Sulfate Soils Manual* 1998 (ASSMAC 1998) – *Assessment Guidelines* to confirm the presence of actual and/or potential ASS.

Should disturbance to identified ASS be required, a project specific ASS Management Plan (ASSMP) will be prepared in general accordance with ASSMAC 1998 – *Management Plan Guidelines* and at minimum contain:

- An overview of environmental conditions of the site and off-site surrounds;
- An overview of the proposed works and the objectives of the ASSMP;
- Define the extent of acid sulfate soils with a review of environmental assessments undertaken relative to the proposed works;
- A review of potential management methods and selection of the most appropriate method for minimising environmental impact associated to the proposed works;
- A program for validating any material produced and treated as a part of completing the works;
- A description of the roles and responsibilities for the implementation of the ASSMP; and
- A description of the contingency measures to be implemented to deal with unexpected events or in the event that of failure of management procedures.

If an ASSMP is required, a development application would also need to be approved for the works by the respective local government authority (LGA), which at CVC is Central Coast Council.

For activities at Delta Coal, Permit 'PER 00022 – Excavation, Stake or Pile Driving' is required to be approved by the sites Environmental Coordinator prior to any soil disturbance which includes requirements to review ASS maps and identify potential ASS prior to the commencement of works potential disturbing ASS.

4.9 Sewerage Disposal and Management

There are two sources of domestic wastewater located at the pit top facilities. The first source is generated in the administration office building and the second is generated in the operations bathhouses and operations area. As of July 2023, both wastewater streams are pumped to the municipal sewer system via an on-site sewage pump station and rising main.

4.10 The Oil Water Separator

Water that is likely to be contaminated with oil and grease, such as runoff from the oil storage facilities, diesel tank storage, workshop / maintenance areas and wash bay is directed to and treated by an oil water separator.

The system includes a packed bed oil separation system where solids are removed in the grit trap and oily water is drawn from the sump through a floating skimmer, into the packed bed oil separator by a non-emulsifying pump. The system has a capacity of 2000 L/hr of through flow. The waste oil is collected in a container and the treated water flows by gravity to the pollution control dams.

A separate oil water separation system is installed on the condensate drain from the compressors on site. This system consists of an in-ground tank where water is passed through and under over a weir arrangement and then discharged to the pollution control dams.

Inspections and maintenance of the separation systems occurs regularly, in addition to water quality monitoring and analysis for total oil and grease at all monitoring points as per **Section 5.3**.

5 Monitoring

To ensure the continued functionality of the surface water management system and to assist CVC identify any potential issues with the system, an on-going water monitoring program is implemented, inclusive of water quality and stream health monitoring.

5.1 Baseline Surface Water Quality Monitoring Data

CVC collates and maintains an up to date database of surface water quality monitoring data for all sampling at the mine.

A baseline water quality assessment is presented in GSS Environmental, March 2013, Chain Valley Mining Extension 1 Project Surface Water Assessment. (GSSE 2013) included as **Appendix 6** (Section 3.52 and Appendix A in particular). However, the GSSE 2013 report noted limited available historic data to determine appropriate baseline concentrations for heavy metals due to a change in testing method to include dissolved and total metals in August 2010.

The below summary baseline takes the average concentration of discharged waters between August 2010 and July 2015 being the last month of routine heavy metals monitoring following variations to EPL 1770, with values adopted from historical Annual Environmental Management Reports (AEMR). For the purpose of developing a baseline value of discharged surface water quality, where the value of the pollutant tested was less than the laboratory limit of reporting (LOR) for the testing method, the LOR value was adopted. LDP1 monitoring data utilised to determine the baseline concentration in Table 5 has been provided as **Appendix 8**.

Table 5 - Summary baseline, surface water quality

Tested Pollutant	**LDP1 Average Value** August 2010 to July 2015 **(mg/L - unless specified)**	**Receiving Environment Chain Valley Bay (GSSE 2013)** **(mg/L)**	**Receiving Environment Marks Point (GSSE 2013)** **(mg/L)**	**ANZECC 2000 / ANZG 2018 DGV's, 95% marine environment (mg/L)**
pH	7.78 pH Units	-	-	Between 7 and 8.5 pH units
Total Suspended Solids	9.7	-	-	-
Conductivity	30,425 µs/cm	-	-	-
Total Oil and Grease	5	-	-	-
Faecal Coliforms	32.5 CFU/100ml	-	-	<150 CFU/100ml (primary contact i.e. swimming) <1000 CFU/100ml (secondary contact i.e. boating and fishing) NHRMC – guidelines for managing risks in recreational water, 2008.

Tested Pollutant	LDP1 Average Value August 2010 to July 2015 (mg/L - unless specified)	Receiving Environment Chain Valley Bay (GSSE 2013) (mg/L)	Receiving Environment Marks Point (GSSE 2013) (mg/L)	ANZECC 2000 / ANZG 2018 DGV's, 95% marine environment (mg/L)
Enterococci	97.1 CFU/100ml	-	-	<40 CFU/100ml (primary contact) <200 CFU/100ml (secondary contact)
Ammonia as N	0.0861	-	-	0.91
Nitrate + Nitrate as N	0.486	-	-	50 (NHRMC -Australian Drinking Water Guidelines, 2011)
Total Kjeldahl Nirotgen as N	0.277	-	-	-
Total Nitrogen as N	0.603	-	-	-
Total Phosophorus	0.0402	0.04	0.08	Algal Low risk = <0.01 Algal Mod risk = 0.01 – 0.025 high risk = 0.025 – 0.1 Algal very high risk = >0.1
Total Phosphorus as P	0.0377	-	-	-
Biochemical Oxygen Demand	2.03	-	-	-
Aluminium (total)	0.1196	0.04	0.12	Insufficient Data (ID)
Aluminium (soluble)	0.0554	<0.01	0.04	ID
Arsenic (total)	0.0023	<0.0005	0.0019	0.0023 (marine low reliability environmental concern level)
Arsenic (soluble)	0.0022	<0.0005	0.002	0.0023 (marine low

Tested Pollutant	LDP1 Average Value August 2010 to July 2015 (mg/L - unless specified)	Receiving Environment Chain Valley Bay (GSSE 2013) (mg/L)	Receiving Environment Marks Point (GSSE 2013) (mg/L)	ANZECC 2000 / ANZG 2018 DGV's, 95% marine environment (mg/L)
				reliability environmental concern level)
Beryllium (total)	0.0020	<0.0001	<0.0001	ID
Beryllium (soluble)	0.0019	<0.0001	<0.0001	ID
Cadmium (total)	0.0004	<0.0002	0.0004	0.0007
Cadmium (soluble)	0.0004	<0.0002	0.0004	0.0007
Chromium (total)	0.0033	<0.0005	<0.0005	0.0044
Chromium (soluble)	0.0025	<0.0005	<0.0005	0.0044
Cobalt (total)	0.0016	<0.0002	<0.0002	0.001
Cobalt (soluble)	0.0015	<0.0002	<0.0002	0.001
Copper (total)	0.0051	<0.001	0.004	0.0013
Copper (soluble)	0.0040	<0.001	0.002	0.0013
Lead (total)	0.0030	<0.0002	0.0012	0.0044
Lead (soluble)	0.0028	<0.0002	0.0004	0.0044
Mercury (total)	0.0001	<0.0001	<0.0001	0.0001
Mercury (soluble)	0.0001	<0.0001	<0.0001	0.0001
Molybdenum (total)	0.0051	0.0024	0.012	0.034 (low reliability DGV)
Molybdenum (soluble)	0.0045	0.0025	0.0116	0.034 (low reliability DGV)
Nickel (total)	0.0042	0.0008	0.0007	0.007
Nickel (soluble)	0.0041	<0.0005	<0.0005	0.007
Selenium (total)	0.0212	<0.002	<0.002	0.003 (low reliability DGV)

Tested Pollutant	LDP1 Average Value August 2010 to July 2015 (mg/L - unless specified)	Receiving Environment Chain Valley Bay (GSSE 2013) (mg/L)	Receiving Environment Marks Point (GSSE 2013) (mg/L)	ANZECC 2000 / ANZG 2018 DGV's, 95% marine environment (mg/L)
Selenium (soluble)	0.0190	<0.002	<0.002	0.003 (low reliability DGV)
Silver (total)	0.0025	<0.0001	0.0004	0.0014
Silver (soluble)	0.0024	<0.0001	0.0004	0.0014
Vanadium (total)	0.0208	<0.0005	0.0016	0.1
Vanadium (soluble)	0.0191	<0.0005	0.0016	0.1
Zinc (total)	0.0404	0.015	0.019	0.015
Zinc (soluble)	0.0336	0.008	0.018	0.015
Anionic Surfactants as MBAS	0.1702	-	-	-

5.2 Impact Assessment Criteria and Trigger Levels

5.2.1 Surface Waters

Table 6 provides water quality parameters and relevant limits to be measured at the LDP as per EPL 1770.

Table 6: Water Quality Monitoring Limits for Chain Valley Colliery

Parameter	Trigger Value	Source
Faecal coliform	200 colony forming units per 100 millilitres	EPL 1770 note: following a variation to EPL 1770 after completion of PRP 8 and PRP 9 in October 2023, CVCs limit for faecal coliform will be reviewed in 6 months (i.e. April 2024).
pH	6.5-8.5	EPL 1770
TSS	50 mg/L	EPL 1770
Oil and Grease	10 mg/L	EPL 1770

5.2.2 Underground Water

Groundwater monitoring is described within the GwMP provided in **Appendix 1.**

5.3 Surface Water Monitoring and Frequency

DC will continue to monitor as required by the EPL and also undertake monitoring beyond the requirements of the EPL. The monitoring locations, parameters to be monitored and the required frequency are detailed in **Table 7** with the position of these monitoring locations shown on **Figure 2**. Surface water quality monitoring summary plots for LDP1 for the period from January 2012 to December 2023 are presented in **Appendix 7**.

Table 7: Surface Water Quality Monitoring Locations and Frequency

Identification	Type of Monitoring Point	Discharge Limits	Parameter	Frequency	Sampling Method
Outlet to Creek (OTC)	Operational (where discharged water enters Swindles creek)	N/A	• pH • Total suspended solids • Biochemical Oxygen Demand • Faecal Coliforms • Enterococci • Total oil and grease • Electrical Conductivity • Total Nitrogen • Total Phosphorus	Monthly (min 4 weeks)	Grab sample
Dam 10 Outlet LDP1 and LDP27	EPL 1770 Licensed Discharge Points 1 (Dam piped discharge) and 27 (Dam spillway)	12,161 kL per day			
USSP	Baseline Data (Swindles Creek Upstream of Site)	N/A			
RW1	Baseline Data (Swindles Creek Downstream of Site)	N/A			

Identification	Type of Monitoring Point	Discharge Limits	Parameter	Frequency	Sampling Method
			• Anionic Surfactants		

All monitoring of waters should be undertaken in accordance with Approved Methods for Sampling and Analysis of Water Pollutants in NSW (DECCW, March 2004). Additionally, pollutant concentration measurements shall be determined in micrograms per litre and within ANZG 2018 (formerly ANZECC 2000) concentration limits unless noted otherwise.

5.4 Stream Health Channel Flow and Riparian Vegetation Monitoring

A program to monitor creek line channel stability and health of riparian vegetation within Swindles Creek is undertaken along a short length of the downstream watercourse. Observations of stream health and stability are undertaken quarterly and recorded on the CVC *'Creek Stability Inspection'* form.

Monitoring of Swindles Creek, as per the creek stability form, includes multiple photographic points at representative locations. Photos are taken over multiple inspections in a repeatable manner, with the inspection specifically including:

- general observations of water quantity and quality;
- documenting locations and dimensions of significant erosive or depositional features;
- documenting evidence of erosion and exposed soils;
- noting general indicators of stream health, including abundance of flora and fauna; and
- a review and comparison of results to previous inspections.

Where degradation or adverse erosion is occurring, additional investigations will be undertaken to assess whether the impacts may be associated with the operation of the mine and ameliorative actions undertaken as required. In addition, further riparian vegetation monitoring will be undertaken in accordance with the Biodiversity Management Plan.

5.5 Groundwater Monitoring Program

Details of the groundwater monitoring program is contained in the GwMP in **Appendix 1**, which includes monitoring of mine inflows and private bore water levels.

5.6

5.6 Additional Operational Monitoring

In addition to the other monitoring described above, DC also undertakes periodic surface water quality monitoring for dams within the site. This additional monitoring allows the performance of the surface water management system to be assessed for various areas around the site. CVC is also committed to monitoring water usage onsite. Water usage is currently monitored through the following:

- metering of the potable supply to site;
- monitoring of the volume of water pumped from the Great Northern Seam sump to the surface and
- maintaining records of the water cart operation, including fill times.

5.7 Inspections and Maintenance

All water management structures will be inspected regularly. **Table 8** contains the inspection and maintenance schedule used to ensure the water management structures are functioning effectively throughout CVC. The inspections will also determine the scheduling of maintenance required for the structures.

Table 8: Inspection Schedule for Water Management Structures

To Be Inspected	Inspection Frequency	Routine Maintenance	Maintenance Frequency
Sediment dams	Monthly	Desilting of dams	Annual however can be amended based on inspection and water quality results.
Drainage channels and associated in-line sumps	Monthly	Remedial works for erosion and clearing of debris	Undertaken as required when erosion or debris is noted within monthly inspections
Works in progress (including temporary erosion and sediment control structures)	Weekly	Repairs and additional controls implemented where structures are damaged or not performing adequately.	As required.
Roads and hardstand areas	Monthly	Roads and hardstand areas are kept clear of debris by sweeping of sealed roads utilising a vacuum street sweeper and unsealed hardstand areas are inspected daily by the control room operator with a watercart available 24/7 to delta coal for dust suppression.	6 monthly street sweeping or as required. Watercart shifts are scheduled daily depending on the need for dust suppression based on weather forecasts and visual moisture status of unsealed areas however is available as/when required.
Oil water separator unit	Weekly mechanical inspection Monthly environmental inspection	Maintenance by a service contractor. Collection of separated oil collection.	6 monthly unit servicing or as required where fault is found during inspection. Separated oil is collected when storage approaches 50% capacity, as determined during weekly inspections.

To Be Inspected	Inspection Frequency	Routine Maintenance	Maintenance Frequency
Oil water separator sump	Monthly	Desilting of the washdown bay sump and cleaning of oil water separator sump.	6 monthly basis minimum or as required from inspections.
Air compressor oily water separator	Monthly	Removal of separated oily water via a vacuum truck as required from monthly inspections	as required determined from monthly inspections
Carpark	Monthly	Re-grading and compaction of carpark to ensure a smooth surface is maintained to prevent erosion	6 monthly or as required.

In addition to these inspections, regular water quality monitoring is undertaken as described above. The results of this monitoring with regards to total suspended solids will assist in assessing the effectiveness of the water management system, along with highlighting any possible areas that need to have additional controls added or improve the function of existing controls.

All water management structures will be maintained in a functioning condition. Where controls are observed to be not functioning correctly, the controls will be restored to meet the required standard. The maintenance and monitoring of specific features of the site are described in the sections below.

5.7.1 Sediment Dams

Visual inspections of the sediment dams are undertaken to determine the clarity of the water and if any maintenance is required. The inspections also enable correct scheduling of de-silting works and prompt repairs and/or replacement of damaged works. When required, the silt from dams is removed and stored so that it is not able to be washed back into the dam. Documented inspections of the above are part of the Monthly Environmental Inspection which is scheduled via a work order (part of the CVC maintenance management system).

As part of the 2022 Independent Environmental Audit of CVC, action 6 required DC to develop and implement a maintenance schedule for desilting on-site dams and drains. The undertaking of desilting of on-site dams and drains will be based on routine inspection to determine the sediment accumulation and requirement for desilting works. Desilting of dams with sediment accumulation will be undertaken on an annual basis.

Dams and drains at CVC are detailed in **Figure 3**. Inspection of drains is undertaken within a monthly environmental inspection issued through the sites work order system to ensure that site drains are clear and operable without sediment accumulation, works are scheduled on the findings of the inspections.

Sediment dams are to be maintained in a condition consistent with the Dams Safety Act 1978.

5.7.2 Drainage Channels

For clean water diversions, any signs of erosion along the length of the drains should be noted and remedial works undertaken as required. Where significant erosion is observed, additional erosion controls are constructed e.g. establishment of vegetation cover, use of temporary sediment devices until the vegetation is established, scour protection (rock-armouring or erosion blanket) of the channel surface.

Where dirty water drainage channels contain in-line sumps, these will be cleaned on a regular basis depending on the accumulation of material within the sumps.

5.7.3 Temporary ESC Structures

Regular visual checks will be made of any temporary erosion and sediment controls (ESC) such as sediment filter fences, sandbag weirs etc. to ensure that they are functioning adequately. Structures will be repaired where required.

5.7.4 Roads and Hard Stand Areas

A water cart will be used around the site to ensure dust is kept to a minimum. This will be undertaken on an as needs basis, with more regular use during the warmer months. The use of chemical dust suppressant is also being trialled to reduce water usage. A street sweeper is routinely used to sweep the sealed entrance roads.

5.7.5 Washbay Oil Water Separator

The packed bed oil separator system is designed to minimise maintenance and servicing. As oil separator systems are critical for the reliable prevention of oil contamination, regular inspections/servicing are important. It is critical that the mechanisms be regularly checked for operation to prevent environmental contamination. Preventative maintenance may also prevent failures before they occur by detecting trends in functionality.

This system has specific weekly and monthly work orders that ensure the system is serviced and maintained.

All accumulated waste oils and solid material shall be disposed of periodically by a licensed operator. The weekly waste management inspection will determine waste oil levels and disposal requirements.

5.7.6 Compressor Condensate Oil Water Separator

Excess oil from the compressors and surrounds is contained, piped to a collection tank which is inspected weekly to ensure the system is serviced and maintained.

Any accumulated waste oil is then removed for recycling by licensed and approved waste management contractors.

5.7.7 Carpark

The CVC carpark was previously unsealed, however, the carpark was sealed in September 2022 which included grading, laying of road base, compaction, covering in gravel and spraying with a bitumen sealant.

5.7.8 Underground Flow Monitoring Devices

Water flow monitoring appliances have been installed in the mine to measure pumped water volumes to and from the mine workings. These appliances shall be maintained in good working order, and if required, the mine will supply a test certificate to certify the current accuracy of the appliances furnished by the manufacturer or by some duly qualified person or organisation.

5.8 Data Recording and Publication

Recording of monitoring data will be undertaken in accordance with the requirements outlined in EPL 1770. DC will collate and maintain an up-to-date database of surface water quality monitoring data for all sampling at the mine. Monitoring results will be interpreted as they are received in order to ensure water quality is maintained within the desired parameters.

A summary of results, including daily volumetric discharge and water quality results, will be prepared monthly and made publicly available on the DC website (www.deltacoal.com.au) in accordance with the requirements of *Protection of the Environment Operations Act, 1997*.

The results will also be compared to relevant site operations and meteorological conditions to further interpret the results. This comparison between samples, sampling periods and against other factors will assist in identifying whether the activities on the site are in fact affecting the water quality of the local catchment.

Results of surface water quality monitoring will be reported in the Annual Review. The results will also be made available to the Community Consultative Committee members on a regular basis as part of the Environmental Monitoring and Reporting process, as well as to the Central Coast Council and Lake Macquarie City Council (LMCC).

6 Reporting

6.1 Regular Reporting

The water monitoring results will be reviewed on a monthly basis to confirm compliance with the conditions specified in **Section 5** or ensure corrective action is taken where results or trends indicate non-compliance or risk of future non-compliance.

A summary of monthly environmental monitoring results will be published on the DC website.

6.2 Annual Review

The water monitoring results will be reviewed on a monthly basis to confirm compliance with the conditions specified in **Section 5** or ensure corrective action is taken where results or trends indicate non-compliance or risk of future non-compliance.

The results will also be included in the Annual Review. The Annual Review will include:

- a summary of monitoring results,
- comparison against the water quality criteria;
- summary of previous years monitoring results;
- comparison against predictions in the Environmental Impact Statement (EIS);
- identify any trends in water quality/quantity;
- identify any non-conformances over the year; and
- describe any actions currently implemented or planned to ensure compliance with the water quality impact criteria.

The Annual Review will be forwarded to the relevant authorities including the DCCEEW, EPA and WaterNSW. The Annual Review will also be forwarded to members of the Community Consultative Committee and local Councils (Central Coast and Lake Macquarie) and will also be placed on the CVC website.

The EPA will be provided with an annual return, including monitoring details, as required by EPL 1770.

6.3 Incident or Non-Compliance Response and Reporting

Environmental incidents and hazards at CVC and MC are reported in DC's incident reporting and management system. Reported incidents are investigated and corrective and/or preventative actions are identified in accordance with DC's Health and Safety Standard – Incident Reporting.

In addition to internal reporting requirements, if an incident causes or threatens to cause material harm to the environment (e.g. a pollution incident), then consistent with Schedule 6, Condition 6 of SSD-5465, DC must immediately notify the Department and any other relevant agencies (such as the NSW EPA and Resources Regulator) after it becomes aware of such an incident. The incident notification must identify the location and nature of the incident, the development application (name and number) and be in writing to compliance@planning.nsw.gov.au.

In accordance with Schedule 6, Condition 7 of SSD-5465, DC must notify the Department and other relevant agencies within seven days of becoming aware of a non-compliance to the conditions of the consent. The non-compliance notification must identify the development, set out the conditions of the consent that have not been complied with, why the non-compliance occurred and the reasons for the non-compliance (if known) as well as what actions have been, or will be, undertaken to address the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au.

CVC and MC have PIRMPs in place, which provide details on how to identify, manage, record and investigate environmental incidents and emergencies. Both PIRMPs identify clear roles and responsibilities for actions required in the event of an incident or emergency.

DC categorises environmental issues at CVC and MC as either serious (Category EI1), significant (Category EI2) or minor (Category EI3). Definitions, immediate actions and follow-up actions for each category are summarised in **Appendix 10**.

The GwMP in **Appendix 1** contains the assessment triggers and ameliorative measures relevant to the groundwater monitoring.

Any incidents or complaints will be recorded and fully investigated to find root causes and corrective actions implemented where necessary. Additionally, the following measures will be undertaken:

- a review of management practices to systematically identify and implement options to modify site practices so as to ensure effective water management and erosion and sediment control activities in order to achieve the goals stated in this plan; and
- additional water quality monitoring may be conducted at a complainant's request at an appropriate frequency.

7 Stakeholder Management, Response and Training

7.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 115 277) for members of the public to lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters. All complaints are recorded and responded to.

The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or if no action was taken, the reason why; and
- follow up contact with the complainant.

7.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:

- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review

7.3 Dispute Resolution

Any disputes that are not adequately addressed by the complaints handling process are handled by DC's Environmental Compliance Coordinator. If the response is still not considered by the complainant to satisfactorily address their concern or the matters raised, a meeting is convened with the Mine Manager and Environmental Compliance Coordinator together with the complainant.

The complainant is advised in writing of the outcomes of the meeting and the actions (where applicable) to be implemented as a result. After implementation of the proposed actions, the complainant is contacted and feedback sought as to their satisfaction or otherwise with the measures taken

If an agreed outcome cannot be determined or the complainant is still not satisfied by the actions undertaken by DC, then an independent review can be requested by the complainant to determine whether further actions should be implemented by DC to resolve the matter.

Condition 2 of Schedule 5 of SSD-5465 (CVC) lists the requirements for an independent review as follows:

INDEPENDENT REVIEW

2. If an owner of privately-owned land considers the development to be exceeding the relevant criteria in Schedule 3, then he/she may ask the Planning Secretary in writing for an independent review of the impacts of the development on his/her land.

If the Planning Secretary is satisfied that an independent review is warranted, then within 2 months of the Planning Secretary's decision the Applicant must:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:

- consult with the landowner to determine his/her concerns;
- conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and
- if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and

(b) give the Planning Secretary and landowner a copy of the independent review.

7.4 Training, Awareness and Competence

Training is an essential component of the implementation phase of this WMP. The Environmental Compliance and Approvals Coordinator will ensure that training and awareness processes are implemented to manage, identify and minimise potential impacts of CVC and to ensure personnel are aware of their roles and responsibilities in terms of water quality management and erosion and sediment control.

Generally training at CVC consists of induction training for new starters and contractors along with environmental awareness training at two-year intervals and ongoing "toolbox" training for all permanent employees as required. Site inductions also specifically identify that no unauthorised clearing is to occur.

As the document owner, the Environmental Compliance Coordinator is the contact point for any person that does not understand this document or their specific requirements and will provide guidance and training to any person that requires additional training regarding this management plan.

8 Audit and Review

8.1 Overview

This document shall be reviewed, and if necessary revised, annually or within 3 months of the following;

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the development consent or EPL.

8.2 Audits

Internal and external audits of this document and all other Environmental Management System documents are to be undertaken every three years. Improvements from the audit are to be incorporated in the site action database to ensure the actions are assigned to the relevant people and completed.

Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

External audits will be conducted utilising external specialists and will consider this document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished.

An Independent Environmental Audit (IEA) was undertaken in 2022. In accordance with SSD-5465 Schedule 6, Condition 9, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

9 Records and Document Control

9.1 Records

Generally, the Environmental Compliance Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data and equipment calibration;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

9.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environmental Compliance Coordinator. Details on document revisions are provided in **Table 9**.

Table 9: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	23/08/2012	Revision 1	LakeCoal	GSS Environmental Chris Ellis
2	21/07/2015	Revision 2	LakeCoal	Niche Environment and Heritage Chris Ellis
3	30/11/2019	Updated to Delta Coal format and site update and results	Delta Coal EMM Consulting	Sally Callander Chris Armit Katie Weekes
4	18/12/2020 17/12/2020 5/3/2021 6/4/2021	Updated for Modification 3 and updated Groundwater Management Plan for Extraction Plan DPIE RFI DPIE Approval	Delta Coal	Chris Armit
5	24 August 2021	Administrative update following approval of Modification 4	Delta Coal	Lachlan McWha

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
6	1 November 2022	Update following completion of 2022 Independent Environmental Audit	Delta Coal	Lachlan McWha
7	16 January 2024	Update following variation to EPL 1770, varying conditions in water modelling and reflecting the completion of site municipal sewer connection (PRP 8 and PRP 9)	Delta Coal	Lachlan McWha

10 Roles and Responsibilities

10.1 Responsibilities

All employees and contractors of Chain Valley Colliery are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this WMP are identified in **Table 10**.

Table 10: Water Management Roles and Responsibilities

Role	Responsibilities
General Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the WMP.
Manager of Mining Engineering	• Overall responsibility for environmental compliance with Mining Lease, EPL, Development Consent and other mining approvals as they pertain to water management.
Environmental Compliance and Approvals Coordinator	• Implementing the forward works program; • Planning for adequate resources to implement this site WMP. • Approving revised versions of this site WMP; • Co-ordination of external audits, corporate reporting and management; • Co-ordinate environmental monitoring, reporting, inspections, environmental training, authority liaison, maintaining complaints register and community liaison; • Allocation of resources within area of responsibility and budget; • The implementation and adherence to this site WMP; • Providing adequate training to employees and contractors regarding their requirements under this site WMP; • Contractor management; and • Delegating tasks associated with this site WMP when responsible personnel are absent.
Employees and contractors	• Comply with the requirements of this WMP.

11 References & Associated Documents

Documents used in the preparation of this management plan are detailed in **Table 11**.

Table 11: References and Associated Documents

Reference Type	Document
Australian standards	AS/NZS ISO 14001:2004 *Environmental management systems – Requirements with guidance for use* AS/NZS ISO 14004:2004 *Environmental management systems – General guidelines on principles, systems and support techniques*
Legislation and regulations	NSW EPA, EPL 1770 *Environment Protection License 1770* Development Consent SSD-5465 (Modification 2) dated 16 December 2015 for the Mining Extension 1 Project *Environmental Planning and Assessment Act 1979* *Mining Act 1992* *Protection of the Environment Operations Act, 1997* *Water Act 1912* *Water Management Act 2000*
Delta Coal documents	Delta Coal - Environmental Management Strategy GSS Environmental – Chain Valley Colliery Mining Extensions 1 Project - Surface Water Assessment March 2013 (GSSE 2013) LakeCoal, 2019. Chain Valley Colliery Annual Review 2018. Doc No. REP 00058, 16 May 2019. Delta Coal, 2020. Chain Valley Colliery Annual Review 2019. GHD – Groundwater Impact Assessment, Chain Valley Colliery Consolidation Project, 7 October 2022.
External documents	Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), National Guidelines for Sewerage Systems - Effluent Management, 1997. Australian and New Zealand Environment Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines), October 2000. ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines Australian Government, Charter: National Water Quality Management Strategy, 2018.

DECCW, March 2004. Approved Methods for Sampling and Analysis of Water Pollutants in NSW.

Douglas Partners, 2020, Geotechnical assessment for Sewer Pipeline, Chain Valley Colliery.

GEOTERRA, 2020, Groundwater Management Plan, Chain Valley Colliery.

GEOTERRA, 2019, Groundwater Management Plan, Chain Valley Colliery.

GEOTERRA, 2014, Groundwater Management Plan, Chain Valley Colliery.

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GSS Environmental, March 2013, Chain Valley Mining Extension 1 Project Surface Water Assessment. (GSSE 2013)

Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008. Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries.

NSW Water Quality and River Flow Objectives, September 1999.

NSW State Rivers and Estuaries Policy, 1993.

NSW Groundwater Quality Protection Policy, adopted in 1998.

NSW Groundwater Quantity Management Policy.

NSW Department of Environment and Conservation (DEC), Environmental Guidelines: Use of Effluent by Irrigation, 2004.

The NSW State Groundwater Dependent Ecosystems Policy, adopted in 2002.

12 Definitions

ANZECC Australia New Zealand Environment Conservation Council

AWTS Aerated Waste Water Treatment System

CC Council – Central Coast Council

DECCW Former NSW Department of Environment, Climate Change and Water

DP&E NSW Department of Planning and Environment (former)

DPIE NSW Department of Planning, Industry and Environment

DoI - Water NSW Department of Industry (Water)

DRE Division of Resources and Energy (within the Department of Trade and Investment, Regional Infrastructure and Services)

EPA Environment Protection Authority

EP&A Act Environmental Planning and Assessment Act 1979

EPL Environment Protection License

GwMP Groundwater Management Plan

LDP Licensed Discharge Point

LMCC Lake Macquarie City Council

MPL Mining Purposes Lease

Mt Million Tonnes

NOW NSW Office of Water (former)

OEH Office of Environment and Heritage

POEO Act *Protection of the Environment Operations Act 1997*

ROM Run of Mine

Planning Secretary Planning Secretary of the Department of Planning, Industry and Environment, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

TARP Trigger Action Response Plan

TSS Total Suspended Solids

WMP Water Management Plan

WSC Wyong Shire Council (now part of Central Coast Council)

Appendix 1: Groundwater Management Plan (GwMP)

GeoTerra

DELTA COAL PTY LTD

CHAIN VALLEY COLLIERY
GROUNDWATER MANAGEMENT PLAN

CVC3-R4A
15 December 2020

GeoTerra Pty Ltd **ABN 82 117 674 941**

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Authorised on behalf of GeoTerra Pty Ltd:	
Name:	Andrew Dawkins
Signature:	
Position:	Principal Hydrogeologist

Date	Rev.	Comments
21.05.2020		Initial Draft
15.12.2020	A	Final

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1. INTRODUCTION

This revised Groundwater Monitoring Program (GwMP) has been prepared in compliance with Schedule 3 (Condition 18D) of the Delta Coal Pty Ltd (DC) Chain Valley Colliery Extension Project Approval SSD 5465 for the addition of Miniwall S5.

Development Consent (SSD-5465 – as modified) was approved on 23 December 2013 which permits the current and proposed activities.

This report is to be read in conjunction with the Water Management Plan prepared for Chain Valley Colliery (Delta Coal, 2019).

This GwMP includes:

- a groundwater water quality and quantity monitoring program;
- trigger levels for mining impacts on groundwater systems;
- procedures to be followed in the event that monitoring of groundwater indicates an exceedance of trigger levels;
- measures to mitigate, remediate and/or compensate for identified impacts;
- a protocol for the notification of trigger level exceedances, and;
- a contingency plan where, in the event of adverse effects on groundwater quality and/or quantity due to mining impacts, Chain Valley Colliery will provide an equivalent supply until the affected supply is restored, or as agreed with the landowner and the NSW Department of Industry - Water (DPIE).

Groundwater related operations at Chain Valley Colliery include the:

- historic Great Northern and Wallarah seams bord and pillar workings;
- current Fassifern Seam development as well as miniwall workings; and
- water storage and management facilities owned and operated by Chain Valley Colliery.

Operation of the GwMP needs a high level of management input to operate Chain Valley Colliery within the relevant requirements and various water licences, particularly to ensure compliance with the water discharges authorised by Environment Protection Licence (EPL) 1770.

An essential part of the plan is monitoring of all groundwater inflows and extraction into and out of the underground with reliable flow meters, as well as monitoring of groundwater levels and water quality in private bores.

This information is necessary for periodical reviews of the groundwater management system and to support any updates/changes to licences.

The proposed mitigation measures minimise and manage the impacts of any potential adverse effects on local aquifers within the GwMP area.

The proposed mitigation measures minimise, where possible, the impacts of the proposed mining on the various groundwater sources, aquifers or groundwater dependent ecosystems that may be present in the Project Area.

1.1 Objectives

The objective of the GwMP is to operate Chain Valley Colliery so that the subsurface mining operations will be conducted in a manner which minimises the potential impacts on groundwater flow and quality, aquifer integrity, groundwater dependent ecosystems and other off-site groundwater related impacts.

In order to achieve this goal, the GwMP will be used to establish procedures to:

- measure, control, mitigate and repair potential impacts that could, or do, occur to the groundwater system overlying Chain Valley Colliery; and
- identify, measure, minimise or where possible, avoid potential significant adverse impacts that can result from mining and subsidence on the groundwater systems within the Project Area.

In addition, the GwMP will be used to:

- monitor groundwater system changes in relation to the leaseholder's mining activities;
- assess the pre and post-mining condition of groundwater systems in the lease area;
- ensure all relevant groundwater criteria are met;
- minimise and manage any impacts on the availability of groundwater to potentially impacted residents, landholders or other groundwater users;
- minimise adverse changes on groundwater dependent ecosystems, where present;
- provide a forum to record and discuss mining impacts; and
- provide an annual report on the monitoring, observations and actions conducted within the preceding 12 months to the Department of Planning, Industry and Environment (DPIE).

These objectives will be met by:

- monitoring groundwater seepage and groundwater quality in the workings during mining within the mine lease area;
- installation of water monitoring appliance(s) to measure pumped water volumes to and from the mine workings. These appliances will be maintained in good working order. If required the mine will supply a test certificate to certify the current accuracy of the appliance(s) furnished by the manufacturer or by some duly qualified person or organisation. The mine water pumping records will be maintained and supplied to DPIE at the end of the water year;
- ensuring that any tail-water drainage will not be allowed to discharge onto adjoining roads, crown land or other lands, or into any unauthorised stream, or any aquifer, by surface or subsurface drains or pipes or any other means without appropriate approval;
- ensuring that any groundwater extracted from the works will not be discharged into any watercourse or source of groundwater except in compliance with the Protection of the Environment Operations Act (1997);
- any works used for the purpose of conveying, distributing or storing groundwater from the works will not be constructed or installed so as to obstruct the free passage of floodwaters flowing in, to or from a river or lake;
- all groundwater extracted from the works will be used or applied only on such land, and for such purposes, as approved by DPIE, and;
- providing a forum to report, discuss and record impacts to the groundwater system that involves the Chain Valley Colliery, stakeholders and DPIE, as required.

1.2 Scope

The GwMP is to be used to protect, monitor and manage the condition of the groundwater system within the Chain Valley Colliery lease area that may potentially be impacted due to coal mining and mine subsidence.

It applies to persons employed or engaged by Chain Valley Colliery when carrying out activities described by this plan.

This GwMP is to be read in conjunction with the current version of the Water Management Plan (WMP) which outlines the monitoring and management of specific factors relating to surface water and groundwater issues due to the predicted subsidence.

All other water management components not directly related to the GwMP are contained as part of the WMP.

The plan covers mining until completion of Domains 1 and 2, although the plan may be used beyond that benchmark with appropriate modification.

1.3 Definitions

For the purpose of this document, the area addressed in the GwMP is defined as the groundwater systems within the Chain Valley Colliery project approval area. The main features in the GwMP area shown in **Figure 1** include the:

- current Chain Valley Colliery workings in the Fassifern Seam;
- the proposed extraction within Domains 1 and 2; and
- the current and proposed extraction of Miniwalls S2, S3, S4 and S5.

1.4 Limitations

This GwMP is based on current monitoring data and the proposed and approved operational aspects relating to Chain Valley Colliery. The relevant groundwater features have been identified from:

- existing studies;
- data supplied by Chain Valley Colliery representatives; and
- associated consultant's reports in the Lake Macquarie area.

The impacts of mining on the groundwater system have been assessed in previous studies (see references). However, it is recognised that prediction and assessment of changes to, and effects from, operation of the Colliery on the groundwater system can be relied upon only to a certain extent.

The groundwater study prepared for the Chain Valley Colliery Mining Extension 1 Groundwater Assessment (GeoTerra, 2013) determined there is a low potential for the mine's impacts on the groundwater system to exceed the predictions and assessments. However, the possibility of impacts above predictions has been considered in this plan.

The plan will not necessarily prevent impacts from the proposed mining, but does identify appropriate procedures to manage the impacts within tolerable limits and identifies procedures that can be followed should evidence of increased impacts and unacceptable risk emerge.

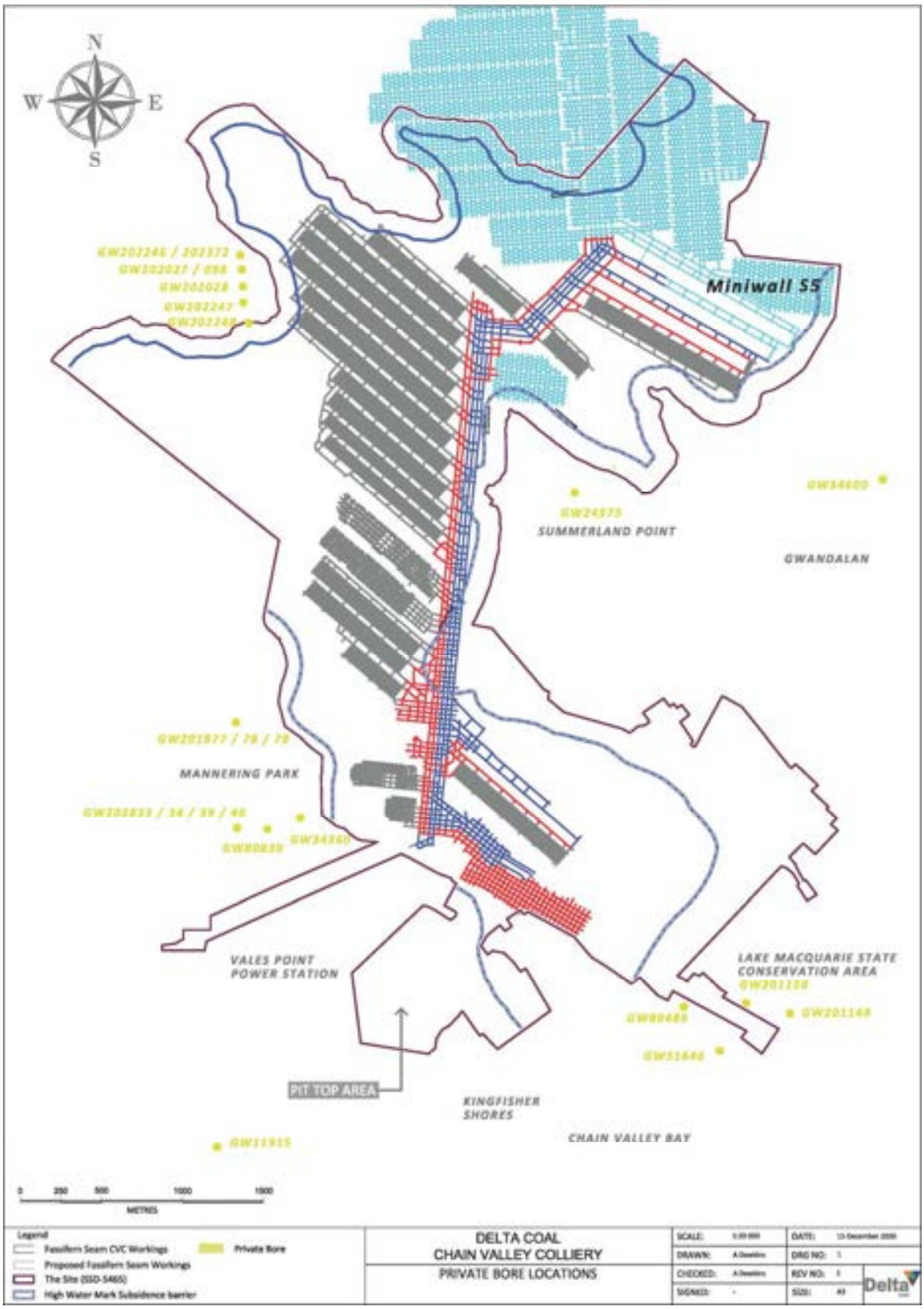


Figure 1 Current and Proposed Workings and Private Bore Locations

2. LEGISLATION

The following sub-sections outline NSW statutory requirements that apply to the mining operation with respect to groundwater.

2.1 Water Management Act 2000

The key legislation for the management of water in the project area is the *Water Management Act 2000* (the Act), which regulates water use for rivers and aquifers where water sharing plans have commenced.

Under the Act, DPIE has prepared a range of statutory water management plans covering aspects such as water sharing, water use, drainage management and floodplain management. In NSW, 36 water sharing plans have commenced, covering 80 percent of water currently extracted. The plans cover most of the regulated river systems (those controlled by major dams for rural water supplies), a number of unregulated river systems and the major inland alluvial aquifers.

The project area is located in the *South Lake Macquarie Water Source* section of the Water Sharing Plan - Hunter unregulated water sources.

The object of the Act is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The Act provides arrangements for controlling land-based activities that affect the quality and quantity of the State's water resources. It provides for four types of approval:

- water use approvals – authorise the use of water at a specified location for a particular purpose, for up to ten years;
- water management work approvals;
- controlled activity approvals; and
- aquifer interference activity approvals – authorise the holder to conduct activities that affect the aquifer. This approval is for activities that intersect groundwater, other than water supply bores and may be issued for up to ten years.

For controlled activities and aquifer interference activities, the Act requires that the activities avoid or minimise impacts on the water resource and land degradation, and where possible the land must be rehabilitated.

2.2 State Groundwater Policy

The *NSW State Groundwater Policy* (Framework Document) was adopted in 1997 and aims to manage the State's groundwater resources to sustain their environmental, social and economic uses. The policy has three component parts:

- The *NSW Groundwater Quality Protection Policy*, adopted in December 1998;
- The *NSW State Groundwater Dependent Ecosystems Policy*, adopted in 2002; and
- The *NSW Groundwater Quantity Management Policy*.

2.2.1 Groundwater Quality Protection

The *NSW Groundwater Quality Protection Policy* (Department of Land and Water Conservation, 1998), states that the objectives of the policy will be achieved by applying the management principles listed below.

- all groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained;
- town water supplies should be afforded special protection against contamination;
- groundwater pollution should be prevented so that future remediation is not required;
- for new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource;
- a groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwater that is incompatible with soil, vegetation and receiving waters;
- groundwater dependent ecosystems will be afforded protection;
- groundwater quality protection should be integrated with the management of groundwater quality;
- the cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource; and
- where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.

2.2.2 Groundwater Dependent Ecosystems

The *NSW State Groundwater Dependent Ecosystems Policy* (Department of Land and Water Conservation, 2002) is specifically designed to protect valuable ecosystems which 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. The policy defines Groundwater Dependent Ecosystems (GDEs), as *"communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater".*

Five management principles establish a framework by which groundwater is managed in ways that ensure, whenever possible, that ecological processes in dependent ecosystems are maintained or restored. A summary of the principles follows:

- GDEs can have important values. Threats should be identified and action taken to protect them;
- groundwater extractions should be managed within the sustainable yield of aquifers;
- priority should be given to ensure that sufficient groundwater is available at all time to identified GDEs;
- where scientific knowledge is lacking, the precautionary principle should be applied to protect GDEs; and
- planning, approval and management of developments should aim to minimise adverse effects on groundwater by maintaining natural patterns, not polluting or causing changes to groundwater quality and rehabilitating degraded groundwater systems.

2.2.3 Groundwater Quantity Protection

The objectives of managing groundwater quantity in NSW are to:

- achieve the efficient, equitable and sustainable use of the State's groundwater;
- prevent, halt and reverse degradation of the State's groundwater and/or its dependent ecosystems;
- provide opportunities for development which generate the most cultural, social and economic benefits to the community, region, state and nation, within the context of environmental sustainability; and
- involve the community in the management of groundwater resources.

3. CURRENT AND PROPOSED OPERATIONS

Chain Valley Colliery is an underground coal mine operated by Delta Coal Pty Ltd (Delta Coal).

The Colliery is located in the Newcastle Coalfields at the southern end of Lake Macquarie in NSW, and is approximately 60 kilometres south of Newcastle, within the Swansea-North Entrance Mine Subsidence District.

The project area incorporates the relatively flat pit top area, existing ventilation shaft and fan site on Summerland Point, as well as foreshore areas and Lake Macquarie.

The terrestrial land within the GwMP area is gently undulating and drains to Lake Macquarie.

Chain Valley Colliery commenced operation in the 1960's extracting coal from the Wallarah seam, the Great Northern Seam and the Fassifern Seam, and currently conducts mining within leases ML 1051, CCL 721 and ML 1632.

The current Fassifern Seam Miniwalls are located underneath Lake Macquarie, within and to the north of Chain Valley Bay.

The mine has completed extraction of Miniwalls 1 to 12 (MW1 to MW12) and has an approved Extraction Plan for Miniwalls N1 and S1, S2, S3 and S4 in the Fassifern Seam.

At the time of writing, the Chain Valley Colliery has completed miniwall S2.

No current or proposed secondary extraction underlies any terrestrial based surface water catchments, with all secondary extraction proposed to be underneath the saline, tidal region of Lake Macquarie.

Chain Valley Colliery currently has Development Consent (SSD-5465 – as modified) for:

- extraction of up to a maximum of 2.1 million tonnes per annum until 31 December 2027 through continued mining via first workings and miniwall methods within the Fassifern Seam;
- continued coal transport for the surface facilities site;
- continued use of the existing surface facilities, and;
- continuation of passive underground activities within the old workings of the Wallarah seam, Great Northern seam and the Fassifern Seam.

The approved mining area is approximately 200m below the sediments of Lake Macquarie, within a boundary set to exclude secondary extraction within the High Water Mark Subsidence Barrier or the Seagrass Protection Barrier**.**

Bord and pillar mining was commenced in the Fassifern Seam in 2006 and secondary extraction in the form of miniwall mining method in the Fassifern Seam commenced in 2011.

The S3 miniwall panel is being mined at 97m wide (rib to rib) with a 40m wide inter-panel pillar, whilst the proposed miniwall panels S4 and S5 will have the same width.

These panel widths are significantly less than previously proposed for Chain Valley and adjacent mines – for example, at Wyee Colliery Longwalls 17 to 21 were up to 150m wide, and were extracted between 150m and 180m below surface.

Historically, Chain Valley Colliery has mined within the Wallarah and Great Northern seams to the east with via bord and pillar methods, while to the south west and west Wyee State Mine (now named Mannering Colliery) has mined the Great Northern and Fassifern seams using bord and pillar and longwall extraction.

Mining within the Wallarah and Great Northern Seams will not be undertaken as part of the Project.

The maximum water depth within the proposed mining areas is greater than 5m, whilst sediment on the bottom of the lake is less than 5m thick over Miniwall S5.

Above the Fassifern Seam over Miniwall S5, overburden (including the lake sediments), ranges from 144 - 161m with a rock cover thickness of 139 – 157m (Strata^2, 2020).

The maximum height of connective fracturing is predicted to be between 79 to 82m for Miniwall S5 according to the Ditton and Merrick (2014) approach, however, where the spanning influence of the 26 – 30m thick Teralba conglomerate is factored in, the potential height ranges from 45 to 50m above the workings (Strata^2, 2020).

3.1 Adjacent Workings

Chain Valley Colliery is entirely surrounded by the existing Mannering, Myuna and Wallarah Collieries as well as by the historic Newvale and Moonee Collieries.

Mannering Colliery (formerly the Wyee State Mine), has conducted longwall mining in the Great Northern and Fassifern seams since the 1960s. Extraction continued until 2002, when mining became uneconomic. The mine was temporarily shut down until 2004 when it was reopened by Centennial Coal. Since 2004, mining progressed in the Fassifern Seam using bord and pillar methods.

The Myuna Colliery commenced operation in 1981 and is currently mining the Fassifern Seam via bord and pillar techniques.

Wallarah Colliery operated from 1979 until 2002, when it was placed under care and maintenance.

Munmorah, Mandalong and Cooranbong Collieries are also nearby, but are not immediately adjacent to the Chain Valley Colliery holding boundary.

3.2 Predicted Subsidence

The maximum subsidence after completion of mining will be located under Lake Macquarie, with the 20mm subsidence line to be contained within the lake high water mark (Strata^2, 2020).

The maximum predicted subsidence, tilts and strains over the proposed workings (assuming a 170m depth of cover) are summarised in **Table 1**.

TABLE 1 Maximum Predicted Subsidence

Parameter	After Extraction of Miniwall S5
Vertical subsidence	350 mm
Tilt	5 mm/m
Strain (Compressive and Tensile)	2 mm/m

To date, the maximum subsidence has been observed as summarised in **Table 2**.

TABLE 2 Maximum Observed Subsidence

Location	Maximum Subsidence (m)
MW1	0.20
MW2	0.40
MW3	0.70
MW4	0.22
MW5	0.46
MW6	0.80
MW7	0.90
MW8	1.00
MW9	1.20
MW10	0.90
MW11	0.60
MW12	0.30
CVB1	0.45
MW S1	<0.1
MW N1	<0.1
MW S2	<0.1
MW S3	<0.15

It is predicted there will be no observable subsidence at the lake foreshore, lake high water mark, or the sea grass beds (Strata[2], 2020).

3.3 Rainfall and Evaporation

Analysis of climate data from the Bureau of Meteorology (BoM) weather station at Peats Ridge indicates the following rainfall data as shown in **Table 3**.

TABLE 3 Rainfall and Evaporation Summary Data

	Rainfall (mm/year)	Evaporation (mm/year)
Maximum	2186	1420
90th Percentile	1685	1247
75th Percentile	1418	1210
Median	1226	1170
20th Percentile	902	1090
Minimum	567	410

4. LOCAL GROUNDWATER SYSTEM

For management purposes, groundwater within the GwMP area has been divided into the following classes:

- **(Mine water**) groundwater and town water that is pumped into or out of the underground workings;
- (**Groundwater**) water contained within strata overlying the mine workings; and
- (**Seeps and springs**) groundwater that discharges to surface water catchments within the project area.

Groundwater flows from the “terrestrial” recharge areas, outside of Lake Macquarie, as well as from the saline waters of Lake Macquarie into the overburden under a regional hydraulic gradient, with dominantly horizontal confined flow along discrete discontinuities and fractures within bedding planes, and / or above fine grained, relatively impermeable strata within the overburden sequence.

The overburden generally contains low yielding aquifers with low hydraulic conductivities. A schematic of the stratigraphic sequence is shown in **Figure 2.**

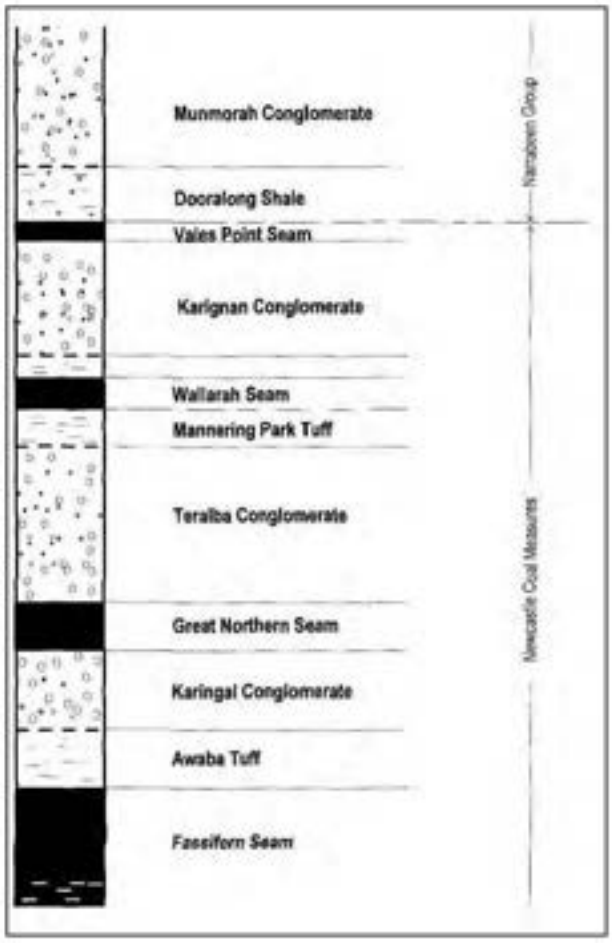


Figure 2 Local Area Stratigraphy

4.1 Alluvial Aquifers

Quaternary to recent alluvial terrestrial sediments comprising sand, gravel, clay and silt are associated with creeks and drainage channels in the local area, to the east, west and south on the shores of Lake Macquarie.

Alluvium in the vicinity of the project area is likely to be present associated with the drainage lines which discharge to Lake Macquarie.

No data is available for the thickness or lithology of alluvium within the project area. However, it is anticipated, if present, to be thin, with limited aerial extent, and no significant water storage or transmitting capacity.

Alluvial sediments within the "terrestrial" areas, outside of the project area, are generally too shallow and limited in extent to be used for groundwater supply.

4.2 Lake Macquarie Sediments

Sediments in the vicinity of MWS2 – S5 within Lake Macquarie consist of unconsolidated sands, clays, silts and gravels from 5 - 23m thick.

4.3 Shallow Bedrock

The shallow bedrock comprises weathered bedrock which potentially contains discontinuous perched aquifers. These have developed at the interface between the soil and bedrock and along zones of locally increased permeabilities caused by weathering of bedrock and faulting.

The depth and permeability of any aquifers is likely to be dependent on the depth of weathering and the extent and frequency of any permeable fracture systems.

Recharge to the shallow bedrock aquifer is primarily through rainfall infiltration, with some infiltration into the underlying basement through fractures, joints and faults.

4.4 Deep Bedrock

The Newcastle Coal Measures are overlain by the Munmorah Conglomerate and the Dooralong Shale of the Triassic Narrabeen Group which comprise the majority of the overburden.

The Munmorah Conglomerate extends to a depth of approximately 120m in the vicinity of the project area and comprises mostly quartz-lithic sandstone interbedded with pebble conglomerate.

The Dooralong Shale is up 20m thick and comprises cross-bedded sandstone intercalated with siltstone and claystone (Forster and Enever, 1992).

Fractured bedrock aquifers would be present within the Narrabeen Group and the Newcastle Coal Measures with discrete water yielding horizons associated with zones of increased permeability i.e. faults and the coal seams.

The overburden and interburden is a low yielding sequence of essentially dry conglomerates and shales.

Joints and fractures associated with fractured bedrock systems tend to be laterally and vertically discontinuous, resulting in poor hydraulic connection and low groundwater yields.

Forster and Enever (1992) state that "*neither the Narrabeen Group nor the Newcastle Coal Measures contain any significant quantities of groundwater and their permeabilities are known to be generally low (<10-7 m/s).*

Any permeable zones which do occur are usually due to jointing, faulting and shearing on bedding planes.

Because of the extremely low permeability of the rock substance, groundwater flow through the overburden strata is almost exclusively by interconnecting defects such as joints and bedding.

For this reason, coal seams with their interconnecting cleat and joint patterns are often found to be 'aquifers' relative to the surrounding strata. Despite this, most underground coal mines on the Central Coast are quite dry, and rarely have any major groundwater problems."

Groundwater in the deep bedrock aquifer is of poor quality with salinity levels ranging from 3000 to 16,000 µS/cm.

Recharge to the deep bedrock aquifer is generally from infiltration of rainfall from overlying aquifers and the flow direction is expected to reflect the local topography.

4.5 Coal Seams

The coal deposits historically or currently mined in the area include the Wallarah, Great Northern and Fassifern seams of the Newcastle Coal Measures which are generally interbedded with tuffaceous claystone.

The coal seams generally have a low primary or inter-granular porosity and permeability, with bedding planes, joints, fractures and cleating imparting an enhanced secondary permeability.

The 4.5 – 5.5m thick Fassifern Seam underlies the Wallarah and Great Northern seams within the project area, and lies between 139 - 157m below surface, with a proposed mining height of up to 3.5m.

4.6 Structure and Intrusions

The overburden dips at approximately two degrees to the south-west.

Superimposed on the regional dip is the Macquarie Syncline, with an axis that runs through the Chain Valley Colliery holding, along with associated faulting and igneous intrusions.

Mapped and inferred geological structures in the project area indicate that MW S5 is expected to extract through the following inferred geological structures:

- at the inbye end, an igneous dyke up to 2m thick, and;
- in the outbye half of the panel, a normal fault with a throw of <1m.

There is also an inferred 3m fault at the outbye end of TG S5, but this is not projected to traverse the MW S5 extraction area.

The fault plane will almost certainly extend upwards through the Fractured and Constrained Zones. However, given that:

- voussoir beam analysis suggests that such a feature would not appreciably impact on the spanning ability of the Teralba Conglomerate; and
- the favourable experiences from previous extraction panels with much greater exposure to major structures,

this fault is considered to be of no material consequence.

Figure 3 shows the major structural features, based on in-seam drilling, mapping in adjacent areas / seams and exploration drilling results. The MW S2 to S4 panels are orientated at 119°, rather than the 134° of earlier CVC panels which is more favourable with respect to the dominant 131° structural direction.

Overall, the structural environment is considered to have no significant adverse implications for S5 panel subsidence and sub-surface fracturing.

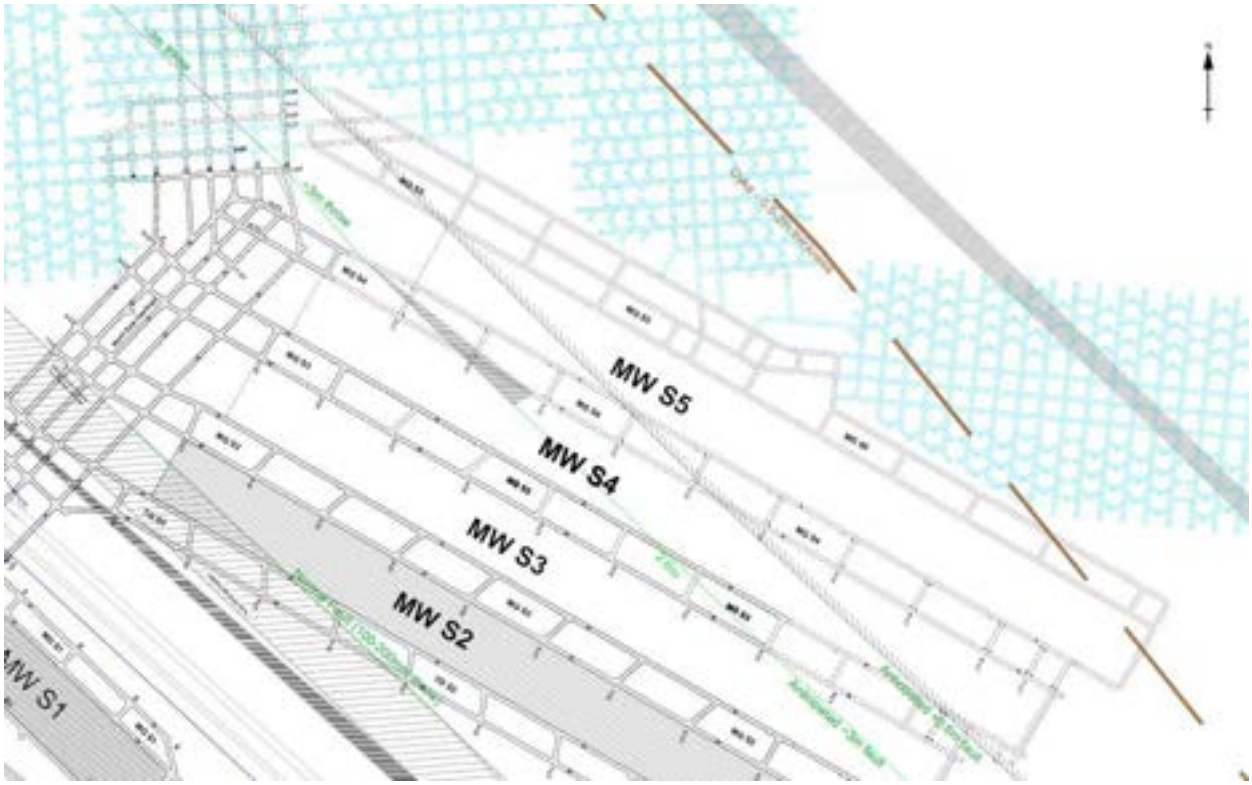


Figure 3 Faulting in the Vicinity of MW S5

4.7 Private Bores Within or Adjacent to the Proposed Mining Area

Twenty three DPIE registered bores are (or were) located within or near the GwMP area as shown in **Figure 1** and **Table 4**.

From the available data, the majority of bores are completed in shallow (<18.3) meters below ground level (mbgl) sandy alluvium with one coal exploration bore converted for use as a domestic water supply (GW31646).

Many shallow (<7 mbgl) deep test bores are present in the area, along with some shallow (<7.2 mbgl) monitoring bores.

Most of the deeper remnant private bores in the GwMP area are potentially used for domestic garden or limited irrigation water supply.

Where the data is available from the DPIE records, groundwater has been obtained from the shallow sandy alluvial / colluvial aquifers with low to moderate yields ranging from 0.13 L/sec to 1.50 L/sec.

TABLE 4 Registered Local Private Bores

GW	E	N	Drilled	Depth (m)	SWL (m)	Aquifer (mbgl)	YIELD (L/s)	Purpose	Bore Currency
11915	363007	6329604	-	5.4	-	-	-	Poultry	no response
24575	365969	6332788	1965	15.2	-	-	-	Domestic	no response
31646	366742	6329317	1960	277.5	3.0	3.0 – 10.6	0.13	Dom. / Coal Explore	not present
34560	364130	6330883	1970	18.3	5.5	5.5	-	Domestic	not present
34600	367678	6332873	1971	61.0	5.7	18.2	0.06	Waste disposal	-
80489	366441	6329674	2003	-	-	-	-	Domestic	no internal access
80830	363757	6330850	2004	-	-	-	-	Test bore	capped / covered
201149	367104	6329608	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201150	366840	6329640	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201977	363730	6331388	2008	7.1	6.0	6.0 – 7.0	-	Monitoring	-
201978	363712	6331391	2008	7.1	6.0	6.0 – 7.0	-	Monitoring	-
201979	363704	6331405	2008	7.2	6.0	6.0 – 7.0	-	Monitoring	-
202027	363829	6334141	2007	3.7	-	-	-	Test bore	not present
202028	363872	6334034	2007	5.5	1.6	-	-	Test bore	not present
202098	363829	6334141	2007	4.0	0.8	-	-	Test bore	not present
202246	363834	6334174	2007	3.5	1.2	0.6 – 3.5	-	Test bore	not present
202247	363899	6333964	2007	5.0	3.6	2.0 – 5.1	-	Test bore	not present
202248	363918	6333881	2007	5.0	-	2.0 – 5.0	-	Test bore	not present
202372	363834	6334174	2007	4.0	-	-	-	Test bore	not present
202833	363568	6330876	2013	6.5	2.50	2.5 – 3.5	-	Monitoring bore	-
202834	363563	6330861	2013	6.5	2.50	2.5 – 3.5	-	Monitoring bore	-
202839	363574	6330883	2013	7.2	2.5	2.5 - 3.5	-	Monitoring bore	-
202840	363573	6330859	2013	5	2.0	2.0 – 3.0	-	Monitoring bore	-

Note: - no data available SWL = standing water level

4.8 Regional Groundwater Use

Registered bores in the vicinity of the GwMP area are generally installed into the Munmorah Conglomerate to a maximum depth of 61m, with the majority of bores installed to less than 30m.

Groundwater yields are generally less than 1 L/s, with one bore reporting a yield of 5 L/s.

The authorised uses of the bores include:

- stock watering;
- poultry;
- industrial;
- domestic; and
- waste disposal.

While it is recognised that not all existing bores are likely to be registered, the database gives an indication of groundwater usage in the area.

Overall, it is concluded that the importance and reliance on groundwater by local landowners and residents is limited.

5. GROUNDWATER IMPACTS FROM PREVIOUS MINING

The Chain Valley Mine is surrounded by other collieries which have been extracting coal from as early as the 1940s using both longwall and bord and pillar methods.

Historical and current mining operations have resulted in extensive dewatering and depressurisation within and overlying the extracted coal seams.

Water is pumped out of the mines which results in a lowering of the potentiometric surface within the overlying aquifers.

Due to the extent of mining in the region, the subsidence effects would have partly depressurised the overburden.

5.1 Wyee State Mine

An extensive study by Forster and Enever (1992) at the adjacent Wyee State Mine (now called Mannering Colliery) assessed the impact of 150 m wide longwall mining on the hydrogeological properties of the overburden.

The study assessed that longwall mining of the Great Northern Seam resulted in measurable changes in the hydrogeological properties over a large proportion of the overburden as a result of the redistribution of stresses. The changes reported for the overburden were:

- **Upper Strata** (more than 115 m above the Great Northern Seam) –the hydrogeological properties of the strata after mining were generally similar to those measured prior to mining. Some strata reported a temporary drop in piezometric pressure which recovered soon after the completion of mining in that area.
- **Intermediate Strata** (65 to 115 m above the Great Northern Seam) – experienced significant permanent piezometric pressure increases after mining. The cause of the increase in pressure was uncertain, however it was concluded that *"since the intermediate strata have not lost piezometric pressure, it is certain that significant vertical drainage has not occurred from these strata and they have formed an effective barrier against vertical hydraulic connection between the surface and the mine."*
- **Lower Strata** (less than 65 m above the Great Northern Seam) – showed significant increased permeability and permanent decreases in piezometric pressure which indicated that significant cracking has occurred and allowed partial drainage into the workings.

Although measured changes in the lower strata indicate hydraulic connection was generated and groundwater seepage to the workings had occurred, the changes in the intermediate and upper strata was not significant, and were due to minor strata movements and the formation of fractures that were vertically discontinuous.

It was assessed that the intermediate and upper strata would form a barrier to vertical drainage and that aquifers from 65 – 115 m above the workings should not be hydraulically vertically connected to the workings, and should not be drained as a result of subsidence.

Aquifers greater than 115 m above the mine workings should not be impacted at all.

It should be noted that the subsidence studied over the Wyee State Mine related to 150 m wide longwalls, whilst the maximum width of the proposed Chain Valley miniwalls is 97 m, with 30.6 m wide pillars. As a result, the predicted subsidence and the height of fracturing over the proposed workings will be significantly less than was observed over the Wyee State Mine longwalls.

5.2 Private Bores

No adverse changes to bore yields, pumping flow duration or groundwater quality have been observed or reported in private bores within the GwMP area.

5.3 Potable Mine Water Supply

The mine has a potable water supply connection from the Wyong Council town-water system.

Historically, a range of 132 – 162 ML/year of potable water is supplied to Chain Valley Colliery, of which approximately 15% is used for pit top operations and 85% is used for dust suppression in the underground.

As required by Schedule 3, Condition 18(b) of SSD-5465, practical measures to minimise potable water consumption and maximise recycled water use have been implemented and continue to be investigated by Delta Coal, as discussed in the associated WMP. However, the use of non-potable water in all operational activities is not possible due to its quality, work health and safety and equipment requirements.

5.4 Licensed Mine Water Discharges

The discharge of mine water from the sedimentation and pollution control ponds is licensed under the *Protection of the Environment Operations Act* 1997 by the Environment Protection Authority (EPA).

Under EPL No. 1770 there is a single licensed discharge point for Chain Valley Colliery (LDP1), which has a maximum discharge volume of 12,161 kL/day.

The Colliery obtained a 4,443 ML/year groundwater licence (20BL173107) on the 12th March 2013 under the *Water Act, 1912* to enable water to be pumped from the underground workings to the sedimentation and pollution control ponds at the pit top.

5.5 Mine Water Pumping and Mine Groundwater Inflow

Historic data indicates that 1,914 – 2,536.4 ML/year of mine water has been extracted via two pumps in the Great Northern Seam workings sump, with a reduction in extraction volumes being evident over the last 3 years as shown in **Figure 4**.

The net groundwater seepage into the workings is estimated from the difference between the annual potable water intake and the annual water volume extracted from the underground workings.

The latest annual groundwater make (2019) from the mine is estimated at 1,913 ML/yr, or 5.24 ML/day.

Temporary increases in groundwater inflows to the mine have been reported in the vicinity of faults and associated fractures. The increases in inflow are usually short lived as the structures associated with fractured bedrock systems tend to be laterally and vertically discontinuous, resulting in poor hydraulic connection and have low groundwater yields (GeoTerra, 2013).

In general, the Fassifern Seam has to date been the driest seam, whilst mining of the overlying Wallarah Seam has been conducted without major adverse impacts to the overlying aquifers or inflow of water from Lake Macquarie (GeoTerra, 2013).

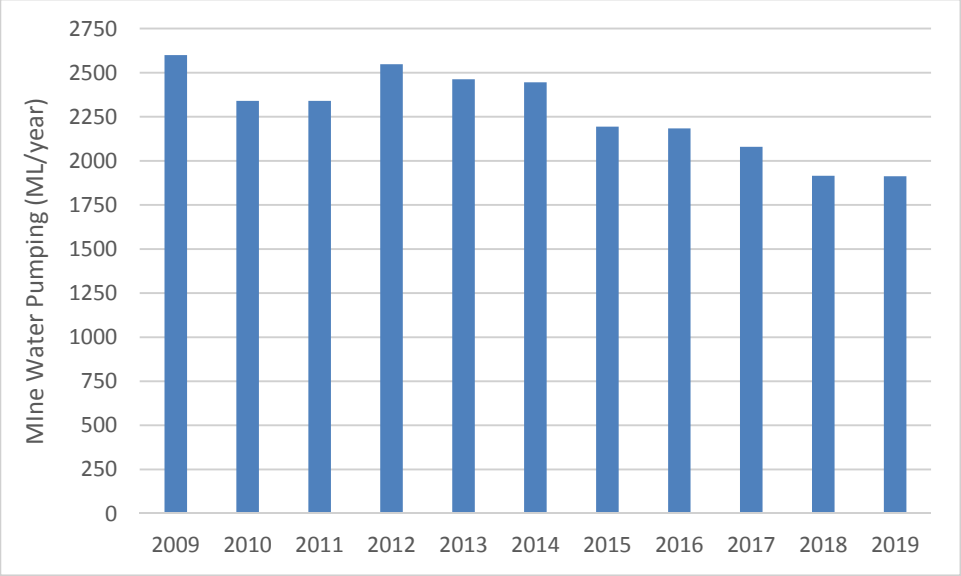


Figure 4 Annual Mine Dewatering Volumes

5.6 Mine Groundwater Quality

Groundwater monitored within the current and historic underground mining areas in the Chain Valley Colliery indicates the inflow water is brackish to relatively saline in subsided areas over the Great Northern Seam workings (11,800 – 28,200 mg/L) with a circum-neutral to mildly alkaline pH (7.30 – 7.76).

Groundwater seepage from a dyke at the northern end of the current Fassifern Seam workings, over the unsubsided main headings, had a brackish salinity of 2,390 mg/L and an alkaline pH of 8.63 as shown in **Tables 5** and **6**.

The data indicates that groundwater within the underground is significantly above the ANZECC (2000) water quality criteria (the default trigger values for physical & chemical stressors in SE Austtralian lowland rivers and 95% protection of freshwater species) for:

- pH (Fassifern dyke);
- electrolytical conductivity (all samples);
- total nitrogen (all samples);
- total phosphorous (Fassifern dyke); as well as,
- filterable copper (Great Northern Seam sump , Fassifern dyke); and
- filterable zinc (all samples except GNS2).

The exceedance in the mine water seepage depends on the guideline applied for the end use of the water.

The groundwater seepage is not generally suitable for potable, livestock or irrigation use, but is suitable for discharge under EPL 1770.

TABLE 5 Water Chemistry - Major Ions

	pH	EC (uS/cm)	TDS	Na	Ca	K	Mg	Cl	F	HCO3	SO4	Total P	Total N	DOC
ANZECC 2000	6.5 -8.0	2,200	-	-	-	-	-	-	-	-	-	0.05	0.5	-
Karignan Ck	6.93	185	100	29	2.2	2.3	3.5	54	0.10	10	6	**0.15**	**0.6**	17
Chain Valley Bay	7.64	47,300	36,100	10500	470	470	1100	19400	1.3	125	2200	**0.06**	0.4	<1
GNS SUMP	7.48	35,600	23,200	7640	590	125	690	13600	0.25	360	1200	0.04	**2.3**	2
GNS1 (roof)	7.30	40,400	28,200	7980	730	80	840	15600	0.47	435	1320	<0.01	**3.4**	<1
GNS2 (pond)	7.76	19,500	11,800	3950	140	38	230	6730	0.57	385	250	0.02	**0.6**	3
Fassifern dyke	**8.63**	3,500	2,390	925	1.9	9.1	2.1	310	5.6	2040	7	**0.65**	**4.1**	3

NOTE: all values in mg/L
samples collected 22/6/2012

TABLE 6 Water Chemistry - Metals

	Fe(T)	Fe	Mn(T)	Mn	Cu	Pb	Zn	Ni	Al	As	Li	Ba	Sr
ANZECC 2000	-	-	1.9	1.9	0.0014	0.0034	0.008	0.011	0.055	0.013 / 0.024	-	-	-
Karignan Ck	1.3	0.82	0.03	0.03	**0.003**	<0.001	**0.014**	<0.01	0.05	<0.01	<0.001	0.026	0.10
Chain Valley Bay	0.10	0.02	0.02	0.01	**0.003**	<0.001	**0.013**	<0.01	0.03	<0.01	0.38	0.041	4.8
GNS SUMP	0.18	0.07	0.06	0.04	**0.004**	<0.001	**0.018**	<0.01	0.04	<0.01	0.98	0.084	31
GNS1 (roof)	0.12	0.07	0.27	0.16	<0.001	<0.001	**0.010**	<0.01	0.03	<0.01	1.3	0.080	44
GNS2 (pond)	0.05	<0.01	<0.01	<0.01	<0.001	<0.001	0.003	<0.01	0.01	<0.01	0.59	0.17	11
Fassifern dyke	2.4	0.08	0.06	0.02	**0.004**	<0.001	**0.019**	<0.01	0.04	<0.01	0.28	0.37	1.0

NOTE: all values in mg/L
metals reported as acidified and 45um filtered samples except where Total (T) values are shown
samples collected 22/6/2012

Analysis of selected areas within the workings and in Lake Macquarie on 14th February 2020 was conducted as summarised in **Table 7** and shown as a Piper Diagram in **Figure ?.**

TABLE 7 Mine Water Chemistry

	pH	EC (uS/cm)	TDS	Na	Ca	K	Mg	Cl	F	HCO3	CO3	SO4	TP
ANZECC 2000	**6.5 - 8.0**	**2,200**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.05**
TGS2 (Goaf Fassi)	8.54	13900	6710	3220	28	11	20	4320	n/a	899	82	**40**	**0.17**
S2 Face (Fassi)	8.46	14600	7810	3240	41	10	15	4410	n/a	917	80	**47**	**<0.05**
11KV Switch)Roof GN Conglomerate)	7.73	33000	19600	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.05
Lake Macquarie	8.14	52100	34900	10800	414	389	1300	16000	n/a	106	<1	2680	<0.05

NOTE: all values in mg/L except as shown samples collected on 14/2/2020

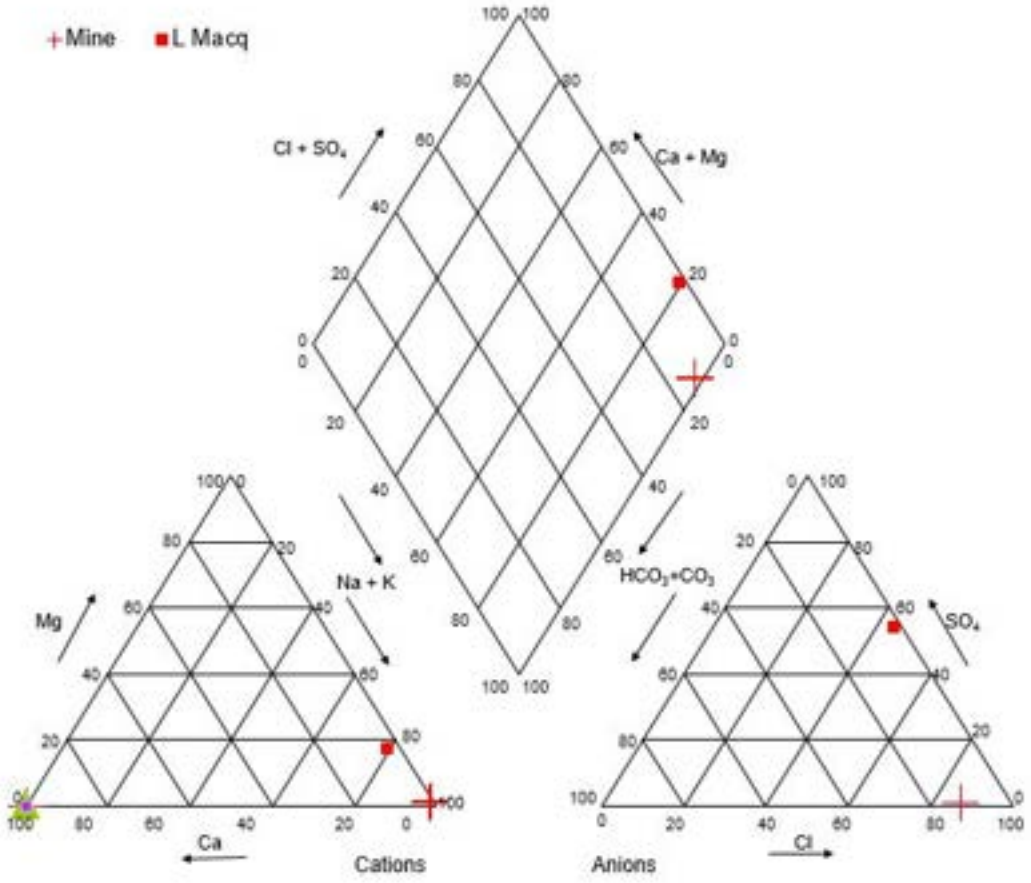


Figure 5 Mine Water Chemistry

6. POTENTIAL GROUNDWATER IMPACTS

It is anticipated that subsidence over the 144 - 161 m deep proposed S5 miniwall workings may affect the overlying groundwater system through:

- surface cracking to approximately 20m below surface;
- height of connective fracturing to less than 50 m above the seam (Strata^2, 2020), with partial loss of groundwater if fracturing extends into an overlying aquifer, which can cause minor groundwater inflow from the goaf to the workings;
- an exponential decrease in overburden permeability with height above the workings;
- connectivity between the mine workings and overlying aquifers within the fractured goaf, which can result in depressurisation of the aquifers;
- dewatering and depressurisation of the Great Northern and Fassifern seams as mining progresses;
- increased aquifer permeability, and, potentially;
- reduced groundwater quality in the overlying aquifers.

6.1 Hydraulic Connection to Lake Macquarie

The Forster and Enever (1992) study at Wyee State Mine, with 150 m wide longwalls, indicated there was no hydraulic connection at heights over 115 m above the extracted workings.

It should be noted that the proposed miniwall has a maximum width of 97 m, which means the height of fracturing would be less than that observed over the 150 m wide Wyee State Mine longwalls.

As a result, hydraulic connection between Chain Valley Colliery and Lake Macquarie over the proposed secondary extraction workings associated with Miniwall S5 is not anticipated as the minimum depth of cover is at least 144 m (including lake bed sediments), or from 139 m of basement (excluding the sediments in Lake Macquarie).

6.2 Aquifer / Aquitard Interconnection

Mining induced cracking and vertical subsidence of strata over the extraction area may potentially extend up to 20 m below surface, with bedding dilation from below the surface zone down to the upper goaf.

In the upper horizons, subsidence can alter the dominance of the pre-mining horizontal flow along or above aquitards to generate a combination of vertical and horizontal flow regimes as aquitards are breached and water drains to lower elevations in the strata.

Vertical flow continues down the strata until the drainage is restricted by intact aquitards, at which the depth the flow then resumes its horizontal dominance.

Below the surface cracked zone, an increase in horizontal flow component can occur due to dilation and bending of strata, even though the layers are not actually breached by vertical cracking. The increased horizontal permeability extends across the subsided area, gradually diminishing as the subsidence and dilation decreases out to the edge of the subsidence zone.

No adverse interconnection of aquifers and aquitards is anticipated within 20 m of the lake bed as there are no recorded aquifers in this interval.

However, there may be an increased rate of recharge into the upper overburden from the lake waters due to the increased secondary porosity and permeability of the subsided, fractured overburden.

6.3 Regional Groundwater Depressurisation

Extensive mining of the Fassifern, Wallarah and Great Northern seams at Chain Valley and surrounding collieries for more than 60 years has significantly depressurised the overburden within the vicinity of the proposed workings.

Groundwater levels within the Fassifern Seam has already been extensively impacted by mining in the area and therefore continued mining is likely to have little additional impact, if any.

The deeper basement lithologies have increased permeability in areas of partial or full extraction due to subsidence induced caving and fracturing over the workings which results in an increased groundwater storage capacity of the overburden through increased secondary porosity.

Groundwater flow rates within the deeper aquifers are likely to increase within the caved and fractured areas due to greater hydraulic connectivity between horizontal and vertical fractures.

A temporary lowering of the regional piezometric surface over the subsidence area of up to 1.0 m due to horizontal dilation of strata may occur due to the increase in secondary porosity and permeability (GeoTerra, 2013). This effect will be more notable directly over the area of greatest subsidence and dilation, and will dissipate laterally out to the edge of the subsidence zone.

Based on similar observations in NSW with similar mining layouts, surficial and mid depth strata groundwater levels may reduce by up to 15m, and may stay at that reduced level until maximum subsidence develops at a specific location. The duration of the reduction depends on the time required to develop maximum subsidence, the time for subsidence effects to migrate away from a location as mining advances to subsequent panels, and the length of time required to recharge the secondary voids.

The degree of groundwater level decline under the lake due to subsidence is predominantly determined by the proximity to a mined panel, however it can also be significantly affected by the rate of lake water infiltration and terrestrial rainfall recharge to an aquifer, as well as changes in the rate or duration of groundwater extraction in any adjacent groundwater bores.

On the basis that the pre-mining circumstances of lake water and rainfall recharge as well as any local bore pumping remain the same, it is anticipated that groundwater levels will recover over a few months as the secondary void space is recharged by lake water and rainfall infiltration.

There is generally no permanent post mining reduction in groundwater levels under the lake, as no new hydraulically connected outflow paths from within the overburden develop.

6.4 Private Bore Yields and Serviceability

Although registered bore sites are located within the predicted 1.0 m groundwater depressurisation area, no private bore yields or serviceability have historically been reported to be, or are predicted to be affected by subsidence or regional groundwater depressurisation associated with the proposed workings, which are entirely located under Lake Macquarie.

No beneficial users of the deep bedrock/coal measures aquifers have been identified in the vicinity of the GwMP Area.

6.5 Groundwater Dependent Ecosystems

Cumulative impacts from the proposed mining are not anticipated to adversely impact on groundwater dependant ecosystems in the 20 mm subsidence area.

This is primarily because no groundwater dependent ecosystems have been identified in the proposed subsidence area within or under Lake Macquarie.

6.6 Groundwater Quality

Previous observations in NSW Coalfields indicates that groundwater quality within the subsided overburden is not generally adversely affected, however there may be increased iron hydroxide precipitation and a lowering of pH if the groundwater is exposed to “fresh” surfaces in the strata with dissolution of unweathered iron sulfide (marcasite) or iron carbonate (siderite).

The degree of iron hydroxide and pH change due to subsidence is difficult to predict, and can range from no observable effect to a distinct discolouration of water pumped out of bores.

The discolouration does not pose a health hazard, however it can cause clogging of pumping equipment and piping in extreme cases.

It should be noted that many bores in the local area can already have significant iron hydroxide levels, and a pre-mining survey of the active bores is required to assess the baseline water quality prior to undermining.

Acidity (pH) changes of up to 1 order of magnitude can occur, however the change can be reduced if the bore has sufficient bicarbonate levels.

The potential for groundwater contamination also exists from spills of fuels, oils and chemicals from both the surface and underground mine workings. Spills may result in the contamination of soil, while the infiltration of rainfall or direct migration of contaminants to the water table has the potential to contaminate shallow aquifers.

The potential for impacts can be minimised through the appropriate storage of fuels and hazardous chemicals, the implementation of appropriate work procedures and regular inspections and maintenance of equipment and plant.

Leaks and spills should be handled in accordance with the PIRMP prepared for the site, and remediated as required on a case by case basis.

Infiltration of potentially contaminated water from the sedimentation dams also has the potential to impact groundwater quality. As the dams receive all site runoff, amenities water and mine water, as well as workshop and wash down water after treatment by an oil separator, there is potential for the water within the dams to be contaminated by dissolved petroleum hydrocarbons and heavy metals. It is understood the dams are not lined with a low permeability layer, and as such, seepage of potentially contaminated water within the dams may be infiltrating alluvial or shallow aquifers.

6.7 Groundwater Seepage to or From Terrestrial Streams

No known springs or streams are present in the GwMP area that would be affected by subsidence and associated regional groundwater depressurisation with the existing and proposed workings.

Overall, the terrestrial streams within the GwMP area will be subjected to no or very low tensile and compressive strains and are not anticipated to be adversely affected by subsidence related stream bed cracking.

No loss of overall stream flow or regional change in stream water quality within the local streams is anticipated to occur.

6.8 Groundwater Inflow to Mine Workings

Loss of lake water or any significant loss of connate groundwater within the overburden to the underlying workings has not been observed in mines in the local area at similar depths of cover to the proposed workings.

Vertical hydraulic connection to the workings is anticipated to be restricted by the Dooralong Shale and the Mannering Park Tuff aquitards, which are not anticipated to be breached by subsidence over the proposed Fassifern Seam workings and are both below the surficial and above the goaf, vertically connected, dilation zones.

The horizontal permeability above and between the aquitards may be enhanced after subsidence, however there is no additional vertical connectivity through or below them to the underlying workings.

Based on available records, the 2019 annual groundwater seepage into the workings was 1,913 ML/yr, or 5.24 ML/day.

No obvious relationship between expansion of the mine and increased groundwater inflow to the workings is evident in the current data, with a reduction in mine water pumping evident over the last three years.

Based on a groundwater modelling assessment (GeoTerra, 2013) the inflow may increase up to 10.5 ML/day as the Colliery expands.

7. GROUNDWATER MONITORING PLAN

The groundwater monitoring program at available (or currently present) locations shown in **Figure 1** is designed to provide a database that enables:

- comparison of anticipated vs observed impacts on the groundwater system through miniwall as well as bord and pillar extraction of the Fassifern Seam at Chain Valley Colliery and any associated subsidence effects; and
- procedures to assess, manage or rehabilitate any adverse effects that exceed specified trigger levels.

As the proposed workings, and the anticipated associated subsidence impacts, are wholly located underneath or within Lake Macquarie, the monitoring plan specifically deals with the following issues.

7.1 Mine Groundwater Inflow

The active underground mining area should be monitored by the underground supervisors to assess whether observable groundwater inflow is occurring to the active panels and if any changes are noted.

Water flow monitoring appliances have been installed to measure pumped water volumes to and from the mine workings. These appliances will be maintained in good working order, and if required, DC will supply a test certificate to certify the current accuracy of the appliances furnished by the manufacturer or by some duly qualified person or organisation.

Daily total mine water pumping records will be maintained, plotted and interpreted annually and will be supplied to DPIE within the Annual Environmental Management Report (AEMR).

7.2 Private Bore Water Levels

Where property access is granted and access inside a producing groundwater bore is possible, water levels within the private bores could be measured at least once before and once after mining is conducted in the GwMP area to assess if any adverse effects due to subsidence have occurred as shown in **Table 8**.

It is suggested that all other shallow monitoring or test bores, or waste disposal bores are not to be included in the monitoring suite.

Where monitoring of groundwater levels is not possible due to installed pump head-works, the mine will assess any reports from landowners in regard to adverse effects on bore water availability that may occur during or after extraction of the proposed workings.

Each property owner may be interviewed before and after the proposed mining to assess the bore's status, pumping rate, and its general duration of pumping as well as the type and set up of the pump.

Where feasible, the bore yield should also be measured, and water levels measured where access inside the bore is possible.

Where private bores are being occasionally or frequently pumped, and could thereby temporarily distort the static regional groundwater levels, the depth to groundwater, where accessible, should be monitored during pump resting periods to assess the regional piezometric surface across the area.

TABLE 8 Suggested Producing Groundwater Bore Water Level Monitoring

GW	Monitoring Frequency	Monitoring Method	Units
11915	Upon access / post mining	Dip meter	mbgl
24575	Upon access / post mining	Dip meter	mbgl
80489	Upon access / post mining	Dip meter	mbgl

Note: mbgl = metres below ground level

7.3 Groundwater Quality

7.3.1 Inactive Private Bores

Where property access is granted and access inside a bore is possible, a pre-mining water sample collection and analysis will be conducted within one month of access being granted and available, and will be repeated at the end of mining in the project area to enable assessment of any subsidence related changes in groundwater quality.

Each bore will be purged prior to sampling until pH and salinity measurements stabilise, which usually involves removal of at least three bore volumes of water.

Samples will be collected, appropriately preserved, kept on ice and transported under chain of custody documentation to arrive at the laboratory within appropriate holding times.

In addition, each piezometer or inactive bore will be monitored in the field for bi-monthly salinity (µS/cm) and pH measurements.

7.3.2 Active Private Bores

Where property access is granted and access to the groundwater bore is possible, an initial water sample collection and analysis will be conducted within one month of access being granted and available, and will be repeated at the end of mining in the project area to enable assessment of any subsidence related changes in groundwater quality.

To date, access to one current bore has been granted (GW80489), however no sample could be obtained as the installed pump was not working.

The use, and any treatment, of the bore water should be ascertained and observations made on the quantum of iron hydroxide precipitating from the pumped water before and after mining.

Each bore will be purged prior to sampling until pH and salinity measurements stabilise, which usually involves removal of at least three bore volumes of water.

Samples will be collected from bores that are current and accessible as shown in **Table 9**, and will be appropriately preserved, kept on ice and transported under chain of custody documentation to arrive at the laboratory within appropriate holding times.

TABLE 9 Suggested Producing groundwater Bore Water Quality Monitoring

GW	Monitoring Frequency	Monitoring Method	Units
11915	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)
24575	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)
80489	Upon access / post mining	In situ pump / bailer	pH EC mg/L (ions, metals, nutrients)

During extraction within the GwMP area, the frequency of monitoring and the parameters to be monitored may be varied in consultation with DPIE once the baseline groundwater quality and its response to mining (if any) is established.

The frequency of post mining monitoring will be reassessed after mining is complete in the GwMP area as it may be possible, depending on results, to lengthen the intervals.

Table 10 presents the physical groundwater quality parameters to be measured.

TABLE 10 Groundwater Quality Monitoring Parameters

SUITE	ANALYTES
Initial monitoring / after mining is completed	Field EC, Eh, pH, temp TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, Cr, Li, Ba, Cs, Rb, Sr (filtered)

7.4 Groundwater Contamination

In accordance with the sites' EPL and WMP, surface water discharged from the dams is monitored monthly for a range of pollutants.

The range of analysis for surface water also includes oil and grease, which allows the assessment of impact, if any, that these dams may be having on underlying aquifers.

8. GROUNDWATER ASSESSMENT CRITERIA AND TRIGGERS

Management of impacts within predictions follow standard assessment review and response protocols.

Contingent measures are included in this plan to ensure the timely and adequate management of the proposed extraction and subsidence impacts outside of anticipated levels.

Where and if required, specialist hydrogeological / hydrological investigations and reports may include:

- the study scope and objectives;
- consideration of any relevant aspect from this plan;
- analysis of trends;
- assessment of any impacts against prediction;
- assessment of the cause of a change or impact;
- options for management and mitigation;
- assessment for the need for contingency measures;
- any recommended changes to this plan; and
- appropriate consultation with DPIE, DRE and EPA.

Site specific mitigation / remediation action plans may include:

- a description of the impact to be managed;
- results of the specialist investigations;
- aims and objections for the plan;
- specific actions required to mitigate/manage;
- timeframes for implementation;
- roles and responsibilities;
- identification of and gaining appropriate approvals from landholders and government agencies; and
- a consultation and communication plan.

Trigger values for further assessment of potential subsidence effects on groundwater systems within the plan area are discussed in the following sections.

The triggers have been developed to reflect the current variability in relevant parameters and to enable the identification of any changes that may be due to either subsidence effects, landowner impacts and/or natural causes.

If trigger values are exceeded, the cause and effect will be investigated and a management plan developed if it is directly related to mining.

The Environment and Community Coordinator shall be responsible for the implementation of agreed actions and shall communicate such actions to the relevant landowners or authorities.

8.1 Mine Water Extraction and Discharge

Chain Valley Colliery holds a DPIE license (WAL41508) to extract up to 4,443 ML/year from the workings, and currently holds EPL 1770 which permits volumetric discharge of up to 12,161 kL/day via its licensed discharge point.

Mine water extraction will be measured daily and daily discharge volumes will be reported on a monthly basis via the DC website.

As part of the AEMR the average monthly groundwater extraction rates will be determined by assessing the difference between the potable water pumped into the workings and the total water pumped out of the workings. This assumes no hydraulic conductivity with Lake Macquarie,

surface potable water leaks, water theft or measurement error.

A trigger for the groundwater extraction will be where the monthly average extracted underground mine water exceeds **10.5 ML/day** (75th percentile groundwater inflow – refer **Table 3**), and this average continues for at least 2 months.

8.2 Private Bore Groundwater Levels

It should be noted that landowners pumping their own bores, as well as the interference effect from other landholders pumped bores can significantly affect temporary standing water levels in a bore, without any influence from mining or subsidence.

On this basis, if the combined monitoring of the outlined private bores indicates a sustained drawdown of **greater than 2 m over a 2 month period** in a private bore, or, if a landowner reports a lack of groundwater availability in a bore that cannot be accessed internally, then the cause of the exceedance will be investigated to assess whether the >2 m drawdown or lack of supply is due to:

- lack of rainfall recharge, using comparison to the cumulative sum of daily rainfall;
- operation of landowner bores either within or outside an affected bores property;
- subsidence; or
- any or all of the above.

The 2 m drawdown trigger level has been derived through extrapolation of similar mining subsidence related effects in similar mining layouts and geomorphological areas in NSW and to be consistent with the minimal impact considerations of the NSW Aquifer Interference Policy.

8.3 Private Bore Groundwater Quality

If a landowner reports an increase in iron hydroxide precipitation or water salinity, as an initial default, the ANZECC 2000 irrigation and livestock guidelines shown in **Table 11** will be used as trigger levels to assess bore water quality.

As no bores are used for drinking water in the GwMP, drinking water quality criteria and triggers are not specified.

TABLE 11 Groundwater Chemistry Criteria (mg/L)

	pH	**TDS**	**Hardness as CaCO3**	Cu	Pb	Zn	Ni	Fe	Mn	As	Cd
Irrigation	*6 - 8.5*	-	*>60-350*	*5*	*5*	*5*	*2*	*10*	*10*	*2.0*	*0.05*
Livestock	-	*<4000/5000*	-	*1 / 0.4*	*0.1*	*20*	*1*	-	-	*0.5*	*0.01*

NOTE: all metals values are for filtered metals;

irrigation criteria for short term trigger values (< 20 years);

livestock criteria for beef / sheep.

9. POTENTIAL GROUNDWATER AMELIORATIVE ACTIONS

9.1 Private Bore Yield

Although it is not anticipated due to the separation distance from the bores to the proposed subsidence area, should the accessibility, available drawdown or yield of a bore be impacted due to subsidence, Chain Valley Colliery is required to provide an alternative water supply until the bore recovers.

If the level does not sufficiently recover and the effect is due to subsidence rather than regional climatic or anthropogenic factors, repairs or maintenance to a bore can be undertaken after maximum subsidence has developed. At this time the pump intake can be lowered, the bore extended to a greater depth or a new bore can be established.

With these mitigation measures in place it is unlikely that water supply to properties will be significantly impacted by the proposed mining.

In the event of a monitored or reported adverse impacts on the yield or saturated thickness of a private registered bore, the cause will be investigated.

If a groundwater level drop of over 2 m for a period of over 2 months is recorded, and the reduction in bore yield is a consequence of subsidence, the mine will enter into negotiations with the affected landowners and Subsidence Advisory NSW with the intent of formulating an agreement which provides for one, or a combination of:

- re-establishment of saturated thickness in the affected bore(s) through bore deepening;
- establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;
- provision of access to alternative sources of water; and/or
- compensation to reflect increased water extraction costs, e.g. due to lowering pumps or installation of additional or alternative pumping equipment.

9.2 Private Bore Groundwater Quality

In the event of an adverse change in groundwater quality to a private bore, particularly in regard to salinity and / or iron levels, the mine will implement an investigation to determine if the cause is due to subsidence.

Although it is not anticipated due to the separation distance from the bores to the proposed subsidence area, if subsidence cracking has caused a notable increase in iron hydroxide precipitates or the landowner reports an adverse change in salinity, and that change exceeds the trigger levels, the mine will enter into negotiations with the affected landowner with the intent of formulating an agreement which provides for one, or a combination of:

- re-establishment of the water supply from a new bore to provide water equivalent to the pre mining status of the bore (on the basis that the landholder has allowed for pre-mining status of the bore to be established);
- provide access to an alternative source of water, or;
- compensate the bore owner to reflect the economic costs incurred due to the subsidence effects on the water quality.

10. CONTINGENCIES

In the event that the proposed monitoring indicates that a trigger has been reached or is being approached, DC will commission a hydrogeologist or hydrologist to review the data, with the outcomes of that review, including any recommendations, being subject to consultation with DPIE.

A trigger of pH or electrical conductivity would initially lead to an increase in the analytes monitored and/or frequency of sampling to confirm the magnitude and extent of the change in groundwater chemistry and verify the change is a consequence of mining.

Should the standing water level trigger be achieved in any bore, the mine staff shall notify the affected landowner(s) and, if it is the hydrogeologist's opinion that the reduction is a consequence of mining, mitigation measures identified in previous sections will be initiated.

An independent authority may also be used where a dispute arises as to the cause of the change, given that groundwater supply and quality can be affected by non-mining related factors such as bore siltation, aquifer depletion by adjoining mining operations, agricultural users, bacterial infection, fertilizer contamination etc.

11. AUDIT AND REVIEW

This document shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Environmental Management Report (AEMR);
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the project approval.

Other factors that may require a review of the GwMP are:

- observation of greater impacts on surface features due to mine subsidence than was previously expected;
- observation of fewer impacts or no impacts on surface features due to mine subsidence than was previously expected; and/or
- observation of significant variation between observed and predicted subsidence.

Internal and external audits of this document will be carried out as described below. If possible, audits shall be objective and be conducted by a person or organisation independent of the document being audited.

Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

11.1 Internal Audits

Internal audits of this document and all other Environmental Management System documents are to be undertaken every three years. Improvements from the audit are to be incorporated in the site action database to ensure the actions are assigned to the relevant people and completed.

11.2 External Audits

External audits will be conducted utilising external specialists and will consider the document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished. External audits will be periodically at a frequency determined by the site General Manager, or in response to significant environmental incidents for which a systems failure has been determined as a contributor to the incident.

An Independent Environmental Audit (IEA) will be undertaken every three years, or as otherwise required by the Department of Planning, Industry and Environment (DPIE).) the audit will be conducted by an audit team whose appointment has been endorsed by the Secretary of DPIE.

Any actions arising from external audits will be loaded into the site actions database to ensure the actions are assigned to the relevant people and completed.

12. RECORDS

Generally, the site Environment and Community Coordinator will maintain all EMS records, which are not of a confidential nature. Records that are maintained include:

- monitoring data and equipment calibration;
- environmental inspections and auditing results;
- environmental incident reports;
- complaint register; and
- licenses and permits.

All records are stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records are maintained for a minimum of 4 years.

13. RESPONSIBILITIES AND ACCOUNTABILITIES

13.1 General Manager

- Ensure that the requisite personnel and equipment are provided to enable this plan to be implemented effectively

13.2 Environment and Community Coordinator

- authorise the Plan and any amendments thereto;
- ensure this plan is reviewed should any changes to the mine plan or if levels of subsidence are greater than predicted. Notify the relevant authorities of any triggers being exceeded;
- reporting in the AEMR;
- ensure that inspections are undertaken in accordance with the schedule;
- ensure that persons conducting the inspection are appropriately trained, understand their obligations and the specific requirements of this plan;
- review and assess monitoring results and inspection checklists;
- promptly notify the General Manager of any identified environmental issue.

13.3 Hydrogeologist / Hydrologist

- assist in compiling and/or reviewing the monitoring to the standard and frequency as outlined in this plan; and
- promptly notify the Environment and Community Coordinator of any identified environmental issue.

14. TRAINING

All personnel who conduct inspections will be trained in the requirements of the plan.

Training will be conducted on maintaining and downloading monitoring equipment, operation of the field testing equipment and sampling procedure for laboratory analysis identification of the various subsidence impacts detailed in this plan.

15. REPORTING

15.1 Annual Environmental Management Report

An Annual Environmental Management Report (AEMR) will be submitted to DPIE each year. As part of the AEMR the groundwater section will include;

- groundwater related activities, and the level of compliance with the GwMP;
- all groundwater monitoring volumes and rates taken by the works;
- the volume groundwater extracted from the works that was discharged via the Licensed Discharge Point;
- all groundwater extraction data;
- the extent of groundwater depressurisation and any groundwater salinity impacts compared with predictions in the Environment Assessment;
- interpretation of the data, discussion of trends and their implications;
- an overall comparison of groundwater performance with predictions for the life of the mine provided in the Environmental Assessment; and
- an outline of proposed adaptive or remediation actions if required.

Notification of the groundwater monitoring results and interpretations will be reported within the required annual period to outline the natural trends and any impacts from mining on the groundwater system.

16. REFERENCES

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Strata^2, 2018 Geotechnical Aspects of S2 and S3 Panel Design

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Strata^2, 2020 Lake Coal Chain Valley Colliery, S5 Panel: Geotechnical Environment, Subsidence Estimates and Impacts

DISCLAIMER

This report was prepared in accordance with the scope of services set out in the contract between GeoTerra Pty Ltd (GeoTerra) and the client, or where no contract has been finalised, the proposal agreed to by the client. To the best of our knowledge the report presented herein accurately reflects the client's intentions when it was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document.

The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site / sites in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site / sites at all points. Should information become available regarding conditions at the site, GeoTerra reserve the right to review the report in the context of the additional information.

In preparing this report, GeoTerra has relied upon certain verbal information and documentation provided by the client and / or third parties. GeoTerra did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. GeoTerra assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to GeoTerra.

Interpretations and recommendations provided in this report are opinions provided for our Client’s sole use in accordance with the specified brief. As such they do not necessarily address all aspects of water, soil or rock conditions on the subject site. The responsibility of GeoTerra is solely to its client and it is not intended that this report be relied upon by any third party, who should make their own enquiries.

The advice herein relates only to this project and all results, conclusions and recommendations made should be reviewed by a competent and experienced person with experience in environmental and / or hydrological investigations before being used for any other purpose. The client should rely on its own knowledge and experience of local conditions in applying the interpretations contained herein.

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Appendix 2: Consultation

Department of Planning, Housing & Infrastructure

Our ref: SSD-5465-PA-130

Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd
PO BOX 7115
Mannering Park NSW 2259

23/10/2024

Subject: Chain Valley Colliery Water Management Plan

Dear Mr McWha

I refer to the Water Management Plan submitted in accordance with condition 18, Schedule 3 of the consent for the Chain Valley Colliery (SSD-5465).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions of consent (SSD-5465).

Accordingly, as nominee of the Planning Secretary, I approve the Water Management Plan (version 7, dated 16 January 2024).

You are reminded that if there are any inconsistencies between the Plan and the conditions of approval, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Kristina Robinson on 02 9860 1543 or at Kristina.Robinson@dpie.nsw.gov.au.

Yours sincerely

James McDonough
Team Leader
Resource Assessments

As nominee of the Planning Secretary

DCCEEW Water Group

Department of Climate Change, Energy, the Environment and Water

NSW GOVERNMENT

Our ref: OUT24/1722

Lachlan McWha

Email: lmcwha@deltacoal.com.au

7 February 2024

Subject: Chain Valley Extension Project (SSD-5465) Water Management Plan Revision 7

Dear Lachlan McWha,

I refer to your request for advice sent on 16 January 2024 to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) Water Group about the above matter.

DCCEEW Water Group has reviewed the Water Management Plan and has recommendations regarding water take and licensing. Please see **Attachment A** for more detail.

Should you have any further queries in relation to this submission please do not hesitate to contact DCCEEW Water Assessments water.assessments@dpie.nsw.gov.au.

Yours sincerely,

Rob Brownbill
Manager, Assessments, Knowledge Division
Department of Climate Change, Energy, the Environment and Water

4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
Locked Bag 5022, Parramatta NSW 2124

www.dpie.nsw.gov.au

Attachment A

Detailed advice regarding the Chain Valley Extension Project (SSD-5465) Water Management Plan Revision 7

1.0 Water take and licensing

1.1 Recommendation – pre-approval

Include a summary of maximum predicted groundwater take currently and ongoing to demonstrate sufficient entitlement is held.

1.2 Explanation

Groundwater take for aquifer interference activities is measured as inflows into the works. Estimates of inflows into any works which will intercept groundwater during mining operation and post closure must be included and compared to entitlement held. The proponent provides a maximum pump limit of 10.5ML/day as a surrogate for estimating inflows but notes that groundwater continues to fill the sumps when the pumps are not operating. A full estimate of groundwater take may not be accounted for if inflows occur after the 10.5ML/day is removed, hence water take will potentially by higher than estimated by pumped volume.

End Attachment A

NSW GOVERNMENT Department of Industry

Contact: Jane Curran
Email: jane.curran@nrar.nsw.gov.au

Chris Armit
PO Box 7115
Mannering Park NSW 2259

Our ref: DOC21/78777, V15/3875-3#2

email: CArmit@deltacoal.com.au

Dear Chris,

15 April 2021

Re: Mannering Colliery (PA 06_0311), Chain Valley Colliery (SSD-5465) Water Management Plan

Thank you for giving the Department of Planning, Industry and Environment – Water (DPIE-Water) the opportunity to review Mannering Colliery (PA 06_0311), Chain Valley Colliery (SSD-5465) Water Management Plan.

The Department of Planning, Industry and Environment recommends the following.

Not required prior to approval

1. Timeframes should be included in the WMP for the actionable responses in the Trigger Action Response Plans (TARPs).

Should you have any further queries in relation to this submission please do not hesitate to contact the Natural Resources Access Regulator's Service Support Team at nrar.servicedesk@dpie.nsw.gov.au.

Yours sincerely

Alison Collaros
Licensing and Approvals Manager (East)
Natural Resources Access Regulator
Department of Planning, Industry and Environment

NSW EPA Consultation

Your ref: SSD-5465-PA-130
Our ref: DOC24/31398-3

Mr Lachlan McWha
Environmental Compliance & Approvals Coordinator
Chain Valley Colliery
Construction Road
CHAIN VALLEY BAY NSW 2259

By email: Major Projects Portal
cc: lmcwha@deltacoal.com.au

19 January 2024

Dear Mr McWha

No Comment – Chain Valley Colliery – Post Approval Consultation for Site Water Management Plan

I refer to your request received via the Major Projects Portal on 16 January 2024 for input from the NSW Environment Protection Authority (EPA) on the Post Approval Consultation for the Chain Valley Colliery Site Water Management Plan (the SWMP).

The EPA understands that the SWMP was prepared to satisfy Schedule 3, Condition 21 of Development Consent SSD-5465.

The EPA's role as a regulatory authority is to set environmental objectives rather than being involved in the development of strategies to achieve these objectives. The EPA encourages licensees and/or proponents to develop management plans as tools to ensure environmental impacts from approved activities are minimised as far as practicable.

The EPA has reviewed the SWMP and with consideration to the above, has no specific comments to make on its content. The EPA considers that the SWMP is broadly consistent with the current requirements of Environment Protection Licence 1770.

If you have any questions about this matter, please contact Phil Koenig on (02) 9995 5940.

Yours sincerely

R Akhurst

REBECCA AKHURST
Unit Head - Operations

Phone 131 555
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Appendix 3: Development Consent and EPL Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

This WMP has been prepared in accordance to Schedule 3, Condition 21 of SSD-5465, which states the requirements of the WMP and what it must address. **Table A1** outlines the requirements of the WMP and where this document addresses these requirements.

Table A1: Requirements from Chain Valley Colliery Development consent SSD-5465

Condition No.	Requirement	Relevant section of this document
	Schedule 2 Administrative Conditions	
22	EVIDENCE OF CONSULTATION 22. Where conditions of this consent require consultation with an identified party, the Applicant must: (a) consult with the relevant party prior to submitting the subject document; (b) provide details of the consultation undertaken including: i. the outcome of that consultation, matters resolved and unresolved; and ii. details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.	**Section 1.4** **Appendix 2**
23	STAGING, COMBINING AND UPDATING STRATEGIES, PLANS OR PROGRAMS 23. With the approval of the Planning Secretary, the Applicant may: (a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program); (b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined); (c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and (d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining mining consent or approval, in common ownership or management.	**Section 8**
	Schedule 3 Specific Environmental Conditions	
18	*The Applicant must prepare and implement a Water Management Plan for the surface facilities sites to the satisfaction of the Planning Secretary.* *This plan must be prepared in consultation with DPIE Water and EPA, by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary and submitted to the Planning Secretary for approval within 6 months of the date of this consent.* *This plan must include:*	**Section 1.4**
	(a) a comprehensive water balance for the development that includes details of: • *sources and security of water supply;* • *water make in the underground workings;* • *water transfers from the underground operations to the surface;* • *water use; and* • *any water discharges;*	**Section 3**

	(b) management plans for the surface facilities sites, that include: • *a detailed description of water management systems for each site, including:* – *clean water diversion systems;* – *erosion and sediment controls; and* – *any water storages;* • *measures to minimise potable water use and to reuse and recycle water;* • *measures to manage acid sulfate soils, if encountered;* • *activities that would involve ground disturbance at the site; and* • *monitoring and reporting procedures.*	**Section 4**
	(c) a Surface Water Management Plan which: • *includes baseline data on surface water flows and quality of Swindles Creek;* • *details surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on surface water resources or surface water quality;* • *provides a program to monitor:* – *surface water discharges;* – *surface water flows and quality; and* – *channel stability;*	**Section 5**
	(d) a Ground Water Monitoring Program which includes a program to: • *monitor and report groundwater inflows to underground workings;* • *predict, manage and monitor impacts to nearby groundwater bores on privately-owned land that may be impacted by the development; and*	**Appendix 1**
	(e) a detailed review of surface water management at the site, with particular reference to the water storages within the dirty water management system, to: • *determine whether the capacity, integrity, retention time and management of the dirty water storages (particularly the final Pollution Control Dam) are sufficient to ensure that water discharged from the site meets the EPL limits and surface water impact assessment criteria within the Surface Water Management Plan; and* • *propose any appropriate changes to the surface water management system.*	**Appendix 7**
	The Applicant shall implement the approved management plan as approved from time to time by the Secretary.	**This document**

	NOTE: The Secretary may require the Applicant to implement upgrades and other changes identified under paragraph (e), in accordance with condition 4 of schedule 2.	
	Statement of Commitments	
	Groundwater *In addition to the management and mitigation measures undertaken at the Colliery for groundwater as described in the WMP, the following commitments specific to the Proposal will be undertaken. Some commitments are already undertaken under the WMP. Delta Coal will:* • *assess whether abnormal or significant groundwater inflow changes occur in the active panels;* • *maintain the water flow monitoring appliances used to measure pumped water volumes to and from the Colliery in good working order;* • *maintain and plot records of daily total Colliery water pumping and annually communicate an interpretation of the findings within the Annual Review. A copy of the Annual Review will be supplied to DPI Water;* • *measure water levels and quality within private bores, where access is possible, in relevant areas to assess if any adverse effects occur due to subsidence from the Proposal; and* • *develop groundwater assessment criteria and triggers, response protocols and contingency measures.*	**GwMP in Appendix 1**
	Although it is not anticipated that private bore yields would be impacted due to subsidence, should such a situation arise, Delta Coal would provide an alternative water supply until the impacted bore recovers.	**GwMP in Appendix 1**
	Any monitored or reported adverse impacts on the yield, saturated thickness or quality of a private registered bore will be investigated by Delta Coal. In the event of a groundwater level drop of over 2 m for a period of two months or more, a notable increase in iron hydroxide, or an adverse change in salinity as a consequence of subsidence, Delta Coal will enter into negotiations with the affected landowners and the Mine Subsidence Board with the intent of formulating an agreement which provides for one, or a combination of: • *re-establishment of saturated thickness in the affected bore(s) through bore deepening;* • *establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;* • *provision of access to alternative sources of water; and/or*	**GwMP in Appendix 1**

	• *compensation to reflect increased water extraction costs (e.g., due to lowering pumps or installation of additional or alternative pumping equipment).*	
	Surface Water *Management and monitoring of surface water will continue to be undertaken in accordance with the Colliery's WMP, which will be reviewed and updated as required to include the commitments made below. Delta Coal will:*	**This document**
	update the WMP to include any changes as a result of the proposed modification;	**This document**
	limit the main underground pumps to a maximum pump out rate of 10.5 ML/day within 12 months of approval;	**Section 3.2.3**
	request an amendment of EPL 1770 to include a condition on the daily discharge volume limit stating that "Exceedence of the volume limit for Point 1 is permitted only if the discharge from Point 1 occurs solely as a result of rainfall at the premises exceeding 10 mm during the 24 hours immediately prior to commencement of the discharge";	**Section 1.1**
	undertake daily measurements of discharge volumes and report publically on a monthly basis via Delta Coal's website;	**Section 5.9**
	continue collection of baseline water quality data to aid in the development of appropriate discharge water quality trigger values;	**Section 5.3**
	engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and provide this assessment to the EPA by 31 December 2013;	**Section 2.4**
	investigate water saving measures to minimise the amount of potable water required from WSC for Colliery operations;	**Section 4.7**
	quantify the groundwater storage capacity in the Great Northern and Wallarah Seams;	**Section 4.3**
	continue effluent monitoring regime of receiving soils from the AWTS in accordance with the parameters and testing frequencies identified in the Colliery's WMP. The results of this monitoring program will be reviewed by a suitably qualified expert and used to determine the appropriateness of the existing irrigation area to receive this effluent;	**Section 5.6**
	develop a program to monitor creek line channel stability and the health of riparian vegetation within Swindles Creek. Monitoring will be undertaken in accordance with Section 8.5.2 of the Surface Water Impact Assessment (EIS Appendix E) and incorporated into the Colliery's WMP or Biodiversity Management Plan; and	**Section 5.4**

	record monitoring data in accordance with the Colliery's WMP and EPL 1770. Monitoring data will be interpreted as it is received to ensure appropriate operational guidance on monitoring water quality within desired parameters. Results of water quality monitoring will be reported in the Annual Review and made available to the CCC, as well as Wyong and Lake Macquarie Councils.	**Section 5.9**

CVC operates under EPL 1770 issued by the NSW EPA under the POEO Act. The EPL has been modified a number of times, most recently on the 2 April 2019. CVC has two Licensed Discharge Points (LDP) under EPL 1770. The main discharge point is defined in the EPL as Point 1 and referred to herein as Licensed Discharge Point 1 (LDP1). Licenced Discharge Point 27 is the spillway which rarely discharges.

Relevant sections of EPL 1770 detail water related requirements and are reproduced in **Table A2** below along with identification of where the requirements are addressed in this document.

Table A2: Environment Protection Licence 1770 Water Quality Requirements

Condition No.	Requirements	Relevant section of this document
2	**Discharges to Air and Water and Applications to Land**	
P1	**Location of monitoring/discharge points and areas**	
P1.2	The following points referred to in the table below are identified in this licence for the purposes of monitoring and/or the setting of limits for the emission of pollutants to the air from the point.	**Noted**
P1.3	The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point. EPA Identification no. / Type of Monitoring Point / Type of Discharge Point / Location Description 1 / Discharge to waters Discharge quality and volume monitoring / Discharge to waters Discharge quality and volume monitoring / Discharge to waters and monitoring from final settlement pond, gravity fed discharge pipe as identified in plan titled "Delta Coal Chain Valley Colliery, Surface EPA Premises Plan, DRG No: C1S0165_2" 10 August 2021 and saved as EPA Document DOC21/691135. 27 / Discharge to waters Discharge quality and volume monitoring / Discharge to waters Discharge quality and volume monitoring / Discharge to waters via dam spillway from final settlement pond adjacent to EPA Point 1 as identified in plan titled "Delta Coal Chain Valley Colliery, Surface EPA Premises Plan, DRG No: C1S0165_2" 10 August 2021 and saved as EPA Document DOC21/691135.	**Section 5**
3	**Limit Conditions**	
L1	**Pollution of Waters**	
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	**Section 2**
L2	**Concentration Limits**	
L2.1	For each monitoring/discharge point or utilisation area specified in the table\s below (by a point number), the concentration of a pollutant discharged at that point, or applied to that area, must not exceed the concentration limits specified for that pollutant in the table.	**Section 5**
L2.2	Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.	**Section 5**
L2.3	To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.	**Noted**

<table>
<tr><td>L2.4</td><td>Water and/or Land Concentration Limits
POINT 1,27<table><tr><th>Pollutant</th><th>Units of Measure</th><th>50 percentile concentration limit</th><th>90 percentile concentration limit</th><th>3DGM concentration limit</th><th>100 percentile concentration limit</th></tr><tr><td>Faecal Coliforms</td><td>colony forming units per 100 millilitres</td><td></td><td></td><td></td><td>200</td></tr><tr><td>Oil and Grease</td><td>milligrams per litre</td><td></td><td></td><td></td><td>10</td></tr><tr><td>pH</td><td>pH</td><td></td><td></td><td></td><td>6.5-8.5</td></tr><tr><td>Total suspended solids</td><td>milligrams per litre</td><td></td><td></td><td></td><td>50</td></tr></table></td><td>Section 5</td></tr>
<tr><td>L3</td><td>Volume and mass limits</td><td></td></tr>
<tr><td>L3.1</td><td>For each discharge point or utilisation area specified below (by a point number), the volume/mass of:
a) liquids discharged to water; or;
b) solids or liquids applied to the area;
must not exceed the volume/mass limit specified for that discharge point or area.<table><tr><th>Point</th><th>Unit of Measure</th><th>Volume/Mass Limit</th></tr><tr><td>1</td><td>kilolitres per day</td><td>12161</td></tr><tr><td>27</td><td>kilolitres per day</td><td>12161</td></tr></table></td><td>Section 5</td></tr>
<tr><td>L3.2</td><td>The volumetric daily discharge limit for the premises is the combined discharge measured at EPA discharge points 1 and 27 and must not exceed 12161 kilolitres per day.</td><td>Section 5</td></tr>
<tr><td>M2</td><td>Requirement to monitor concentration of pollutants discharged</td><td></td></tr>
<tr><td>M2.
3</td><td>Water and/ or Land Monitoring Requirements</td><td>Section 5</td></tr>
</table>

	POINT 1 **Pollutant** / **Units of measure** / **Frequency** / **Sampling Method** Biochemical oxygen demand / milligrams per litre / Once a month (min. of 4 weeks) / Grab sample Enterococci / colony forming units per 100 millilitres / Once a month (min. of 4 weeks) / Grab sample Faecal Coliforms / colony forming units per 100 millilitres / Once a month (min. of 4 weeks) / Grab sample Oil and Grease / milligrams per litre / Once a month (min. of 4 weeks) / Grab sample pH / pH / Once a month (min. of 4 weeks) / Grab sample Total suspended solids / milligrams per litre / Once a month (min. of 4 weeks) / Grab sample POINT 27 **Pollutant** / **Units of measure** / **Frequency** / **Sampling Method** Enterococci / colony forming units per 100 millilitres / Daily during any discharge / Grab sample Faecal Coliforms / colony forming units per 100 millilitres / Daily during any discharge / Grab sample Oil and Grease / milligrams per litre / Daily during any discharge / Grab sample pH / pH / Daily during any discharge / Grab sample Total suspended solids / milligrams per litre / Daily during any discharge / Grab sample	
M3. 2	Subject to any express provision to the contrary in this licence, monitoring for the concentration of a pollutant discharged to waters or applied to a utilisation area must be done in accordance with the Approved Methods Publication unless another method has been approved by the EPA in writing before any tests are conducted.	**Section 5**
M8	**Requirement to monitor volume or mass**	
M8. 1	For each discharge point or utilisation area specified below, the licensee must monitor: a) the volume of liquids discharged to water or applied to the area; b) the mass of solids applied to the area; c) the mass of pollutants emitted to the air; at the frequency and using the method and units of measure, specified below. **Point 1** **Frequency** / **Unit of Measure** / **Sampling Method** Continuous during discharge / kilolitres per day / In line instrumentation **Point 27** **Frequency** / **Unit of Measure** / **Sampling Method** Continuous during discharge / kilolitres per day / In line instrumentation	**Section 5**

G2	Other general conditions	
G2.1	Completed programs	**Noted**

Program	Description	Completed Date
Coal Mine Particulate Matter Control Best Practice	Requires licensee to conduct a site specific Best Management Practice (BMP) determination to identify ways to reduce particle emissions.	28-September-2012
Assessment of Potential Impacts of Metals in wastewater	The licensee must conduct an assessment of metals detected in wastewater discharges from the mine in accordance with the ANZECC water quality guidelines. To obtain a greater understanding of the type and concentration of metals discharged in mine water and entering the receiving waters. To limit the concentration of metals discharged in mine water within ANZECC guidelines.	23-October-2013
Air Quality Monitoring	The licensee must evaluate best locations and install monitoring devices as defined in Project Approval MP10_0161 under the Environent Planning & Assessment Act 1979.	31-December-2013
PRP4 - Upgrade to Clean and Dirty Water Management System	The licensee must review and upgrade separation of the Clean and Dirty Water Management System and review and upgrade bunding.	14-August-2015
PRP5 - Remediation of Dam Wall and Spillway formalisation	The licensee must design and remediate the dam wall on the final control pond and formalise a spillway to prevent dam seepage and to ensure that volumetric discharge can be monitored	27-February-2015
PRP 6 Upgrade to Sewage Treatment Systems	Assessment of options for improved disinfection of effluent from STP on licenced premises.	06-January-2015
PRP7 Sewage Treatment System Concept Design	Provide the EPA with a Concept Design and Timetable for Implementation of Upgrade to the Sewage Treatment System	19-February-2016
PRP 8 - Connection of Bathouse Wastewater to Sewer	Connection of Bathhouse to Central Coast Council Sewer.	14-July-2023
PRP 9 - Office Area Wastewater Sytem Upgrades to Best Practice	Office area wastewater treatment system upgrade to best practice.	27-July-2023

Appendix 4: Standard Erosion and Sediment Controls

Land Clearing Procedures (Clearing and Topsoil Stripping)

Minimise land disturbance to avoid exposing unnecessary land to the processes related to erosion and sedimentation. This is achieved by:

- All operations are planned to ensure that only the areas which are under active excavation are cleared and that there is no damage to any trees and pasture areas outside the limits to be cleared.
- Limiting the cleared width to that required to accommodate excavation plus areas required for topsoil stockpiling.
- General vegetation clearing will not be undertaken until earthwork operations are ready to commence.
- All proposed erosion and sediment control measures are implemented in advance of, or in conjunction with, vegetation clearing and soil stripping operations.
- Prior to vegetation clearing or soil stripping operations, the stripping panel is delineated on a plan and in the field will be marked by survey pegs placed at intervals on each side of the disturbed area. Topsoil limits and the topsoil stripping depths are shown on the pegs.
- Where possible, topsoil is stripped in moist but not wet condition to reduce deterioration in topsoil quality and dust generation and only be stockpiled when no areas of reshaped overburden are available for direct placement and spreading.

Topsoil Stockpiles

Where suitable areas are unavailable for the immediate respreading, topsoil is stockpiled to a maximum depth of three metres and subsequently applied when the areas become available. The period of the stockpiling is minimised in order to reduce the detrimental effects of the storage of any native seed in the soil and damage to the soil structure.

All stockpiles are shaped, trimmed (max batter slope 3H:1V) then ripped and immediately sown with a sterile cover crop and permanent pasture species to provide stockpile stabilisation. Sediment fence is constructed around the downslope perimeter of the stockpiles where required to provide temporary sediment control until vegetation becomes established. Surface drainage in the vicinity of the stockpiles is configured as to direct any runoff around the area so not to cause any potential erosion of the loose material.

Where topsoil is used as the growing medium, it is re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Re-spreading on the contour aids runoff control and increased moisture retention for subsequent plant growth. Re-spread topsoil should be levelled to achieve an even surface, avoiding a compacted or an over-smooth finish.

Access Tracks

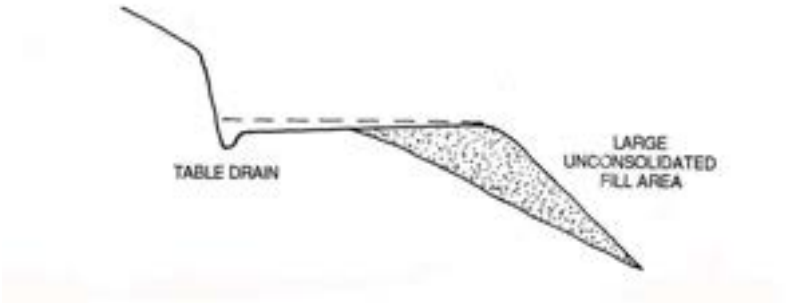
Access tracks are constructed in accordance with appropriate standards such as those described in *Managing Urban Stormwater: Soils and Construction Vol. C - Unsealed Roads*. Surface drainage is optimised and stabilised, thereby reducing roadside erosion and sedimentation. Appropriate control measures are constructed on all access roads with cross fall drainage at 3% either side of the road crown to be largely responsible for immediate water shed from the road surface. Techniques that could be used to provide crossfall on the track include crowing, infall and outfall

- Crowning



Crowning allows water to be shed on both sides

- Infall



- Outfall

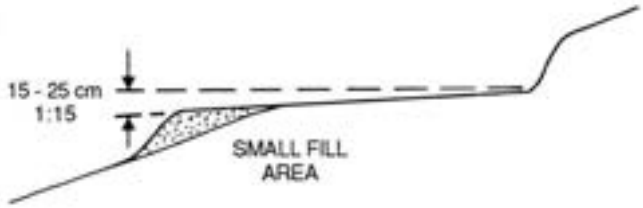


Table Drains, Mitre Drains, Culverts and Cross Drains are used where required to safely convey the water from the track surface so to prevent runoff from eroding them or adjacent land. Mitre Drain spacing should not exceed 50m even on soils with low erodibility. Cross Drains are placed every 20m to 90m depending on the road grade and soil erodibility as required. Refer to Table 5.2 of Vol2C – Unsealed Roads of the 'Blue Book' for more detail.

Cut and fill batters associated with service tracks are formed to a safe slope and stabilised by vegetation. Where cut batters are greater than 1.5m, stabilisation methods are applied to these areas such as laying back, revegetation and drainage. Stabilisation is assisted by spreading topsoil and/or by applying chemical or organic mulch over the exposed batter surface. Where fill batters are greater than 2:1, re-grading may be required.

Planning and construction of new tracks is undertaken in accordance with the guidelines presented Vol. 2C - Unsealed Roads of the 'Blue Book'.

Haul Roads

Run off from haul roads to be constructed within Chain Valley Colliery is to be contained within the mine water management system. The ultimate goal for the site is that water is not allowed to discharge from the site unless through a LDP. If the runoff from future haul road constructions are not contained within the existing mine water system, dams will be constructed to contain this water and allow it to be pumped back into the mine water management system for release through the LDPs.

During any construction of haul roads, temporary erosion and sediment controls (see **Section 1.1.8**) will be implemented. Sediment fencing will be strategically located around fill termination points as the road alignment approaches clean water drainage lines. The silt fencing will not be removed until construction of the appropriate

drainage and culverts are completed. Temporary sediment trapping devices may be required during construction to treat sediment-laden runoff from small areas (0.5 ha or less). Where haul roads are required to cross any watercourses, they will generally be constructed so that they cross perpendicular to the watercourse, subject to other constraints. Once constructed, long term sediment controls such as mine water sediment dams will be constructed at the outlet points of the storm water drains to contain water within the mine water management system. However haul roads at Chain Valley are currently sealed bitumen surfaces and erosion of the permanent structures may be effectively controlled by regular cleaning to prevent the accumulation of coal fines.

Diversion Structures (Clean Water)

In order to minimise the volume of dirty and mine water to be treated, all clean run-on water is diverted where possible into clean water drainage lines to be directed off-site. This not only reduces the potential for erosion to occur on disturbed areas, but also reduces the pressure on the dirty and mine water management controls which are required to treat sediment-laden runoff to an acceptable standard for discharge. Suitably designed and constructed diversion drains are implemented where practical around the Chain Valley Colliery in accordance with 'Blue Book' standards relating to channel design. In general, the drains should be trapezoidal in shape with maximum side slopes of 1V:2H. Where peak design water velocities exceed 1.5m/s, the drains should be protected from scour using either erosion channel liners and/or geofabric with rock rip-rap armouring.

Diversion Structures (Mine and Dirty Water)

Catch drains are utilised throughout the site to minimise erosion and re-direct potentially contaminated runoff into dirty water sediment dams and mine water dams. Runoff from disturbed areas, such as stockpile areas, is conveyed to these dams by catch drains and bunds.

Bunds shall be constructed similar to top soil emplacement areas, bunds shall be shaped, trimmed (max batter slope 3H:1V) then ripped and immediately sown with a cover crop and permanent pasture species to provide bund stabilization.

For runoff from rehabilitation areas, the water management structures should be appropriately designed before layout and construction. Typically the water management structures include contour banks, which are constructed at intervals down the slope of rehabilitation areas to control surface flow and minimize erosion. The effect of these is to divide long slopes into a series of short slopes with the catchment area commencing at each bank. This prevents runoff from reaching a depth of flow or velocity which would cause erosion. As the slope angle of the landform increases, the banks are spaced closer together. Bank spacing is determined based on the surrounding catchment layout and the bench spacing guide contained in Table 4.1 of *Vol2E – Mines and Quarries* of the 'Blue Book'. The banks should have a longitudinal grade of 1.2%. Where peak design water velocities exceed 1.5m/s, the drains should be protected from scour using either erosion channel liners and/or geofabric with rock rip-rap armouring.

Control Devices

Mine water dams and mine water sediment dams (generally smaller structures) are used at Chain Valley Colliery to contain potentially contaminated 'mine' water. This water has the potential to contain elevated salinity concentrations and/or potential hydrocarbon contamination as a result of runoff from haul roads, workshop areas and areas exposed to carbonaceous material. They also function as sediment dams for sediment control but are not allowed to spill into neighbouring watercourses unless released through a LDP.

Dirty Water sediment dams are intended to catch runoff from disturbed areas that are not exposed to potential contamination of hydrocarbons or carbonaceous material. These include general construction areas and rehabilitation areas. In general dirty water sediment dams should be constructed on all disturbed areas not draining to mine water dams. The dams are constructed for the purpose of capturing sediment-laden runoff prior to off-site release. Dirty water sediment dams assist in improving water quality throughout the mine site.

The number and capacity of dams will be related to the total area of catchment, the duration of disturbance and the anticipated soil loss. The capacity of each dam is derived from the benchmark design reference for sediment control, *Managing Urban Stormwater: Soils and Construction Vol. 1* and *Vol. 2E Mines and Quarries* (the Blue Book) (Landcom, 2004 and DECC, 2008). The dams are constructed to at least the recommended minimum design criteria as presented in Table 6.1 of Vol 2E Mines and Quarries of the Blue Book. For most areas, this is the 90th percentile, 5 day rainfall event for a Type F/D basin (soils that are fine textured and possibly dispersive).

The following points will be considered when selecting future sites for sediment dams:

- Each dam will be located so that runoff may easily be directed to it, without the need for extensive channel excavation or for excessive channel gradient. Channels will discharge into the dam without risk of erosion. Similarly, spillways will be designed and located so as to safely convey the maximum anticipated discharge.
- The material from which the dam is constructed will be stable and be imported from elsewhere on the mine, if necessary. Highly dispersible clays will require treatment with gypsum and/or bentonite to prevent failure.

Temporary Erosion and Sediment Controls

Prior to any construction activity (including soil stripping, road construction, bulk earthworks), temporary erosion and sediment control measures are installed. The following sub-sections include temporary erosion and sediment control features that may be utilized at the site.

Sediment Filter Fences

There may, on occasion, be a disturbance area which is either not protected by existing structures or requires additional temporary protection against erosion and sedimentation. In these cases it may be suitable to install sediment filter fencing. Sediment filter fences filter run-off leaving the site, trapping sediment and allowing filtered water to pass. Sediment filter fences are constructed around the base of any areas of exposed land that are not subject to concentrated overland flow, that are not adequately protected by existing structures and that are not within the mine water management system. Sediment filter fencing is installed around the extent of the disturbance areas where sediment-laden water could potentially enter clean downstream receiving waters.

Sediment filter fences are normally placed on the contour or slightly convex to the contour. The contour on each end of the fence should be turned to create a stilling dam up slope of the fence. Where possible, a silt fence system should consist of a series of overlapping fences. Each fence should be NO longer than about 40 metres. They should not intercept large concentrated or channelised flows. The fences are constructed in accordance with the Sediment Fence Standard Drawing (SD6-8) of the 'Blue Book'. Silt fences require regular maintenance. Trapped sediments should be removed, pickets straightened, filter cloth re-secured and tightened.

Sandbag Weirs

Sandbag weirs are sometimes installed within existing swale drains or existing drainage channels, which are not able to be regularly graded. The use of these devices is limited to temporary erosion and sediment control in channels during construction or high disturbance phase mining.

The weirs are typically installed at a minimum of 40 metre intervals. As with sediment filter fences, sandbag weirs may be installed prior to any works commencing on the site in existing channels and immediately after the construction of new channels. Inspections of the sandbag weirs after rain should take place with removal of the collected sediment as required. Damaged/shifted bags should be repaired or replaced.

Temporary Drains

Runoff from areas exposed during the works is to be controlled by construction of temporary contour and diversion drains. These drains generally take the form of channels constructed across a slope, with a ridge of the lower side. They should be implemented immediately after a construction site is cleared to intercept and divert runoff from the site to nearby stable areas at non-erosive velocities. The drains should be formed with a gentle grade of approximately 1.2%

Temporary Silt Traps

Temporary sediment trapping devices may be required during construction to trap and filter sediment-laden runoff from small areas (0.5 ha or less) prior to discharge. They are used to trap small amounts of run-off water and filter sediment from runoff before entering the natural watercourses or to protect adjacent lands. These would typically be used at the discharge point of mitre drains and other similar devices.

Appendix 5: Acid Sulfate Soil Risk Map Review

Figure 4 - DPIE Acid Sulfate Soil Risk Map

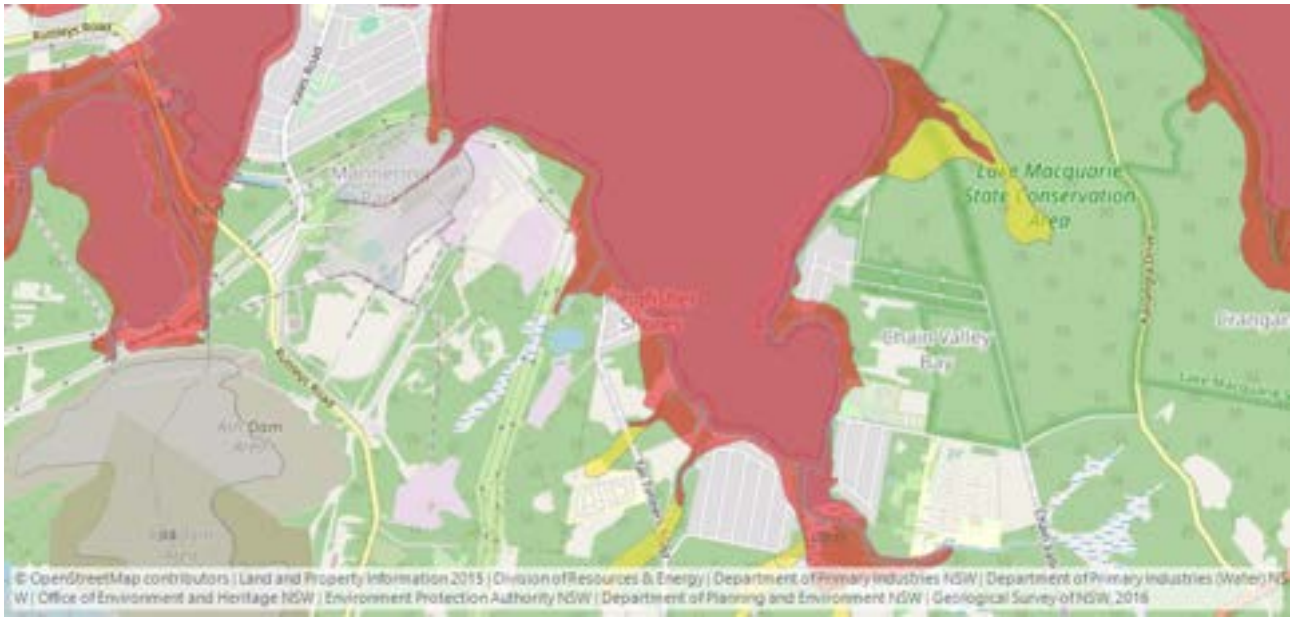


Figure 5 - ASRIS Acid Sulfate Soil Data Set (.KMZ)



Appendix 6: Surface Water Assessment, GSS Environmental 2013



LakeCoal Pty Ltd

Chain Valley Colliery - Mining Extension 1 Project

Surface Water Assessment

March 2013

EMG00-008

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

EXECUTIVE SUMMARY

LakeCoal is seeking an approval under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* to extend the currently approved extraction area at Chain Valley Colliery to allow underground mining of the Fassifern Seam, with all secondary extraction to occur beneath Lake Macquarie. This extension would allow continuation of mining operations at the Colliery (by a further 14 years) and would increase the maximum approved rate of production from 1.2 million tonnes per annum (Mtpa) to 1.5 Mtpa ROM coal. The additional 300,000 tonnes per annum would continue to be transported back to the existing pit top facilities by conveyor where it would be processed and then transported via private roads to Vales Point Power Station.

GSS Environmental (GSSE) was commissioned by EMGA Mitchell McLennan (EMM), on behalf of LakeCoal Pty Ltd, to prepare this Surface Water Assessment (SWA) to fulfil the requirements detailed in the Director-General's Requirements relating to the preparation of an Environmental Impact Statement (EIS) to accompany the Part 4 application.

The key aspects addressed within the SWA include the identification of potential surface water impacts as a result of the proposed extension to mining; a description of the proposed mitigation and management measures to be implemented to address these potential impacts; licensing requirements; recommendations for ongoing surface water monitoring, and a detailed site water balance, including a discussion on water sources and predicted discharges from the Colliery.

A detailed 'daily time-step' water balance model was developed in GoldSim to understand water demands and flows around the pit top area of the Colliery and to demonstrate that future water management at the Colliery is sustainable. A water balance was previously undertaken for Chain Valley by AECOM in July 2011. The water balance investigation for the SWA was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance also investigated the pit top water use in more detail to aid the future decision making process in regards to water management at the site.

The Groundwater Assessment undertaken for this Proposal predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day progressively throughout the life of the Proposal, without any significant change to the quality of water extracted from the Fassifern Seam. The detailed 'daily time-step' water balance model developed in GoldSim utilised the results of the Groundwater Assessment and commitments made by LakeCoal regarding groundwater management. It indicated that a combination of underground storage utilisation, an amendment to the daily discharge volume condition within EPL 1770 and limiting the maximum daily pump rate to 10.5 ML/day is required to effectively manage water at the pit top area.

It is therefore proposed to utilise existing storage capacity in both the Wallarah and Great Northern Seams to mitigate the effects of peak groundwater inflow rates and significant rainfall events at the pit top area in order to reduce the potential for exceedance of the 12.161 ML/day LDP1 (the Colliery's single licensed discharge point) daily discharge limit. LakeCoal has indicated that these seams have a combined storage capacity of approximately 3-4 weeks (based on a 10.5 ML/day inflow) which GSSE believes is sufficient to adequately manage the predicted increase in water make expected as a result of the Proposal.

The water balance also estimated that the potable water used in the pit top area may be reduced by 32.3 kL/day (11.8 ML/year) as a result of proposed water saving measures at the Colliery, including the use of rainwater tanks and the reuse of water within the sedimentation ponds for dust suppression purposes.

As a result of the SWA, including the site water balance, a number of recommendations have been identified including the below:

- Investigate the actual available underground storage capacity due to the importance of this storage in regards to the management of water during the life of the Proposal;
- Seek an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours.
- Limit the maximum pump out rate from underground to 10.5 ML/day, within 12 months of the Proposal being approved, in order to adhere to aforementioned proposed EPL amendment. The timing of this commitment is due to the substantial upgrades involved with fully automating the pumps and having them controlled by a SCADA system.
- Collect more extensive baseline water quality data to aid the development of appropriate pollutant trigger values.
- Engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and issue this assessment to the EPA by the 31st December 2013.

No adverse impacts to the surrounding environment are expected as a result of the Proposal since the water make from underground is not expected to change in terms of either discharge flow rates (i.e. quantity) or water quality.

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Appendix A – Baseline Site Water Quality LDP 1
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1.0 PROPOSAL DESCRIPTION

1.1 Introduction

The Chain Valley Colliery (the Colliery) is an underground coal mine located at the southern end of Lake Macquarie, approximately 60 km south of Newcastle (**Figure 1.1**). The Colliery is operated by LakeCoal Pty Ltd (LakeCoal), on behalf of the Wallarah Coal Joint Venture. Underground mining has occurred at the Colliery since 1962, with coal extraction undertaken using a combination of bord and pillar and miniwall mining methods. The Colliery has extracted coal from three seams – the Wallarah Seam, the Great Northern Seam and the Fassifern Seam, with current extraction activities restricted to the Fassifern Seam as approved under the Colliery's existing approval, MP10_0161.

Geological features identified during mining of the approved secondary extraction area (Domains No. 1 and No. 2 – MP10_0161) will prevent LakeCoal from recovering all of the resource approved for mining. It is currently estimated that the reserve within the approved secondary extraction area will be exhausted by late 2013. If access to further coal resources is not approved by this time, the Colliery will be forced to shut down affecting employment and the supply of coal to Vales Point Power Station and other customers. LakeCoal is therefore seeking an approval under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* to extend the area of extraction and allow continuation of mining operations at the Colliery.

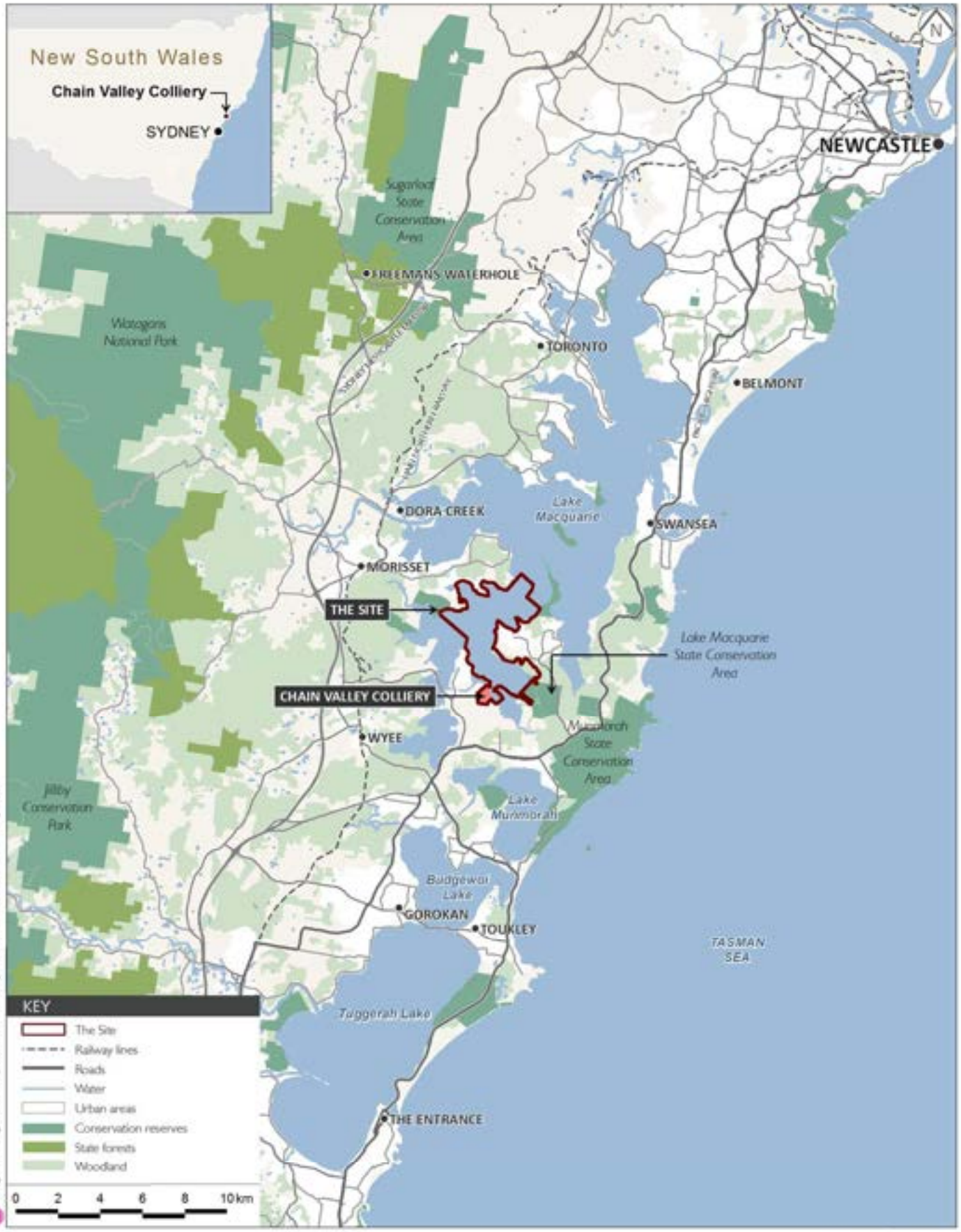
1.2 The Proposal

The Proposal comprises:

- an extension of the currently approved extraction area to allow underground mining of the Fassifern Seam within the Site, with all secondary extraction to occur beneath Lake Macquarie (see **Figure 1.2**);
- an increase to the maximum approved rate of production from 1.2 million tonnes per annum (Mtpa) to 1.5 Mtpa ROM coal. The additional 300,000 tonnes per annum will be transported via private roads to Vales Point Power Station;
- a change from the current hours for haulage of coal from the Colliery to Delta Electricity's Vales Point Power Station on private roads, i.e. from 5:30 am to 5:30 pm, Monday to Friday (excluding public holidays) to 24 hours a day, seven days a week;
- minor upgrades and modifications to surface infrastructure; and
- an extension of the approved mining period by a further 14 years, i.e. to around 2027.

The Proposal includes the consolidation of the above with all the operations and environmental activities currently approved under MP10_0161, as modified, within a single Development Consent.

The proposed coal extraction activities are to be undertaken entirely within the Fassifern Seam and will comprise both first workings (development) and secondary extraction by miniwall mining methods. The indicative mine plan is shown on **Figure 1.3**. As is the case with the secondary extraction areas approved under MP10_0161, the proposed secondary extraction areas are located entirely below the bed of Lake Macquarie, in areas where the depth of cover approximates 200 m. Coal would continue to be transported back to the existing pit top facilities by conveyor where it would be processed and then distributed to customers via truck in the same manner as currently approved.



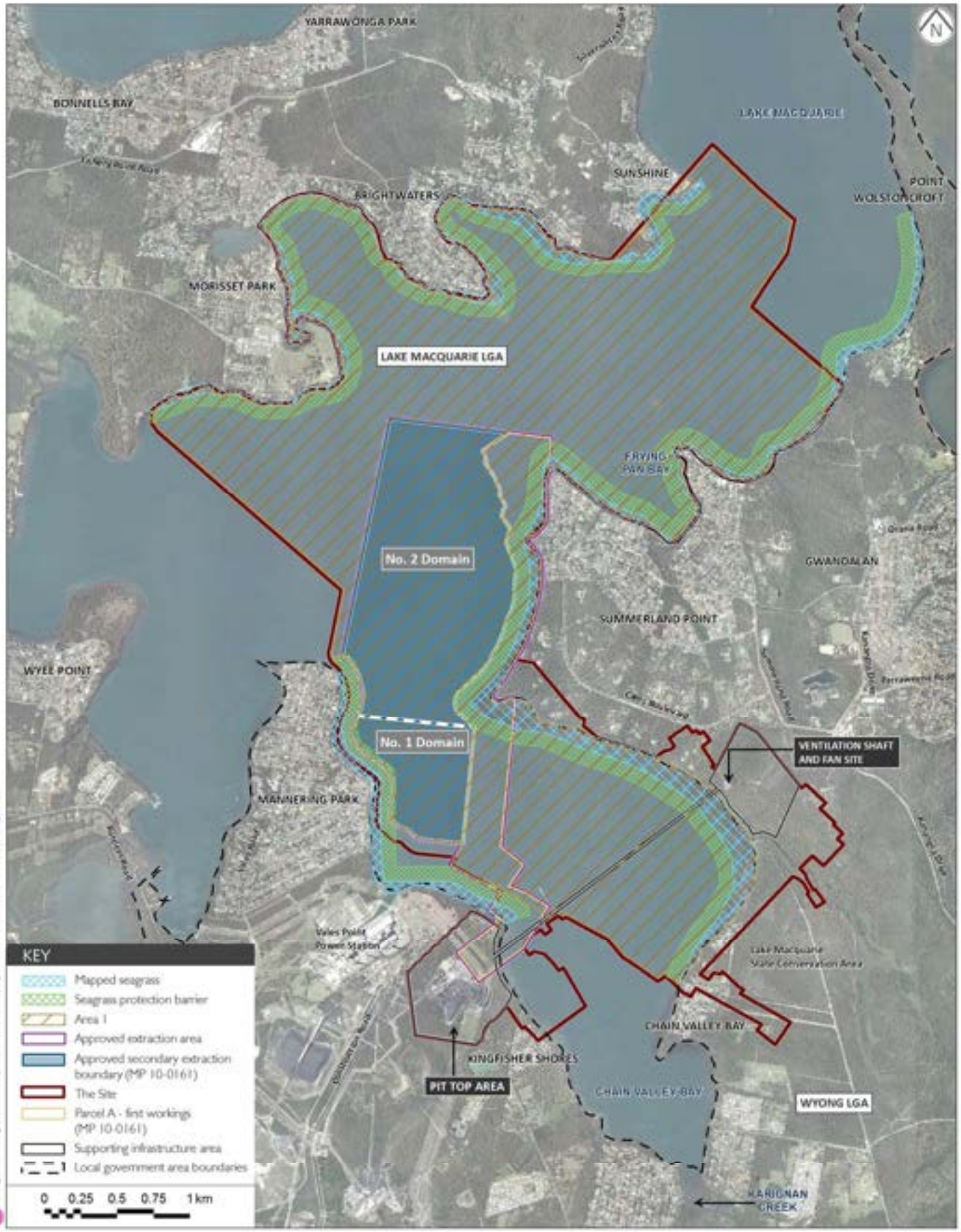
Integrated Design Solutions | 030634 Chain Valley Mine - ME1 F1.1 Rev E - 12 February 2013

Regional context

EMM

Chain Valley Colliery Mining Extension 1 Project - Environmental Impact Statement

Figure 1.1

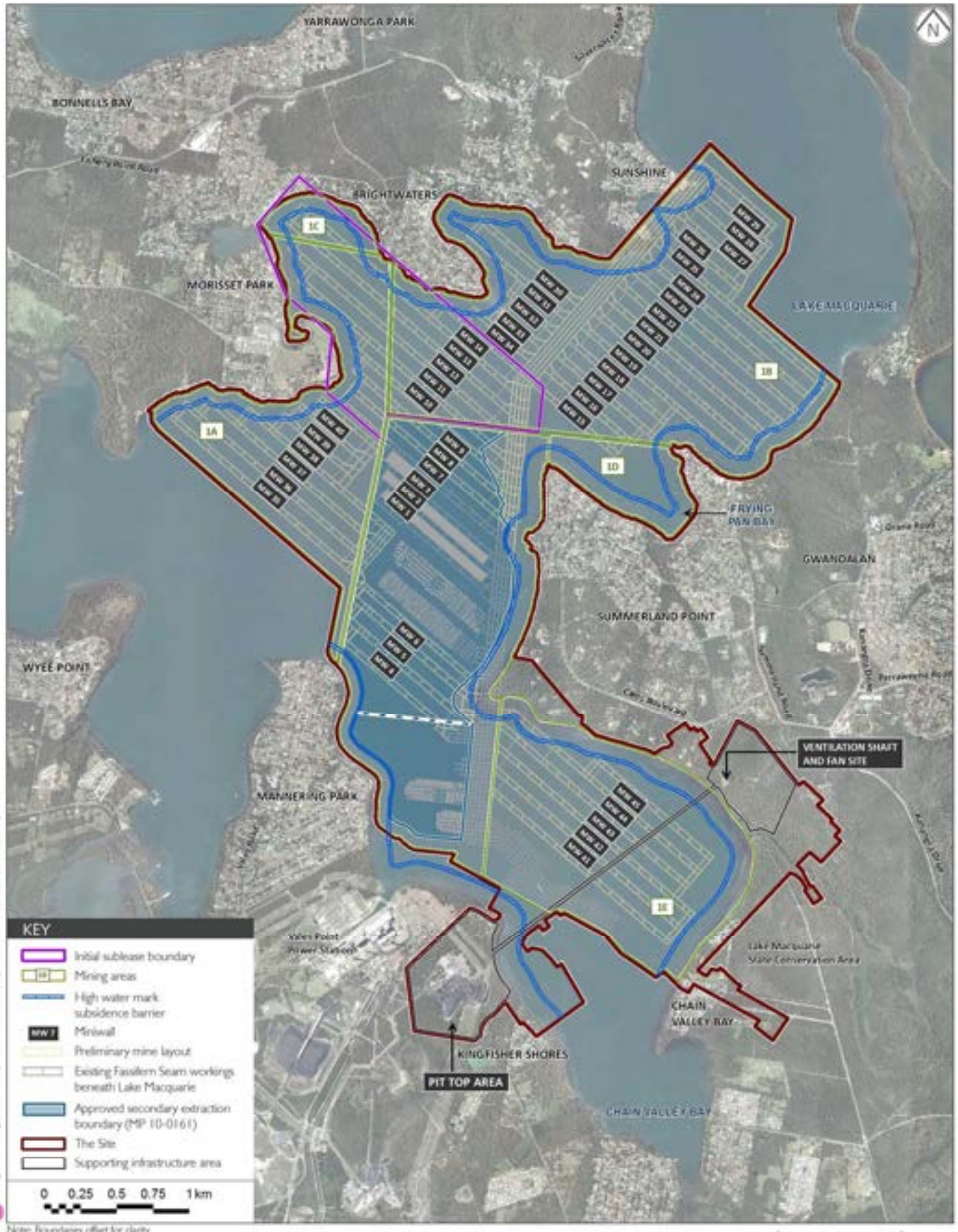


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The Site

Chain Valley Colliery Mining Extension 1 Project - Environmental Impact Statement

Figure 1.2



Note: Boundaries offset for clarity

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Preliminary mine layout

Chain Valley Colliery Mining Extension I Project - Environmental Impact Statement

Figure 1.3

1.3 Purpose of this Report

1.3.1 Scope of Surface Water Assessment

LakeCoal engaged EMGA Mitchell McLennan (EMM) to prepare the Environmental Impact Statement (EIS) for the Chain Valley Colliery - Mine Extension 1 Project (the Proposal). GSS Environmental (GSSE) was subsequently engaged by EMM as a sub-consultant to undertake the Surface Water Assessment (SWA) component of the EIS.

As the proposed mining is all to be undertaken underground, the extent of this SWA is limited to the potential impacts from the management of the mine dewatering and surface operations. The primary potential surface water impacts from the Proposal comprise increased amounts of water make from the underground workings that will need to be managed to satisfy the requirements of Environmental Protection Licence (EPL) 1770 and the consequential increased discharge of water (predominantly sourced from underground) into Lake Macquarie.

The SWA:

- collates relevant data, including meteorological data (rainfall events), surface water flow regimes (water quality and quantity), catchment characteristics, surface water features, and surrounding land uses. Information has been collected from a literature review of the Colliery and NSW government records, as well as from a site inspection undertaken by GSSE personnel on 4 June 2012;
- identifies key issues, relevant assessment criteria and constraints relating to surface water;
- considers existing controls for management of surface water at the Colliery;
- recommends safeguards and mitigation measures to be implemented to ensure that potential surface water impacts are managed and appropriate criteria are met;
- presents a detailed site water balance to assist with the assessment of water security and predicted discharges;
- provides recommendations for ongoing surface water monitoring; and
- assesses the potential impacts of the Proposal on surface water flows within the pit top area (surface component of the Colliery) and the surrounding watercourses.

1.3.2 Director-General's Requirements

The Director-General's Requirements (DGRs) for the Proposal were provided in a letter from the Department of Planning and Infrastructure (DP&I) on 14th August 2012.

Table 1 provides a summary of the DGRs relevant to the SWA and related environmental assessment requirements provided by other government agencies. It also indicates where the specific requirements have been addressed within this document.

Table 1 - Summary of DGRs relevant to Surface Water Assessment

Agency	Details of Requirements	Location addressed
Department of Planning and Infrastructure (DP&I) – DGRs	The EIS must include a: • Detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes: o A description of the existing environment, using sufficient baseline data; o An assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant guidelines, policies, plans and statutes; and o A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment. The EIS must address the following specific issues: • Water Resources – including: o Detailed assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including detailed modelling of potential groundwater impacts; o A detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures; o An assessment of proposed water discharge quantities quality/ies against receiving water quality and, if relevant, flow objectives; o Identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000*; and o A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts.	Section 3.0 Section 6.0 Section 6.0 Section 6.0 See Groundwater Assessment Report Section 5.0 Section 6.0 Section 2.2.1 Sections 6.0 and 8.0
Wyong Shire Council	Wyong Shire Council has made the following comments relevant to the Surface Water Assessment. • Details of any change to the existing settling ponds and water control facilities shall be included in the Environmental Assessment. • The project shall consider sustainable options in relation to the provision of new infrastructure, rainwater reuse etc. • Details of any change to the Colliery's current potable water use shall be included in the Mine/Water Balance.	Section 6.0 Section 6.5 Sections 5.3.6 and 5.4.2

Agency	Details of Requirements	Location addressed
Department of Environment, Climate Change and Water (DECCW) (now Office of Environment and Heritage)	DECCW requires the following information to determine the extent of environmental impacts of the proposal.	
	Water	
	The EA must provide sufficient information to demonstrate that the proposed development can be operated whilst complying with the *Protection of the Environment Operations (POEO) Act 1997*, in particular, the protection of water quality, including groundwater, during construction, operation and following mine closure.	Section 6.0
	Potential impacts on water quality and quantity must be addressed, and mitigating measures proposed, for all on site water resources, all receiving waters downstream, and Lake Macquarie. The EA must assess:	Section 6.0
	• Details of all proposed water discharges including locations, water volumes, water quality and under what conditions;	Section 6.0
	• The expected water quality of all proposed discharges assessed in accordance with the Guidelines for Fresh and Marine Water Quality (ANZECC 2000);	Sections 3.5.2 and 6.3
	• DECCW requires very careful consideration of metal and salt discharges from the premises. The concentrations of metals and salinity in discharge waters should be directly compared with those in the receiving waters and Lake Macquarie using the Guidelines for Fresh and Marine Water Quality (ANZECC 2000). All impacts on receiving waters should then be assessed and mitigation measures proposed where ANZECC criteria cannot be met.	Sections 3.5.2 and 6.3 Section 3.5.2
	• Quality of runoff from exposed soils, roads and coal handling areas;	See Groundwater Assessment Report
	• Quality of seepage water into access pits;	Sections 4.1 and 6.4
	• Design and location of all sediment and erosion control structures;	Sections 3.5.2 and 6.3
	• Methods proposed to deal with pollutants other than sediments that may be in the water;	Sections 4.1.2, 4.1.3 and 6.4
	• Spillage controls and bunding;	Section 6.4.1
	• Sealing, kerbing and guttering of trafficable areas;	
	• Provision of truck washing facilities capable of washing wheels and under body of vehicles leaving the premises;	Section 6.4
	• Potential impacts on water quality and quantity for receiving waters downstream of the mine; and	Sections 6.2 and 6.3
	• Potential long terms impacts on Lake Macquarie.	Sections 5.0, 6.3 and 7.0
	The methodology, data and assumptions used to design any pollution control works and assess the potential impact of the proposal on water quality, must be fully documented and justified.	Appendices B and C
	The EA must include a detailed Water Management Plan and site water balance (which includes cumulative water balance modelling and assessment for all existing mines in the vicinity and the proposed mine) incorporating the following matters:	Appendices B and C
	• Maximum on-site reuse of wastewater together with adequate water storages to avoid any discharge of pollutants from the premises. This must include correct installation and sizing of the wastewater collection and recycling systems;	Appendices B and C
	• Details of all measures employed to minimise all water discharges	Appendices B and C

Agency	Details of Requirements	Location addressed
	from the premises at all times; • Prevention of wet weather overflows of contaminated stormwater by collection and reuse or treatment of contaminated first flush stormwater; • Segregation of contaminated water from non-contaminated water to minimise the volume of polluted water to be dealt with; • Management of groundwater and surface waters; and • Detailed design and management of all proposed water storages. **Monitoring Programs** The EA should include a detailed assessment of any noise, air quality, water quality or waste monitoring required during the construction phase and on-going operation of the facility to ensure that the development achieves a satisfactory level of environmental performance. The evaluation should include a detailed description of the monitoring locations, sample analysis methods and the level of reporting proposed.	Appendices B and C Appendices B and C Section 8.0
I&I NSW	**Environmental Management** • LakeCoal must present in the EA the infrastructure upgrade and improvements required at the Chain Valley pit top layout and hardstand areas, coal handling and stockpiling, hydrocarbon management, waste management and water use and management.	Sections 6.0
Lake Macquarie City Council	**Surface and Groundwater** The proponent must assess the following: • The impact of the mining operation and final landform on riparian corridors and creeklines. • Stormwater management issues including the maintenance of pre-development peak stormwater discharges and volumes; and the management of water quality and the health of riparian corridors. • The necessary erosion and sediment control requirements and provide a short and long term management plan. • Changes to stream hydrology resulting from subsidence including impacts on downstream ecology and riparian habitats. • Impacts of altered stream hydrology on alluvial flows. • Impacts on local and regional groundwater hydrology including substantial aquifers relied upon by adjoining properties and nearby land uses. • Impacts on groundwater dependent ecology. • Quantification of any off-site impacts due to altered mine water discharges. • Options for mine water reuse.	Sections 6.2, 6.3 and 8.5.2 Sections 4.1.2, 6.2 and 6.3 Sections 4.1 and 6.4 See Subsidence Assessment Report Section 6.2 See Groundwater Assessment Reports See Groundwater Assessment Reports Section 6.2 Section 6.5

1.4 Literature Review

The following documentation was reviewed by GSSE as part of the SWA:

- Assessment of metals in Sediment from Lake Macquarie, New South Wales, Australia, using normalisation models and sediment quality guidelines (Roach 2005);
- Baseline Site Water Quality LDP 1;
- Bureau of Meteorology weather station data;
- *Contour/detail survey, settling ponds Chain Valley Colliery, Ruttleys Road, Chain Valley Bay* prepared by Pearson & Associates (2009);
- *Chain Valley Colliery - Mine Extension 1 Project, Groundwater Assessment* prepared by Geoterra (2012)
- *Chain Valley Colliery Water Management Plan, Environmental Management Plan* prepared by GSSE in 2012;
- *Environmental Assessment Chain Valley Colliery Domains 1 and 2 Continuation Project*, LakeCoal Pty Ltd prepared by AECOM (July 2011);
- *Environmental Protection Licence 1770 – Chain Valley Colliery,* Environmental Protection Authority – NSW (Dec, 2011);
- *Mine Operation Plan (2008-2015)* prepared by LakeCoal;
- *Mine Water Balance Chain Valley Continuations of Mining* prepared by AECOM (July 2011);
- Various government legislation, policy and guideline documents; and
- Various 'in-house' LakeCoal spreadsheets and records detailing coal analysis, employee shift work records, historic pump flow rates, water usage and water cart records, and water quality data.

A full list of references used for the development of this SWA is contained in **Section 10.0**.

2.0 RELEVANT LEGISLATION, POLICY AND GUIDELINES

2.1 Introduction

A number of legislative requirements, government policies and guidelines relating to surface water management are applicable to the Proposal and have been considered in this SWA. The relevant policies, guidelines and legislative requirements are summarised in **Sections 2.2 and 2.3**.

2.2 Legislation

The Acts considered during the development of this SWA included the following:

- *Water Act 1912 and Water Management Act 2000*;
- *Protection of the Environment Operations Act 1997*;
- *Environmental Planning and Assessment Act 1979*; and
- *Mining Act 1992*.

2.2.1 Water Act 1912 and Water Management Act 2000

The *Water Act 1912* and *Water Management Act 2000* (WM Act) contain provisions for the licensing of water capture, interception and use. If any dams are proposed as part of a Proposal, consideration must be given to whether the dams need to be licensed. There are currently no new dams proposed for the site. All existing dams are for the purpose of Erosion and Sediment Control (ESC), and these are exempt from the licensing requirements.

LakeCoal is committed to obtaining all relevant licences for the continuation of their mining operations. LakeCoal has developed a water management plan inclusive of a groundwater management component, separate to the EIS process, which has been provided to the NSW Office of Water in support of a licence application for the interception and incidental groundwater take under the *Water Act 1912.* The Application for this licence was lodged on the 5th October, 2011 and is in the process of being determined.

2.2.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is relevant to the Proposal as it contains requirements relating to the prevention of the pollution of waters. In this regard, the discharge of water from the Colliery's pit top area will need to be controlled to an agreed standard to reduce the potential for pollution of the receiving waters. As mentioned previously, the Colliery has an existing EPL under the *POEO Act* for the discharge of water from site. As demonstrated in this SWA, there will be no additional discharge points required as a result of the Proposal.

2.2.3 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies the planning approval and development consent requirements for mines and quarries. The State Environmental Planning Policy (SEPP) *Mining, petroleum production and extractive industries* 2007 notes the types of mining operations permissible under the EP&A Act with and without development consent. Generally, only exploration and rehabilitation activities are permitted without consent, while mining or quarrying developments require consent.

This SEPP requires consent authorities to consider whether or not the consent should be issued subject to conditions to ensure that impacts on significant water resources, including surface water and groundwater, are either avoided or minimised as far as practicable.

Where development consent is required and the development exceeds thresholds set by the EP&A Act (as per this Proposal), the development is considered a 'designated development' and an EIS must be lodged with the application. This SWA forms part of the EIS.

2.2.4 Mining Act 1992

Mining and associated exploration activities must be undertaken in accordance with approvals issued under the *Mining Act 1992* (Mining Act).

There are five types of approvals issued under the Mining Act, all of which can be granted subject to conditions, including conditions for protection of the environment. The conditions often include requirements for addressing soil and water issues. For mining operations, the conditions of approval require mining to be undertaken in accordance with a mining operations plan (MOP) that has been assessed and approved by the Division of Resources and Energy within the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS). The MOP documents site activities and progress towards the required environmental and rehabilitation outcomes, including a description of the soil and water management measures to be implemented. The Chain Valley Colliery MOP covering the 2008-2015 period will be reviewed and updated as required to include the relevant aspect identified during this Proposal.

2.3 Policies and Guidelines

Key policies and guidelines which are relevant to the preparation of this SWA include:

- ANZECC, Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the "ANZECC Guidelines"), October 2000;
- NSW Water Quality and River Flow Objectives, September 1999;
- NSW State Rivers and Estuaries Policy;
- Environmental Guidelines: Use of Effluent by Irrigation, Department of Environment and Conservation (NSW), 2004;
- Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008; and
- NSW Farm Dams Policy.

2.3.1 ANZECC Guidelines

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) outline a number of defaults trigger values for assessing water quality. The water quality monitoring results for the downstream watercourse (Swindles Creek to the east of the pit top area shown in **Figure 4.1**) will be assessed generally in accordance with these values (refer **Section 8.3** for more information relating to trigger values). ANZECC defines a *Slightly to moderately disturbed systems* as an ecosystem in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. Due to the historical industrial activity and residential development within the Lake Macquarie catchment, this catchment fits this definition. Key default trigger values presented in the ANZECC Guidelines for *slightly-moderately disturbed marine systems* in NSW are shown in **Table 2**.

Table 2 - Key Default Trigger Values for Marine Environment 95% Protection Levels (ANZECC 2000)

Indicator	Trigger Value micrograms per litre (µg/L)
Ammonia	910
Cadmium	0.7
Chromium	4.4
Cobalt	1
Copper	1.3
Lead	4.4
Mercury	0.1
Nickel	7
Silver	1.4
Vanadium	100
Zinc	15

The Colliery currently utilises the EPL concentration limits as assessment criteria for pH and TSS. In regards to electrical conductivity (EC,) the ANZECC guidelines do not define limits for EC in estuaries and marine environments. However, the Colliery's discharge generally ranges between 13,900 and 34,800 (µS cm^{-1}). This concentration reflects the EC within Lake Macquarie which averages between 28,000 and 34,000 µS cm^{-1} (AECOM, 2011) with the lower recorded values a function of rainfall events.

2.3.2 NSW Water Quality and River Flow Objectives

*NSW Water Quality and River Flow Objectives w*ere established by the NSW Government in September 1999 for the majority of NSW catchments. Eleven water quality objectives (WQOs) were developed for NSW rivers and estuaries and provide guideline levels to assist water quality planning and management.

According to the Lake Macquarie and Tuggerah Lakes objectives, Swindles Creek, located adjacent to the Colliery's pit top area, is classified as an "Estuary".

There are numerous WQOs for "Estuaries" within the Lake Macquarie and Tuggerah Lakes catchment depending upon the environmental values within the area. The most relevant of these objectives for Chain Valley Colliery are:

a) aquatic ecosystems (maintaining or improving the ecological condition of water bodies and their riparian zones over the long term);

b) visual amenity (aesthetic qualities of waters); and

c) secondary contact recreation (maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed).

Generally the water quality objectives are directly in line with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) default trigger values for slight to moderately disturbed ecosystems in south-east Australia. These values are presented in **Table 3** to **Table 5.**

Table 3 – Aquatic Ecosystems Guidelines for Estuaries in Lake Macquarie and Tuggerah Lakes

Aquatic ecosystems	
Relevant Indicator	**Criteria**
Total phosphorus	30 µg/L
Total nitrogen	300µg/L
Chlorophyll-a	4 µg/L
Turbidity	0.5–10 NTU
Dissolved oxygen	80–110% Note: Dissolved oxygen values were derived from daytime measurements. Dissolved oxygen concentrations may vary diurnally and with depth. Monitoring programs should assess this potential variability.
Chemical contaminants or toxicants	Table 4 of the WMP or Table 3.4.1 & 5.2.3 ANZECC (2000)
Biological assessment indicators	This form of assessment directly evaluates whether management goals for ecosystem protection are being achieved (e.g. maintenance of a certain level of species diversity, control of nuisance algae below a certain level, protection of key species, etc.). Many potential indicators exist and these may relate to single species, multiple species or whole communities. Recognised protocols using diatoms and algae, macrophytes, macro-invertebrates, and fish populations and/or communities may be used in NSW and interstate (e.g. AusRivAS).

Table 4 – Visual Amenity Guidelines for Estuaries in Lake Macquarie and Tuggerah Lakes

Visual amenity	
Indicator	**Criteria**
Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of the water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and litter.
Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts.

Table 5 – Secondary Contact Recreation Guidelines for Estuaries in Lake Macquarie and Tuggerah Lakes

Secondary contact recreation	
Indicator	**Criteria**
Faecal coliforms	Median bacterial content in fresh and marine waters of < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL (minimum of 5 samples taken at regular intervals not exceeding one month).
Enterococci	Median bacterial content in fresh and marine waters of < 230 Enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).
Algae & blue-green algae	< 15 000 cells/mL
Nuisance organisms	Use visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.

Secondary contact recreation	
Indicator	**Criteria**
Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. Toxic substances should not exceed values in tables 5.2.3 and 5.2.4 of the ANZECC 2000 Guidelines.
Visual clarity and colour	Use visual amenity guidelines.
Surface films	Use visual amenity guidelines.

2.3.3 NSW State Rivers and Estuaries Policy

The *NSW State Rivers and Estuaries Policy* has three policy objectives to manage the rivers and estuaries of NSW in ways which:

- Slow, halt or reverse the overall rate of degradation in the systems;
- Ensure the long-term sustainability of their essential biophysical functions; and
- Maintain the beneficial use of these resources.

The default ANZECC water quality trigger levels including those identified in Table 2 summarise water quality guidelines proposed to protect and manage the environmental values of national water resources. As such through the adoption of ANZECC, the above guidelines will be met.

2.3.4 Environmental Guidelines: Use of Effluent by Irrigation

This guideline is advisory in nature and provides information on best management practices where effluent is managed by irrigation, and is applicable to the irrigation of the treated effluent from the Colliery's administration building.

Primarily this guideline provides information for the design and operation of effluent irrigation systems and is consistent with the *POEO Act*. This guide provides information on the parameters and frequency of monitoring required for effluent water quality and soil contamination. This guideline defines an effluent quality trigger for faecal coliforms of less than 1000cfu/100ml. **Table 6** outlines criteria for the classification of effluent and **Table 7** shows the recommended monitoring frequency for specific soil and water parameters potentially impacted by effluent irrigation.

Table 6 - Classification of Effluent for Environmental Management

Constituent	Strength (average concentration mg/L)		
	Low	Medium	High
Total Nitrogen	<50	50-100	>100
Total Phosphorous	<10	10-20	>20
BOD^5	<40	40-1,500	>1,500
TDS	<600	600-1,000	>1,000-2,500
Other Pollutants (e.g. Metals, pesticides)	Effluent with more than five times the ANZECC and ARMCANZ (2000) long-term water quality trigger values for irrigation waters must be considered high strength for the purpose of establishing a strength class for runoff and discharge controls and will require close examination to ensure soil is not contaminated.		
Grease and Oil	Effluent with more than 1,500 mg/L of grease and oil must be considered high strength and irrigation rates and practices must be managed to ensure soil and vegetation is not damaged.		

Table 7 - Recommended Effluent Sampling Frequency

Constituent	Low	Medium	High
TSS	Quarterly	Quarterly	Monthly
Oil and grease	Biannually	Quarterly	Quarterly
Total P	Biannually	Quarterly	Quarterly
Total N	Biannually	Quarterly	Quarterly
BOD5	Quarterly	Quarterly	Monthly
PH	Quarterly	Quarterly	Monthly
EC dS/m; TDS	Quarterly	Quarterly	Monthly
Cations	Quarterly	Quarterly	Quarterly
SAR (√ (meq/L))	Quarterly	Quarterly	Quarterly
Metals	Yearly	Yearly	Yearly
Faecal coliforms (cfu/100ml)	Weekly	Weekly	Weekly

2.3.5 Managing Urban Stormwater: Soils and Construction

In NSW, the most relevant and comprehensive guidelines for the designs of stormwater controls relating to mines is contained in *Managing Urban Stormwater: Soils and Construction Vol 2E – Mines and Quarries* (DECC, 2008) in conjunction with the references to Volume 1 (Landcom, 2004). Both of these references are referred to in this report as the *Blue Book*. The principles of surface water control, including the design of ESC structures, have been adopted in this SWA where applicable.

2.3.6 NSW Farm Dams Policy

The *NSW Farm Dams Policy* was introduced in 1999. Under this policy it is not necessary to obtain a licence or other consent from DECCW for a farm dam provided:

- They are not collecting flow from a major stream; and
- The combined capacity does not exceed the Maximum Harvestable Rights Dams Capacity (MHRDC) for the property.

2.3.6.1 Maximum Harvestable Right Dam Capacity

All the sedimentation ponds are exempt from harvestable right calculations under the *NSW Farm Dams Policy*. This is because the purpose of the ponds is to prevent the contamination of downstream waterways.

3.0 EXISTING SURFACE WATER ENVIRONMENT

3.1 Climate / Rainfall

The Lake Macquarie region has a borderline oceanic/humid subtropical climate like much of central and northern NSW. Summers tend to be warm and winters are generally mild. Precipitation is heaviest in late autumn and early winter.

A review of the Bureau of Meteorology (BOM) website indicated that there were no weather stations located in the immediate vicinity of the Site, however, numerous stations were identified in the general Lake Macquarie region. All of these weather stations contain similar average annual rainfall statistics. Together, these weather stations contain over 100 years of complete daily rainfall data which made it suitable for use in the detailed water balance described in **Section 5.3.1**. Rainfall statistics for the Colliery region include:

- Minimum annual rainfall – 600mm in 1944;
- Average annual rainfall – 1206mm;
- Median annual rainfall – 1155mm; and
- Maximum annual rainfall – 2031mm in 1990.

The average annual evaporation at the Site is approximately 824mm and is highest in December and lowest in June. Additional information on the evaporation data and trends at the Site is provided in **Section 5.3.2**.

3.2 Landform

The Colliery's pit top area is relatively flat with the majority of the runoff flowing east into the sedimentation ponds, prior to discharge. Earthen diversion drains exist on the northern and eastern boundaries and help to convey this runoff into the ponds. Overflow from the sedimentation pond system discharges to Swindles Creek which flows into Lake Macquarie.

The car park and the adjacent access road are the only areas where the runoff does not discharge into the sedimentation ponds and is conveyed directly off-site. Management of the carpark runoff has recently been reviewed at the Colliery with recommendations and commitments provided within the Colliery's Water Management Plan (WMP) (**Appendix B**). No watercourses traverse the pit top facilities.

3.3 Surrounding Land Uses

The Colliery's pit top area is located on the western side of Chain Valley Bay, on relatively flat land, largely devoid of vegetation. It is situated in an existing industrial area accessed from Ruttleys Road.

The existing ventilation shaft and fans are located on freehold land at Tiembula Road, Summerland Point, on the eastern side of Chain Valley Bay. Parts of the Lake Macquarie State Conservation Area are located on both the eastern and western sides of the lake, which provide bushland and open space along the foreshore.

Neighbouring industrial facilities comprise Mannering Colliery to the south and Vales Point Power Station to the west. The nearest residential areas are Kingfisher Shores and Chain Valley Bay to the

south-east, Mannering Park to the north-west, and Summerland Point and Gwandalan to the north-east.

The area surrounding the Colliery is also used for a number of recreational purposes. Fishing and sailing are popular on Lake Macquarie, along with other water based recreational activities. Camping facilities, walking tracks and picnic areas are available within the Lake Macquarie State Conservation Areas.

3.4 Soils / Geology

The Colliery's surface facilities are situated on the shore of Lake Macquarie. This area principally comprises the Doyalson soil landscape with small parts on the Wyong soil landscape. The Doyalson soil landscape is characterised by gently undulating rises on Munmorah Conglomerate with broad crests, ridges and long gently inclined slopes. Local relief is up to 30 metres and slope gradient is less than 10%. Doyalson soils are strongly acidic, of low fertility and exhibit slight to high erodibility. The Wyong soil landscape is characterised by broad, poorly drained deltaic floodplains and alluvial flats of Quaternary sediments. Local relief is less than 10 metres and slope gradient is less than 3%. Wyong soils are strongly acidic, poorly drained, impermeable, of very low fertility and contain saline subsoils.

3.5 Existing Surface Water Quality and Assessment Criteria

3.5.1 Licensed Discharge Points

The discharge of excess mine water from the sedimentation and pollution control ponds is licensed under the *POEO Act* by the Environment Protection Authority (EPA) through the Chain Valley Colliery Environment Protection Licence (EPL 1770). Under EPL 1770 there is a single licensed discharge point for the Colliery (LDP 1) shown in **Figure 4.1**. The EPL has been modified a number of times, most recently in December 2011. A draft variation to EPL 1770 was also submitted by LakeCoal to the EPA on 7th February 2012. The EPA subsequently issued a draft variation to LakeCoal on 14th November 2012 which LakeCoal responded to with comments on 3rd December 2012. LakeCoal had not received any further feedback from the EPA and had not been issued with the EPL variation at the time this SWA was finalised (February 2013).

LDP 1 has a daily discharge limit of **12,161 kL/day** and a limit for pH and TSS as shown in **Table 8**.

Table 8: Concentration Limits for LDP 1 (EPL 1770)

Pollutant	Unit of Measure	100th percentile Concentration Limit
pH	pH	6.5-8.5
TSS	Milligrams per litre (mg/L)	25

Currently, discharge from Site is un-metred and is calculated from continuous monitoring of the underground pumping rates and surface flow meters. Water currently leaks from Pond D10 as per **Figure 4.1** and much of this water does not pass through LDP 1. LakeCoal is committed to rectifying LDP 1 and has engaged a dam engineer to design a metred spillway to be able to obtain direct measurements of the daily discharge from Site. LakeCoal is committed to upgrading the main embankment, spillway and discharge monitoring point of the final sediment dam as part of the Proposal.

EPL 1770 initially contained two discharge points, one at the pit top area (current) and a second at the Ventilation Shaft Site. These two points had individual discharge limits of 8161 kL/day and 4000 kL/day respectively. The separate discharge points related to the workings in both the Wallarah and Great Northern Seams, which had different pumps and pump out lines. With the cessation of mining in the Wallarah Seam (1997), the subsequent construction of a dewatering borehole from the Wallarah to the Great Northern Seam, and decommissioning of the pump out line leading to the Ventilation Shaft Site in 2003, the EPL was amended to combine the discharge volume limit (12,161 kL/day) to the single point at the pit top area as is currently contained in EPL 1770. It is expected that these volumes were originally based on mine dewatering data, with no consideration given to surface water runoff volumes.

3.5.2 Existing Surface Water Quality

Generally, the main runoff pollutants from the pit top area (including soils, roads and coal handling areas) comprise sediment and coal fines, which are both treated in the sedimentation ponds. However, there is some potential for this pit top runoff to contain hydrocarbons. Runoff from all areas where this is likely is directed to the oil/water separator, as described in **Section 4.2.6**. Water pumped from underground is saline and contains a number of heavy metals with concentrations elevated above ANZECC criteria. The management of this underground water is discussed in **Section 6.2.1**.

Due to the age of the Colliery and its previous operation under existing use rights, limited baseline water quality data was collected prior to Project Approval (MP 10_0161). However, following the project approval, regular sampling has been undertaken. Since 2008, regular water quality samples have been taken from LDP 1, and since September 2011, this sampling has been expanded to include upstream and downstream monitoring. The analysis results of these samples are presented in **Appendix A**.

One purpose of the monitoring currently undertaken is to enable site specific trigger values to be developed. The Colliery requires a minimum of 2 years of monthly sampling data for this to occur. Though baseline data only requires 2 years of data, LakeCoal intends to continue the monitoring program into the future with ongoing reviews of the developed site specific triggers and monitoring regime, based on the data collected.

EPL 1770 only sets concentration limits for pH and TSS, however it also defines a number of other pollutants to monitor. Regular monitoring of these pollutants has been undertaken as per the requirements of the EPL. In the absence of extensive baseline data, the most relevant water quality guidelines for the pollutants not covered by the EPL are the default trigger values presented in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) for slightly to moderately disturbed estuaries and marine environments in NSW.

The baseline data from LDP 1 presented in **Appendix A** shows that, historically, zinc, nickel, silver, copper, cobalt, cadmium and aluminium levels have exceeded the ANZECC guidelines. However, post-August 2010, the sampling procedure was improved to enable dissolved and total concentrations to be differentiated. Following the application of the improved monitoring procedure all pollutants have been below the ANZECC guidelines with the exception of copper and zinc which have had concentrations recorded slightly above the ANZECC guidelines (refer to **Appendix A** for more details).

A similar trend was observed in samples taken from the main pond discharge point except at this location, aluminium also exceeded the ANZECC trigger values on one occasion. It should be noted that aluminium and copper levels have routinely exceeded ANZECC guidelines in the upstream sampling point and aluminium, zinc and copper levels have exceeded ANZECC guidelines in the downstream sampling location.

Although it is recognised that some of the metal concentrations have exceeded the ANZECC (2000) criteria, it has not yet been established whether the results are indicative of on-site sources, upstream sources and/or background conditions.

In addition to the required monitoring, total oil and grease, anionic surfactants such as MBAS and faecal coliforms are also regularly monitored. The ongoing monitoring requirements are addressed in the **Section 8.0**.

4.0 EXISTING SURFACE WATER MANAGEMENT

Current water management is segregated into clean and dirty water systems and is achieved through the use of purpose built controls. The existing WMP for the Colliery was prepared in 2012 and consolidated the existing water management practices utilised at the pit top area with the water management requirements outlined in the Environmental Assessment (EA) prepared by AECOM in 2011 and subsequent project approval (MP 10_0161). A copy of the WMP is contained in **Appendix B**. An overview of the water management system at the pit top area is detailed below and shown on **Figure 4.1**. A schematic water flow diagram of the existing water management system is shown on **Figure 4.2**.

4.1 Existing Erosion and Sediment Control Structures

ESC structures are implemented across the Colliery's surface activities for all phases of the operation - including construction, operational, and maintenance activities - to mitigate the potential impact on watercourses and the surrounding environment. Water management at the Colliery comprises capture and treatment of 'dirty' water runoff from disturbed areas and underground water pumped from the main Great Northern Seam Sump. All surface mine water and underground mine water is captured by the Colliery's sedimentation dams prior to discharge under EPL 1770. The ponds discharge through LDP 1 into native vegetation and flow to Swindles Creek prior to draining into Lake Macquarie on the western shoreline of Chain Valley Bay. The ventilation shaft and fan site on the eastern side of Chain Valley Bay will not require upgrades to water management as a result of the Proposal. As such, this site is not considered further in this SWA. The WMP (**Appendix B**) contains further information on ESC structures to be used at the Colliery.

4.1.1 Clean Water Diversion

During the development of the WMP, improved clean water management was recommended through the use of catchment separation and the diversion of collected clean water away from disturbed areas through diversion banks and channels. In addition to this recommendation protection for the receiving environment is currently being improved by passing the clean water runoff through a basin prior to discharge from site. This basin is sized to provide an area where ponding can occur and allow coarse sediment to settle out and then to be removed. LakeCoal is currently in the process of implementing these recommendations.

4.1.2 Pit Top Catchment Areas

For the purpose of the SWA, runoff from the pit top area has been assessed in terms of four main catchment areas (shown in **Figure 4.1)** including:

- Catchment 1 – The carpark, office building and partial runoff from the workshop roof;
- Catchment 2 – The rear storage yard and oil water separator and the remaining workshop roofed area;
- Catchment 3 – The stockpile, entry road and bathhouse; and
- Catchment 4 – The sedimentation ponds.

Runoff from Catchment 1 has historically been considered clean catchment and as a result was not subject to water quality treatment. While a large portion of this area is undisturbed, the carpark is unsealed (gravel hardstand) and is responsible for some deposition of sediments in the adjacent drainage swales. Additionally runoff from the main entry and haul road has been occasionally reporting to this drainage swale resulting in the accumulation of coal fines. Formalised control

N
W
E
S

AREA TO BE REGRADED
VEGETATED AREA
WET AREA TO BE REHABILITATED
APPROX. LOCATION OF 330KV TRANSMISSION LINES
GPT
APPROX. BOUNDARY VEGETATED AREA
POWERLINES EASEMENT
DOWN CAST SHAFT
THE STORAGE YARD CATCHMENT (#2)
GPT
THE CARPARK CATCHMENT (#1)
COMPRESSOR OIL SEPERATOR
SURFACE WATER SILT TRAP DAM
REHABILITATED AREA
APPROX. LAKE MACQUARIE WATER MONITORING POINT
ENTRY GATE TO COLLIERY
D11
D12
D13
APPROX. OUTLINE PROTECTED WETLAND AREA
THE STOCKPILE CATCHMENT (#3)
D8
SETTLING AND DIFFUSING POND
APPROX. LOCATION OF DOWNSTREAM SAMPLING POINT RW1
D7
FILTRATION WALL
D9
WEIGHBRIDGE
SUBMERGED SPILLWAY
D10
LOWLYING MARSHLANDS EVAPORATION AREA
OVERFLOW
D6
OVERFLOW PIPE
D1
D5
MAIN SPILLWAY
COAL STOCKPILE AREA
OVERFLOW PIPE
D4
D3
D2
EPL 1770 LDP1
SEDIMENTATION POND CATCHMENT (#4)
SURFACE WATER FILTRATION DAMS
TIDAL CREEK
WATERCART REFILL LOCATION
APPROX. LOCATION OF UPSTREAM SAMPLING POINT USSP

LEGEND:

- STOCKPILE AREA
- EXISTING BUND LOCATION
- WATER BASIN
- CLEAN WATER DIVERSION CHANNEL
- DIRTY WATER DIVERSION CHANNEL
- CLEAN WATER FLOW ARROWS
- DIRTY WATER FLOW ARROWS
- BUND/CHANNEL CATCHMENT SEPARATION
- CATCHMENT BOUNDARIES
- POWER LINES
- PROPOSED BUND LOCATION
- VEGETATED AREA
- PROTECTED WETLAND AREA
- SURFACE MAINTENANCE STRATEGY AREA
- IRRIGATED TREATED WASTE WATER AREA

0 50 100m
Scale 1:2500

FIGURE 4.1

WATER MANAGEMENT SYSTEM (INCLUDING PROPOSED STRUCTURES)

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

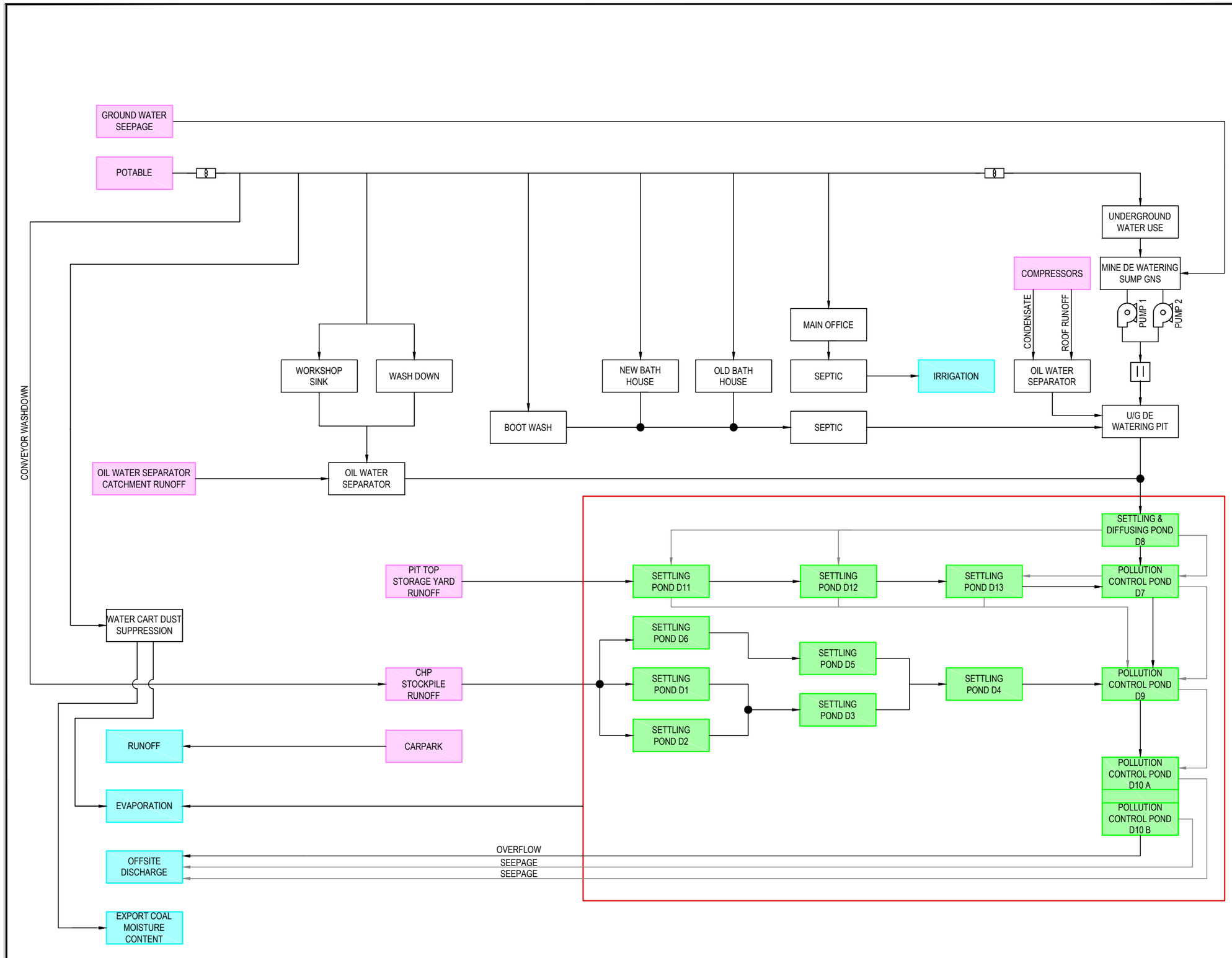
File:
Fg4.1_EMG00-008_Water_Management_System_130206

Projection:
GDA 94 MGA Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	28/08/2012	MS	DB	AB
2	06/02/2013	LH	DB	AB

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LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- MECHANICAL FLOW METER
- MAGNETIC FLOW METER
- FLOW DIRECTION

FIGURE 4.2

EXISTING WATER MANAGEMENT SYSTEM SCHEMATIC

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg4.2_EMG00-008_Water_Management_System_120904

Projection:
MGA_94 - ZONE 56

Version:	Date:	Author:	Checked:	**Approved:**
A	28/08/2012	MS	DB	AB
B	04/09/2012	MS	DB	AB

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structures to improve the runoff water quality from this catchment are described in the WMP **(Appendix B).**

The majority of runoff from Catchment 2 currently drains east into the sedimentation ponds via a pit and pipe network and earth bunding. Runoff from the area surrounding the oil water separator currently drains to an adjacent swale and is responsible for the deposition of fine sediments in this swale. The majority of the storage yard is gravelled hardstand, however, there are some exposed disturbed areas due to regular heavy vehicle movement resulting in runoff also containing sediment. This runoff is captured within the pollution control dams (dams D11, D12 and D13 shown on **Figure 4.1**) which function as primary settling ponds prior to discharge into the main sedimentation ponds D7 and D9.

Runoff from Catchment 3 is contained by two main drainage channels that surround the coal stockpile and report to the sedimentation ponds (Catchment 3). Runoff from this area contains a significant amount of coal fines. The runoff from the area adjacent to the weigh bridge currently collects and pools in an adjacent drainage channel. Runoff from the main entry/haul road contains coal fines and a small component of this catchment has been reporting to the clean water carpark catchment (Catchment 1). The majority of the runoff from Catchment 3 reports to sedimentation dams D1 to D6 (Catchment 4). These dams also function as primary settling ponds before discharging into the main mine water sedimentation ponds. A small portion of the area surrounding the Run-of-Mine (ROM) bin and bathhouse, reports to the storage yard area (Catchment 2).

The WMP includes measures to improve water management on site and ensure water management structures comply with industry best practice. Refer to the **Section 6.4** for details on the proposed changes relating to ESC. The minor upgrades and modifications to infrastructure proposed at the pit top area will not increase volumes of stormwater runoff from the Site.

4.1.3 Sedimentation Ponds

With the exception of the carpark stormwater runoff, all of the Colliery's 'dirty' water including surface water runoff, septic treated bathhouse wastewater, treated water from the oil water separator and underground mine water is conveyed into the sedimentation ponds (shown in **Figure 4.1**) prior to discharge under EPL 1770. These ponds treat the collieries wastewater and runoff quality through the settlement of fines and suspended solids. In addition, they also prevent hydrocarbon spills from discharging off-site and into Lake Macquarie. They have been constructed with a mixture of earth, crushed rock, crushed recycled brick and stone and are interconnected through a series of overflow pipes and spillways.

Water is directed through the ponds from a number of inlet locations. A detailed survey of the ponds was undertaken by Pearson and Associates in 2009 with the relative storage capacities provided in **Table 10**. Runoff from the stockpile area is collected primarily by ponds D1, D2 and D6 and is combined into D4 and D5 before flowing into D9. Runoff from the storage yard is directed to D11, D12 and D13 before also overflowing into D9.

The underground mine water is pumped to a pit adjacent to the compressor house and is combined with the septic treated wastewater from the bathhouse, the treated compressor condensate water and runoff from the ROM bin area. From this pit, the water is piped to D8 for settling and diffusion. Water within D8 spills into D7 via a spillway at the southern end of the pond. However, due to the leaky nature of the ponds an unknown amount of water diffuses through the pond walls. The water in D7 flows into D9 in a similar manner. In D9 the underground water is combined with the pit top runoff.

The primary spill from D9 to D10 is at the northern end of D9. Once in D10, the water travels over a shallow buffer spillway to the main discharge spillway and offsite at LDP 1. Currently the main discharge from the LDP is un-metred and the quantity of water discharged from site is calculated from continuous monitoring of the underground pumping rates and surface flow meters. As noted in

Section 3.5.1, LakeCoal is committed to upgrading the main embankment, spillway and discharge monitoring point of the final sediment dam.

4.2 Additional Water Management

In addition to ESC structures, there are a number of additional water management areas implemented at the Colliery. These are described below.

4.2.1 Potable water

Potable water, obtained from the Wyong Shire Council, provides the water required to support the Colliery's operation. Information supplied by LakeCoal indicates that approximately 132 ML/year of portable water is used by the Colliery. Potable water is consumed in the following processes:

- When cutting coal at the coal face - to reduce respirable dust and propensity for frictional ignition of coal dust and methane gas;
- When transferring coal along the underground conveyor system and at transfer points - to reduce dust make;
- In cleaning;
- In equipment;
- For drinking water supply;
- For emergency fire fighting purposes; and
- Pit top amenities, wash down and dust suppression activities.

It is estimated that approximately 20 ML/year (15%) is used for pit top operations and 112 ML/year (85%) is used in the underground operations. As required by Schedule 3, Condition 31(d) of MP10_0161, practical measures to minimise potable water consumption and maximise recycled water use have been and continue to be investigated by LakeCoal, as discussed in the WMP (**Appendix B**). Potential initiatives currently being investigated include;

- Reuse of dirty water contained within the sedimentation ponds for dust suppression purposes;
- Using the water cart for dust suppression of the ROM stockpile instead of the existing sprinkler system which is less efficient with water and is currently not operational; and
- Installing rainwater tanks on the operations block and workshop area including plumbing to the bathhouse.

However, the use of non-potable water in all operational activities is not possible due to its quality, work health and safety and equipment requirements.

4.2.2 Groundwater

In addition to the potable water, naturally saline groundwater migrates into the Colliery's underground workings. This water is pumped to the main sump within the Great Northern Seam, and then to the sedimentation ponds on the surface. This water cannot be used for operational purposes due to its high salinity.

4.2.3 Dust Suppression

An estimated 11-12 ML/per year of potable water is currently used for dust suppression. A reduction in the consumed volume is anticipated through the implementation of water for dust suppression on the ROM stockpile, haul roads and storage yard being preferentially sourced from the sedimentation ponds.

4.2.4 Alternative Supply

An investigation has been undertaken to source water from the Mannering Park Sewerage Treatment Plant (STP) following Reverse Osmosis (RO) treatment at Vales Point Power Station (VPPS). However, currently all available water is consumed in the VPPS operations.

As required in the future, alternative water sources will be investigated. The current considerations for alternative water supply include the surrounding unutilised bores and a comprehensive rain water harvesting system.

4.2.5 Wastewater Disposal and Management

There are two sources of domestic wastewater located at the pit top, namely the administration office building, and the bathhouse and operations area. Both wastewater streams are treated by separate treatment systems. The administration office stream treatment system comprises an aerated wastewater treatment system (AWTS) while the bathhouse system is a traditional septic system comprising a three part septic tank system. Following treatment, the office waste water is reused to irrigate the landscaping surrounding the office building via a drip irrigation system, while the bathhouse wastewater is discharged to the pollution control ponds.

LakeCoal is currently seeking to improve the effluent management on site by improving the quality or reducing the quantity of effluent discharged to the pollution control ponds and is currently seeking advice from Wyong Shire Council on the feasibility of connecting into a sewage pipeline located to the east of the pit top. This connection would enable the main waste water streams to be removed from the pollution control ponds on site.

During investigations into the feasibility of this connection, Chain Valley proposes to characterise the effluent waste streams and monitor the quality of the water discharged from the pollution control ponds for water quality parameters relevant to effluent. As discussed in **Section 8.5.1** and within the WMP (**Appendix B**), increased monitoring of both the effluent and effluent irrigation area is also undertaken, and will continue during the life of the Proposal, in accordance with the WMP.

4.2.6 Oil Water Separation

Water that is likely to be contaminated with oil and grease, such as runoff from the oil storage facilities, diesel tank storage, workshop/maintenance areas and wash bay is directed to and treated by an oil water separator. This system consists of a packed bed oil separation system where solids are removed in the grit trap, and oily water is drawn from the sump through a floating skimmer into the packed bed oil separator by a non-emulsifying pump. The oil water separation system was upgraded in 2012 and has a capacity of 2000L/hr through flow. The waste oil is collected in a container and the treated water flows by gravity to the sedimentation ponds.

An additional oil water separation system is installed on the condensate drain from the compressors on site. This system consists of an underground tank where water is passed through an under over weir arrangement prior to discharge to the sedimentation ponds.

5.0 SITE WATER BALANCE

5.1 Introduction

As part of this SWA, it was necessary to demonstrate that the proposed water management practices will comply with licence conditions with respect to discharge, or if this is determined to be unachievable, recommend mitigation and/or management measures to enable these conditions to be achieved. A site water balance has been developed to understand water demands and flows around the pit top area (surface component of the mine).

A water balance was undertaken for the site by AECOM in July 2011. The water balance investigation for the Proposal was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance included a more detailed investigation of the pit top water use to aid the future decision making process in regards to water management at the Colliery. This site water balance (provided in **Appendix C**) includes commitments regarding water savings measures to be implemented at the Colliery including the use of rainwater tanks and the reuse of dirty water from the sedimentation ponds for dust suppression purposes.

The model used to represent the Colliery water balance was GoldSim Version 10.50 (GoldSim Technology Group LLC). This software is a graphical, object oriented system simulation software for completing either static or dynamic systems. It is like a “visual spreadsheet” that allows one to visually create and manipulate data and equations. GoldSim is commonly used to undertake ‘daily time step’ water balance simulations for coal mines within NSW due its enhanced modelling capability and flexibility compared to spreadsheet models that have predominately been used in the past.

5.2 Model Representation and Accuracy

The Colliery water cycle, as proposed (including increased quantities of water make from underground, rainwater tanks and reuse of dirty water from dams for dust suppression purposes etc.) is shown in **Figure 4.1**, with a schematic water flow diagram provided in **Figure 5.1**. This system was simplified and modelled in GoldSim as shown in **Figure 5.2**. The following simplifications were incorporated in the model:

- Daily time steps over a simulation length of over 100 years were used for the analysis – daily rainfall data was the shortest data period available;
- A monte carlo (probabilistic) simulation with 100 realisations to simulate the uncertainty in the model results brought about by the variation in pumped flows from underground, and a deterministic simulation to model water processes at the site when pumping at the maximum pump rate from underground (worst case scenario);
- The underground storages within the Wallarah and Great Northern Seams were not modelled in the water balance due to operational uncertainties and uncertainties regarding the actual size of these storages. Based on information provided by LakeCoal, these underground storages were assumed to be sufficient to store water during periods of wet weather;
- The carpark catchment runoff was not included in the water balance as it does not report to the sedimentation ponds;
- Runoff from catchments was represented by an initial loss/runoff factor, as described in the site water balance report (**Appendix C**);
- The compressors at the site were not included for simplicity as their contribution to the overall water cycle was considered to be negligible;
- Operating rules/precedents were established within the model in accordance with advice from LakeCoal. In reality the same decisions may not be made by staff due to influences outside the model;

- Rainwater tanks collecting runoff from the workshop and old bath house roofed areas were modelled as an individual tank. Overflow from this combined tank was modelled as occurring when the capacity of the tank exceeded 80% of the overall capacity. Similarly, the tank was filled up with potable water when the capacity dropped below 20% of the overall capacity to ensure water was always available for proposed uses (toilet flushing and bootwash etc.);
- Ponds D1 to D6 and Ponds D7 to D13 were each modelled as single storages to simplify the water balance processes at the site;
- No amenity potable water used (sinks, showers, toilets, etc.) was assumed to be lost from the water balance system. In reality a small fraction of this water may be lost (e.g. through consumption, etc.) however this loss was considered to be negligible in regards to the overall site water balance; and
- Daily dust suppression was modelled to occur on days when less than 5mm of rain fell on the site. This dust suppression water was then modelled as leaving the site via either evaporation or within the exported coal.

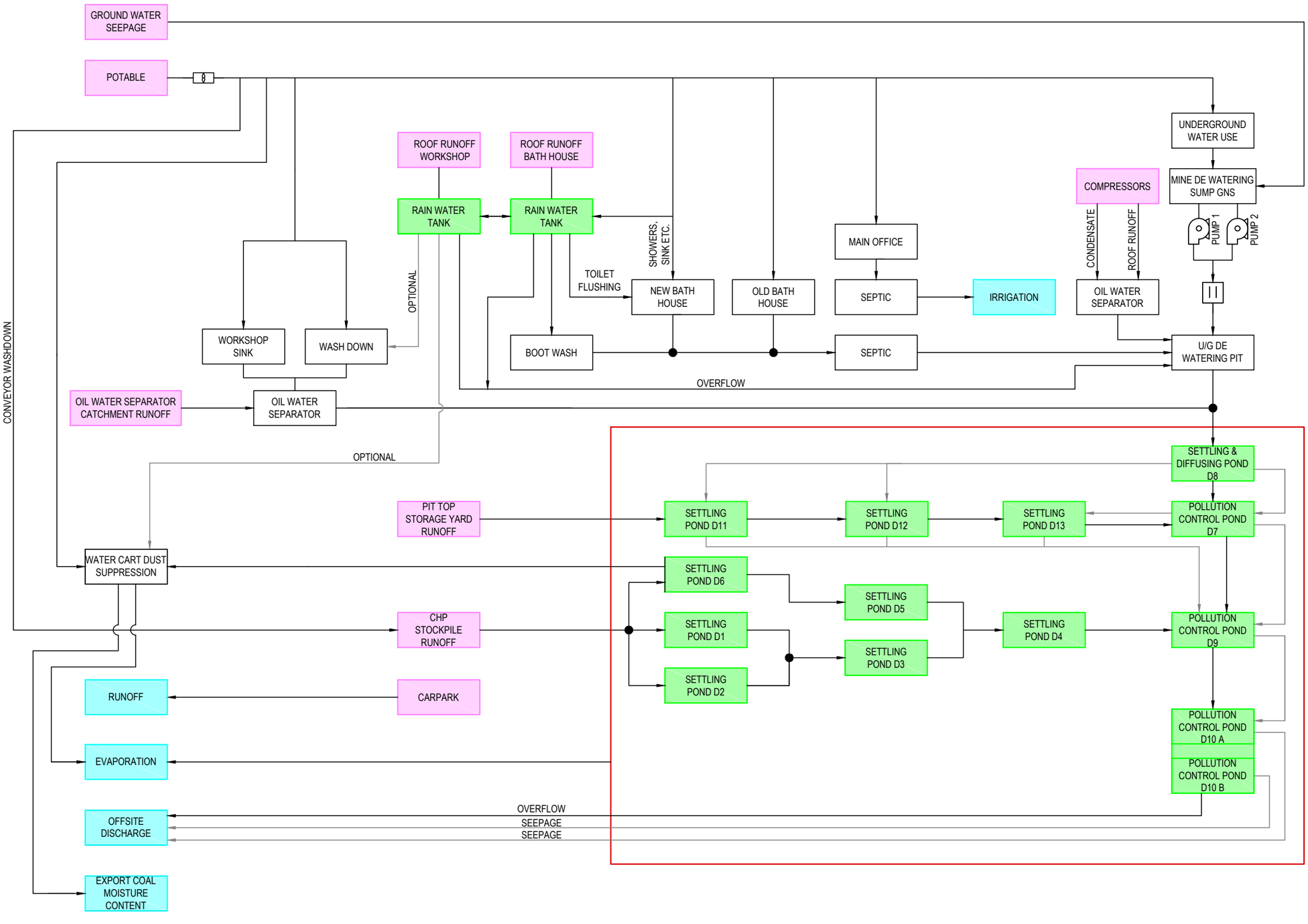
The accuracy of the model and results are limited by the following factors:

- Lack of sub metering data regarding pit top and specific areas of underground usage of potable water;
- Lack of water cart usage records to calculate seasonal dust suppression rates. Records from Summer and Autumn were available and an average daily dust suppression rate from these records was calculated and used in the water balance; and
- Distance between Peats Ridge BOM weather station (used for pond evaporation rates) and the site of 33km.

The effect of these errors is considered to be negligible in comparison to the variation in the daily volumes of water being extracted from the underground workings. It is also important to note that the volumes of water discharged via LDP 1 are not currently metered and hence the extent of any errors cannot be verified. Reference should be made to the Groundwater Assessment Report (Geoterra, 2012) regarding the accuracy of the expected volumes of water make as a consequence of underground mining that must be pumped to the surface and, ultimately, to the LDP.

Calibration of the model parameters was not possible in this investigation due to the lack of downstream monitoring information at LDP 1. A broad brush validation of the model results was undertaken based on a range of Average Recurrence Interval (ARI) rainfall events, a generalised estimate of storage capacity available within the sedimentation ponds, pumping rates, catchment areas and runoff coefficents. This ‘sanity check’ of the results demonstrated a strong correlation between the site discharges calculated for certain rainfall events and within the GoldSim model.

Where assumptions have been made, they have generally been conservative. Therefore, results presented in this section are considered to represent potential worst case impacts.



LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- MECHANICAL FLOW METER
- MAGNETIC FLOW METER
- FLOW DIRECTION

FIGURE 5.1

PROPOSED WATER MANAGEMENT SYSTEM SCHEMATIC

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

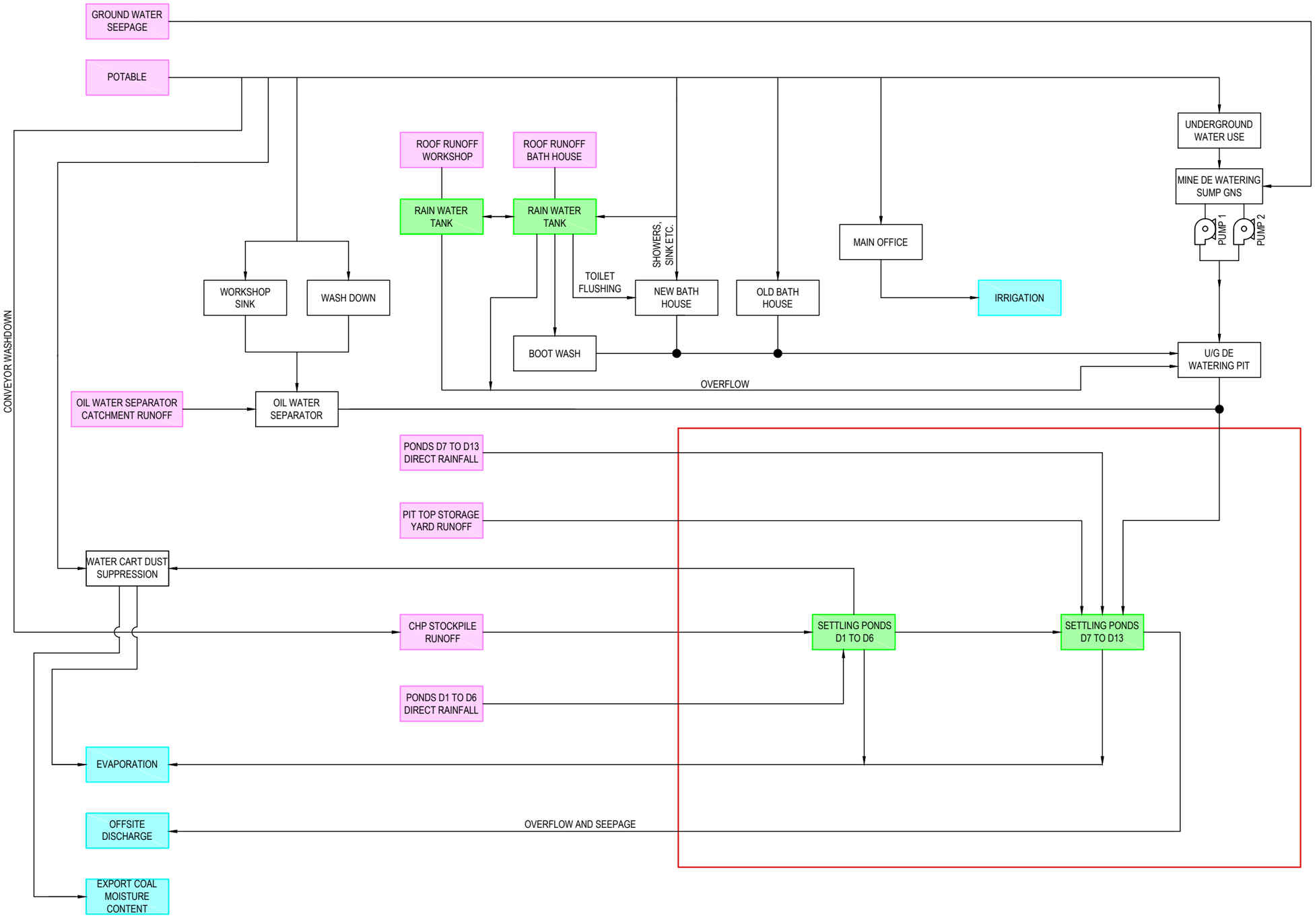
File:
Fg5.1_EMG00-008_Water_Management_System_120904

Projection:
MGA_94 - ZONE 56

Version:	Date:	Author:	Checked:	**Approved:**
A	28/08/2012	MS	DB	AB
B	04/09/2012	MS	DB	AB

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- FLOW DIRECTION

FIGURE 5.2

WATER BALANCE SCHEMATIC
AS MODELLED IN GOLDSIM

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg5.2_EMG00-008_Water_Management_System_120904

Projection:
MGA_94 - ZONE 56

Version:	Date:	Author:	Checked:	**Approved:**
A	28/08/2012	MS	DB	AB
B	04/09/2012	MS	DB	AB

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

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5.3 Data (Model Inputs and Outputs)

5.3.1 Rainfall Runoff

5.3.1.1 Rainfall

There are no long term weather stations located in the immediate vicinity of the Site, however numerous stations are located in the general Lake Macquarie region. Rainfall data was obtained from the BOM's website for these stations. A comparison of the average annual rainfalls at these stations is provided in the water balance (**Appendix C**). Rainfall information for a weather station at Mannering Colliery was also obtained. However, only 14 months of data was available. It was therefore excluded from the water balance model.

The dataset developed for the water balance used information from the Wyee and Norah Head stations. There are other stations in the general vicinity, however these stations (Wyee and Norah Head) were selected due to their proximity to the Colliery and length and completeness of the data, which together, provide over 100 years of rainfall data. A summary of the annual rainfall data used in the water balance is provided in **Figure 5.3**.

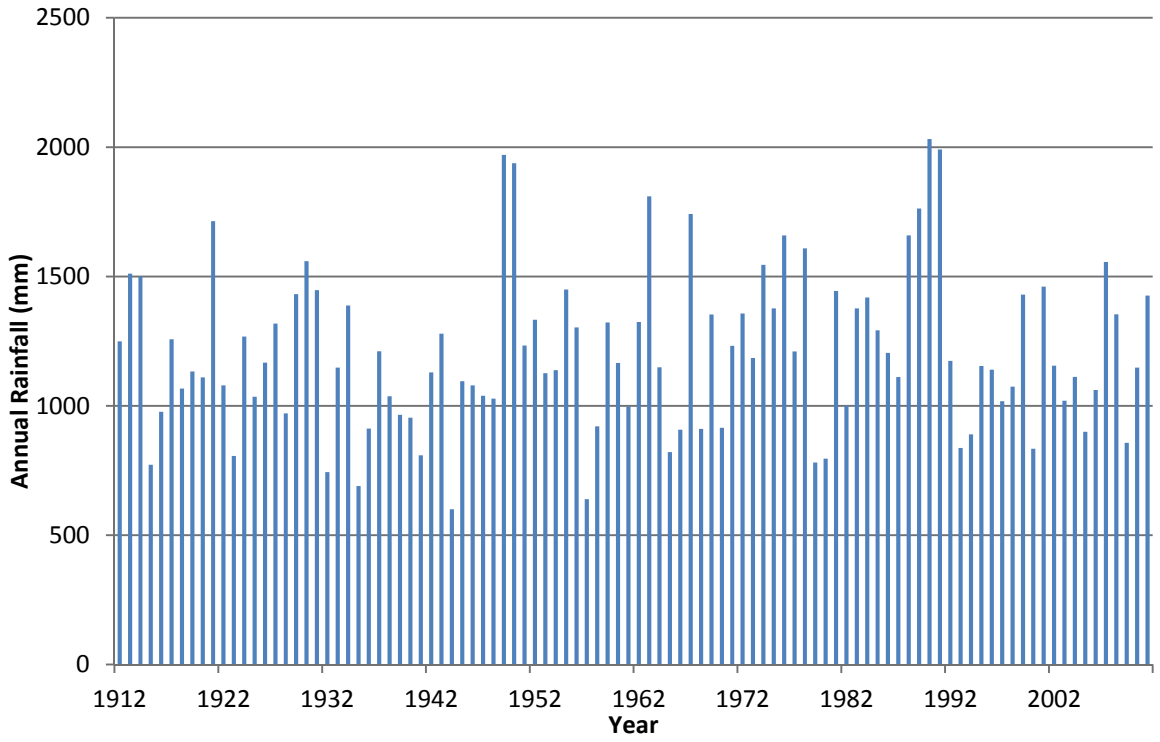


Figure 5.3 – Annual Rainfalls in Chain Valley Region

5.3.1.2 Runoff

Runoff volumes from the pit top areas were estimated using the rainfall data described above. The pit top area was segregated into four distinct catchments (as summarised in **Section 4.1.2**) using contour information provided by LakeCoal, information from the EA (AECOM 2011) and observations made by GSSE personnel during previous site inspections. These catchments were further broken up into eight sub-catchments for the purpose of the Colliery's water balance, as shown in **Table 9**.

With the exception of the carpark, runoff from each of these sub-catchments is directed to the sedimentation ponds. LakeCoal has committed to installing rainwater tanks connected to the

workshop and old bath house roofs. As such, these were included in the GoldSim model. Runoff from the car park discharges directly off-site, hence it is not part of the mine water cycle. Management of this carpark runoff has recently been reviewed at the Colliery with proposed water quality control measures contained within the WMP.

The daily step GoldSim model was used to estimate the surface water runoff from different sub-catchments at the pit top area. An initial loss and runoff factor was assigned to each sub-catchment. This was used to convert daily rainfalls into surface runoff values when the daily rainfall exceeded the initial loss of rainfall.

All hardstand areas were assigned an initial loss value of 2mm and a runoff factor of 0.9 which equates to a high proportion of rainfall/runoff. These runoff coefficients are considered conservative but reflect the large impermeable area in the catchment which includes laydown areas, compacted roads and coal stockpile areas. The free water surfaces of the sedimentation ponds and the roofed areas were modelled as completely impervious areas, capturing all precipitation.

Catchment areas and the estimated average annual runoff volumes estimated from the GoldSim model are provided in **Table 9.** This table also indicates which of the four main catchments (as shown in **Figure 4.1**) that these more specific areas fall within.

Table 9 – Pit Top Catchment Areas, Soil Loss Parameters and Estimated Average Annual Runoff Volumes

Major Catchment Name	Sub-Catchment Name	Catchment Area (ha)	Initial Soil Loss (mm)	Runoff Factor	Average Annual Runoff Volume (ML/year)
Carpark (Catchment 1)	Carpark (not modelled)	NA	NA	NA	NA
Storage Yard (Catchment 2)	Oil Water Separator	0.15	2	0.9	1.40
	Workshop (Roof)	0.24	2	0.9	2.82
	Old Bath House (Roof)	0.11	2	0.9	1.29
	Pit Top Storage Yard	3.03	2	0.9	27.63
Stockpile (Catchment 3)	CHP Stockpile	5.34	2	0.9	48.70
Sedimentation Ponds (Catchment 4)	Ponds D1 to D6	0.41	0	1.0	4.93
	Ponds D7 to D13	1.97	0	1.0	23.54
Total Catchment reporting to Sedimentation Ponds (excluding carpark)		**11.25**	**-**	**-**	**110.31**

5.3.2 Evaporation

Evaporation data was obtained from the BOM's station at Peats Ridge on Waratah Road (station number 61351), approximately 33km south-west of the mine. This was the closest meteorological weather station to the Colliery with over 25 years of evaporation information. Evaporation data from this weather station was adjusted for the change in site conditions from the measuring site to the sedimentation ponds by multiplying the average monthly rates by a pan coefficient of 0.7.

Figure 5.4 provides a representation of the adjusted average monthly evaporation at this weather station.

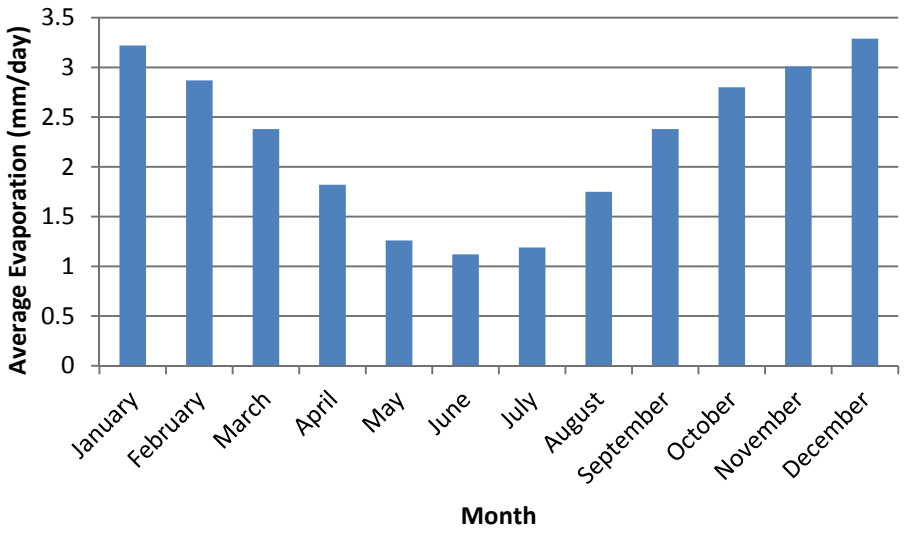


Figure 5.4 – Average Adjusted Monthly Evaporation Rates

The average annual evaporation rate was approximately 824mm as compared to the annual average rainfall of approximately 1206mm, giving an annual surplus (difference between annual rainfall and annual evaporation) of approximately 382mm.

Evaporation from the sedimentation ponds was calculated using a daily step within the GoldSim model similar to the runoff model calculations. This model used the evaporation rate, modified by the pan coefficient, and the surface area of the ponds, which was calculated using survey data provided by LakeCoal. Modelling in GoldSim indicated that approximately 19.2 ML of water would evaporate out of the sedimentation ponds on average every year.

5.3.3 Underground Water Extraction

The Groundwater Assessment (Geoterra, 2012) undertaken for this Proposal predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day as a result of the Proposal. This estimated pumping rate is an average value and therefore pumped flow rates may exceed this value on occasions. It should be noted however, that this average daily volume was calculated as an 'end of mining' estimate and can be considered a 'worst case' prediction of groundwater inflow rates and is not expected to occur for the majority of the Proposal life.

Pump rate information provided by LakeCoal indicates that the two existing underground dewatering pumps from the Great Northern Seam sump have a maximum pumping rate of 72 L/sec and 64 L/sec respectively. This equates to a total maximum pumping rate from underground of approximately 11.75 ML/day. However, within 12 months of the Proposal being approved LakeCoal is committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day (equivalent to the predicted average daily volume that will need to be pumped from the coal face during the later stages of the Proposal). The proposed timing of this commitment's implementation is dictated by the substantial upgrades required to fully automate the pumps and have them controlled by a SCADA system.

It is noted that a number of storages exist in both the Great Northern and Wallarah Seams. As such, it would be possible to turn these pumps off during periods of high rainfall in order to stay within the LDP discharge limit of 12.161 ML/day. This is further discussed in **Section 6.2.1.**

5.3.4 Sedimentation Pond Characteristics

Information pertaining to the GoldSim modelling of the sedimentation ponds was obtained from survey data supplied by LakeCoal. This information is shown in **Table 10**. It should be noted that the volume of Pond D6 was not available and was estimated based on a 1m depth, the surface area and standard stage/storage relationships. Ponds D1 to D6 and D7 to D13 were each modelled as single storages to simplify the water balance processes at the Site.

Table 10 – Sedimentation Pond Parameters

Pond	Surface Area (m^2)	Volume (m^3)
D1	201	80
D2	178	51
D3	317	284
D4	1153	547
D5	726	770
D6	568	568[1]
Total Ponds D1 to D6	**3143**	**2300**
D7	3323	3856
D8	3423	2933
D9	3287	3796
D10	3707	4802
D11	391	297
D12	523	229
D13	370	168
Total Ponds D7 to D13	**15 024**	**16 081**

1. *Calculated using surface area and assumptions from LakeCoal based on site observations.*

5.3.5 Loss of Water through Coal Export

During mining and conveying, the moisture content in the coal increases due to the use of water sprays at the coal face and at transfer points along the conveyor system. A review of the Colliery's coal analysis data indicates that the inherent (air dried) moisture content of the coal from underground is approximately 2.7%. This same data indicates that the total moisture of the Colliery's coal that is exported from the Colliery is approximately 7.3% which means that around 4.6% of this total moisture content is added to the coal prior to export. This equates to 69,000 tonnes of additional water at the proposed maximum rate of production of 1.5 Mtpa. Therefore, approximately 69.0 ML of water is exported from the Colliery every year, or 188.9 kL/day.

5.3.6 Additional Data Supplied by LakeCoal

A limited amount of water usage and flow monitoring data at Colliery was available for this water balance investigation. However, where historic information was lacking, data and operational information was made available to best derive estimates of the respective water balance parameters (flow rates, water usage, etc.). Additional data supplied by LakeCoal, as used in the water balance model, is shown in **Table 11**, as well as comments/assumptions on how this data was derived.

Table 11 – Supplied and Derived Data

Parameter	Value	Comments/Assumptions
Potable Water: Underground (includes increase of 25% to account for any additional underground potable water demand)	139.583 ML/yr	Average of underground potable water from March and April 2012 (monitored water use) with an additional 25% to account for increased potable water used underground as a result of the Proposal.
Potable Water: Main Office	211 L/day	Includes shower, sink and toilet facilities. Shower (26 L/day): Assumes 9L/min, 10 min/person, 2 showers per week. Toilet (154 L/day): Assumes 12 employees, employees at work 5 days/week, 6 L/toilet flush, average employee flushes 3 times/day (at work). Sink (31 L/day): Assumes 12 employees, 1.2 L/wash, employees at work 5 days/week, employees use sink 3 times/day.
Potable Water: Workshop	3724 L/day	Includes equipment washdown and sink use. Equipment Washdown (3712 L/day): Assumes 1 hour wash/day, 1.031 L/sec flow rate. Sink (12 L/day): Assumes 1.2 L/wash, 1 sink used 10 times per day.
Potable Water: Old Bath House	24 L/day	Includes sinks facilities. Sinks (24 L/day): Assumes 1.2 L/wash, 2 sinks each used 10 times per day.
Potable Water: New Bath House (Showers, Sink)	8519 L/day	Includes shower and sink facilities (assumes rainwater tank water used for toilets flushing). Shower (8190 L/day): Assumes 9L/min, 10 min/person, average of 91 shift ends / day (calculated from shift information provided by LakeCoal). Sink (329 L/day): Assumes 160 employees, 1.2 L/wash, employees at work 4 days/week, employees use sink 3 times/day.
Potable Water: Conveyor Washdown	11.135 kL/day	Assumes it is used 3 hrs/day, 1.031 L/s flow rate.
Bootwash Water Demand	273 L/day	Assumes it is used 3 L/person/shift, average of 91 shift ends / day (calculated from shift information provided by LakeCoal).
New Bath House Toilet Flushing Demand	1097 L/day	Assumes 160 employees, employees at work 4 days/week, 4 L/toilet flush (reduced for urinals), average employee flushes 3 times/day (at work).
Dust Suppression Demand	11.28 ML/yr	Calculated from available water cart records (3/01/2012 to 11/05/2012).
Combined Rainwater Tank Capacity	30 kL	Proposed rainwater tank capacity from discussions with LakeCoal and commitments made in the WMP.

5.4 Water Balance Results

5.4.1 Expected Discharge from the Colliery

The probabilistic GoldSim simulation indicated that when applying the historic variation in pumping rates from underground to the predicted 'worst case' average of 10.5 ML/day, the corresponding 95th percentile average daily discharge volume of 13.171 ML/day (including pit top runoff) exceeds the daily discharge limit of 12.161 ML/day. The greatest volume calculated in GoldSim using this probabilistic analysis was 14.394 ML/day.

However, as noted in **Section 5.3.3**, LakeCoal is committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day within 12 months of the Proposal being approved. As such, the GoldSim model was run (using a deterministic simulation) assuming that the pumps from the Great Northern Seam sump were constantly pumping at this 10.5 ML/day rate. This scenario assumes that adequate capacity is available in the underground workings to effectively store water during periods when the groundwater inflow rate exceeds the underground dewatering rate. This is further discussed in **Section 6.2.1**. It should be noted that assuming a constant underground pump rate of 10.5 ML/day is a 'worst case' scenario and is only predicted to occur, on occasions, near the end of the Proposal's life.

The daily discharge through LDP1 predicted by GoldSim assuming a constant underground pumping rate of 10.5 ML/day is shown in **Figure 5.5**.

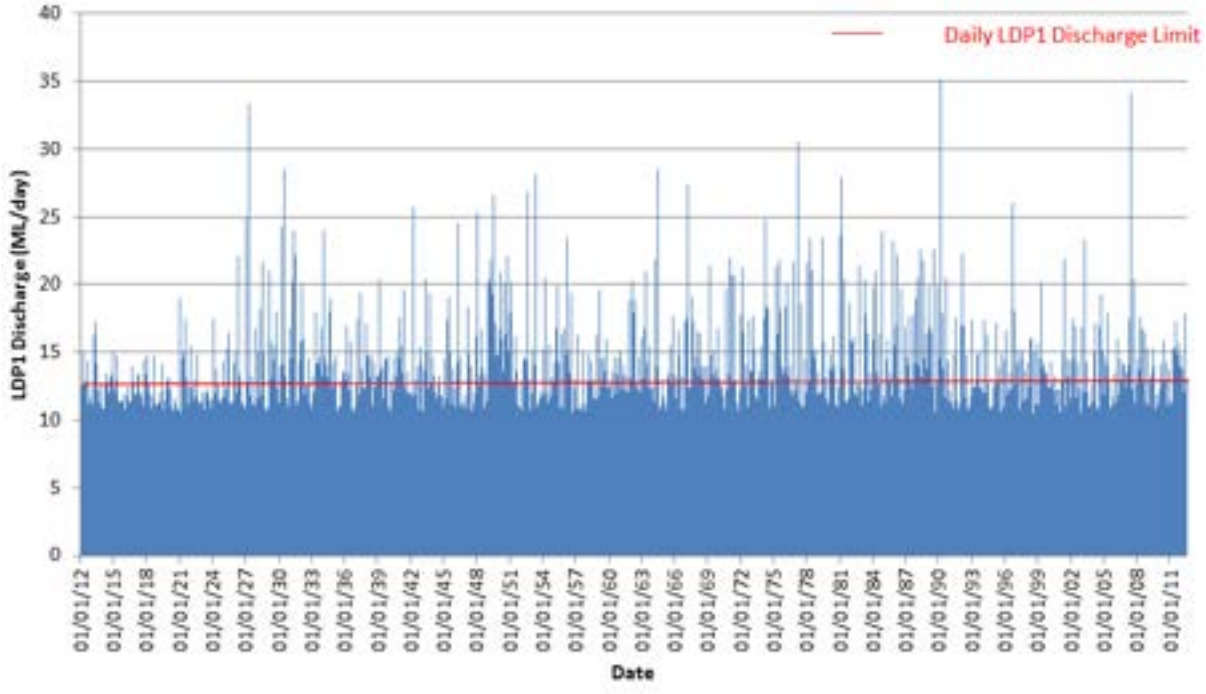


Figure 5.5 – LDP1 Discharge Results Assuming Constant Maximum Pumping Rate from Underground

The results shown in **Figure 5.5** indicate that if water make from underground is constantly pumped to the surface at 10.5 ML/day then exceedances of the LDP1 limit of 12.161 ML/day will occur regularly.

Key statistics from this GoldSim modelling, assuming a constant discharge from underground of 10.5 ML/day, include:

- Daily average discharge through the LDP1 of 10.716 ML/day;

- Maximum discharge through LDP1 of 35.124 ML/day; and
- Likelihood of LDP1 exceedance on any given day of 4% (or approximately 15 times per year).

These results indicate that underground storages within the Great Northern and Wallarah Seams are required to mitigate peak groundwater inflow rates. In addition, the results indicate that additional storm surge storage capacity is required at the pit top area to effectively mitigate peak runoff flow rates during large rainfall events, even when no pumping from underground occurs during such an event. These issues are further described in **Section 6.2.2**.

5.4.2 Potable Water Use

The total amount of potable water used at the colliery was investigated in the GoldSim model, with and without the committed water savings measures (as described in **Sections 4.2.1**) in order to quantify how much potable water these measures are likely to save at the site. GoldSim modelling estimates that the potable water used in the pit top area will be reduced from 55.9 kL/day to 23.7 kL/day with an overall saving of 32.3 kL/day (11.8 ML/year) as a result of water saving measures being implemented.

This equates to an approximate reduction in total potable water of 8.9% (for current levels of potable water use) and 7.4% (allowing for a 25% increase in the underground potable water use as a result of the proposed future mining works).

6.0 SURFACE WATER IMPACTS AND PROPOSED MANAGEMENT MEASURES

The following section outlines the anticipated surface water impacts associated with the Proposal, and the proposed surface water management measures to be implemented at the Colliery. The Proposal includes only minor upgrades and modifications to surface infrastructure within the Colliery's pit top area. The Proposal's greatest potential to impact on surface water is from the increased water make expected from the proposed extension of underground mining activities. Therefore, management predominately focussed on this element of the Proposal.

6.1 Objectives

The key objectives of surface water management at the Colliery, as addressed in this SWA, are:

- the prevention of the flow of pollutants into watercourses and the sedimentation on receiving waters, being Swindles Creek to the east of the pit top and Lake Macquarie;
- the control of discharges from the site to ensure that all discharges are within the water volume and quality criteria set out in EPL 1770;
- to minimise site potable water usage requirements and maximise runoff water reuse; and
- to ensure there is sufficient water available to meet the Colliery's water requirements.

6.2 Water Discharge Quantity Management

6.2.1 Pit Top Area including Pumping from Underground

The water balance model demonstrated that with a constant pumping rate from underground of 10.5 ML/day (equivalent to the predicted average daily volume that will need to be pumped from the coal face during the later stages of the Proposal) the Colliery has the potential to exceed the 12.161 ML/day LDP1 discharge limit approximately 4% of the time (equivalent to 15 days per year). As such, it is proposed to utilise the existing underground storages to store excess water in order to reduce the number of potential exceedances of the discharge volume limit. Using underground storages for water management is common practice in Hunter Valley coal mines and is already undertaken at the Site to a certain extent.

LakeCoal has indicated to GSSE that operationally the Colliery can store approximately 3 to 4 weeks worth of groundwater within the Wallarah and Great Northern Seams. This equates to somewhere between 255 to 305 ML of storage capacity (as shown in the draft 'Water Storage & Pump Lines Schematic' provided by LakeCoal) that could be used to store groundwater during periods of wet weather or to attenuate pumping requirements during periods of excess groundwater inflow towards the end of the Proposal's life. If operated and managed effectively it is considered that this amount of underground storage will be sufficient to adequately manage the predicted increase in water make expected as a result of the Proposal. It is recommended that an investigation into the actual available underground storage capacity be undertaken due to the importance of this storage in regards to the management of water during the life of the Proposal.

As discussed in **Section 5.3.3**, LakeCoal is committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day. As a result of this commitment and the utilisation of the underground storages the Proposal is not expected to increase the existing flow rates pumped to the pit top area from the main Great Northern Seam sump. As such, the Proposal is not expected to have any negative impacts on the surrounding environment, including cumulative impacts, long term

impacts and impacts to riparian corridors and creeklines. In addition, all mine water extraction will be measured daily and daily discharge volumes will be reported publically on a monthly basis via LakeCoal's website.

6.2.2 Storm Surge Capacity in Sedimentation Ponds

Although the Proposal is not expected to have any negative impacts on the surrounding environment, the GoldSim water balance undertaken for the Proposal did indicate that additional pond storage capacity or an amendment to EPL 1770 is currently required in the pit top area to adequately manage peak runoff flow rates during large rainfall events. These findings are different from those made during the AECOM (2011) water balance which was only based on annualised runoff volumes and did not take short term, high intensity, rainfall spikes into consideration.

Due to the regular pumping from underground and no existing procedures relating to the active dewatering of the sedimentation ponds, the Colliery does not appear to have sufficient storm surge capacity to mitigate peak runoff flow rates from the pit top area in order to comply with the 12.161 ML/day daily discharge limit at LDP 1. This lack of 'available' storage within the ponds is generally only considered to be an issue regarding the daily discharge limit volume and is not believed to be a significant water quality issue, primarily because the runoff from the pit top area is generally considered to be of a better quality compared to the water make from underground. Further the predicted frequency of this occurring is predicted to be approximately 15 times per year when the pump rate from the underground workings is limited to 10.5 ML/day.

As described in **Section 3.5.1**, it is believed that the 12.161 ML/day daily discharge limit was initially set with no consideration given to surface water runoff volumes. Assuming a maximum pumping rate from underground of 10.5 ML/day (as committed to by LakeCoal as part of this Proposal), calculations within the GoldSim water balance model indicate that the 12.161 ML/day daily discharge limit at LDP 1 would be adhered to for a 17mm rainfall event over a 24 hour duration. Therefore, as part of the Proposal LakeCoal will seek an amendment to EPL 1770 to include a condition on the daily discharge volume limit stating that:

> *'Exceedance of the volume limit for Point 1 is permitted only if the discharge from Point 1 occurs solely as a result of rainfall at the premises exceeding 10mm during the 24 hours immediately prior to commencement of the discharge'.*

This proposed amendment to the EPL would resolve the issues associated with the lack of 'available' storage within the ponds and allows for the relative accuracy and assumptions made with regards to runoff volumes from the pit top area. EPL conditions such as the condition proposed above are not uncommon in the Lake Macquarie region with both Mandalong and Mannering mines containing similar conditions within their respective EPLs.

6.3 Water Quality Management

An assessment of the potential impact of the Proposal on the water quality of the downstream receiving waters (including Lake Macquarie) primarily relates to the expected quality of groundwater make as a result of the proposed mining operations. Water inflow from a dyke in the Fassifern Seam is relatively fresh to brackish, but inflows from the Wallarah and Great Northern Seams have salinity levels similar to seawater, indicating a hydraulic connection (albeit through an indirect pathway) to Lake Macquarie.

The Groundwater Assessment predicted that the overall water inflow quality into the proposed Fassifern Seam workings will be similar to the existing water quality. If the fracturing in the proposed, previously un-mined areas does not create a hydraulic connection with the Lake (as predicted in the Subsidence Impact Assessment, Ditton 2012) then the Proposal may result in an improvement to the underground water quality by diluting the current Wallarah and Great Northern Seam inflows.

However, LakeCoal has identified that the majority of the groundwater make comes from the Wallarah and Great Northern Seams and therefore freshening of the groundwater is unlikely.

Since the water make from underground is not expected to change in regards to both peak flow rates (refer to **Section 6.2**) and water quality, the Proposal is not expected to have any detrimental impacts to the surrounding environment, including cumulative impacts, long term impacts and impacts to riparian corridors and creeklines. Reference should be made to the existing surface water quality described in **Section 3.5.2** and the WMP (**Appendix B**). It is recommended that:

- more extensive baseline water quality data be collected to aid the development of appropriate pollutant trigger values (refer to Sections 8.2 and 8.3); and

- LakeCoal engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and issue this assessment to the EPA by the 31st December 2013.

6.4 Erosion and Sediment Control Structures

A number of improvements to ESC structures will be implemented in accordance with the WMP (refer to **Appendix B**), however these improvements are unrelated to managing potential impacts arising from the current Proposal. Since no changes to runoff regimes at the pit top area are anticipated as a result of the Proposal, no additional ESC structures are required in this area to facilitate the proposed underground mining works.

In accordance with the DGRs, should trucks continue to be used for coal haulage, LakeCoal will upgrade the truck washing facilities at the pit top area including capability to wash wheels and under the body of vehicles leaving the premises. As discussed in **Section 3.5.1**, the Colliery are also committed to rectifying issues relating to LDP1 including the currently un-metered discharge from site and seepage along the external dam wall that surrounds Pond D10.

6.5 Potable Water Management

Since the introduction of the miniwall mining method, the demand for potable water in underground operations has increased. An additional amount of potable water used in the underground operations is therefore likely due to the Proposal. From discussions with LakeCoal, it was estimated that this increase could be as high as 25%. Although this increase was incorporated into the site water balance (**Section 5.0**), it should be noted that this increase is very much an upper limit estimate and is considered conservative for the proposed works at the Colliery.

Potable water is an increasingly valuable and scarce resource and stakeholder concerns have been raised regarding the volume of potable water being consumed on-site. Therefore, LakeCoal is committed to trying to minimise their potable water use at the site. As part of the EA (AECOM, 2011), LakeCoal made a number of commitments including the installation of rainwater tanks on two buildings at the pit top area. These rainwater tanks, which would collect runoff from the workshop and old bath house roof areas as described in **Section 5.0**, were included in the water balance investigation.

LakeCoal also intend on reducing the potable water consumption at the site by drawing water from the sedimentation ponds to use on-site for dust suppression purposes. LakeCoal has indicated that Pond D6 is practically the most appropriate pond to draw the water from, although the surrounding ponds D1-D5 could also be used if required. This water use for dust suppression purposes was also included in the water balance modelling of the site.

As discussed in **Section 5.4.2,** the site water balance investigated the total amount of potable water used at the Colliery, with and without the water savings measures described above. The water

balance model estimated that the potable water used in the pit top area will be reduced from 55.9 kL/day to 23.7 kL/day with an overall saving of 32.3 kL/day (11.8 ML/year) as a result of these water saving measures.

Since the potable water used underground is much higher than the potable water used in the pit top area (approximately 85% of the total potable water use) a reduction of the potable water used in the underground mining operations will have more of an effect on the overall potable water used at the site. Underground potable water saving measures should be investigated to minimise the amount of potable water required from Wyong Council. Environmentally feasible alternative water sources will also be investigated by LakeCoal, with investigations being undertaken to source water from the Mannering Park Sewerage Treatment Plant (STP) following Reverse Osmosis (RO) treatment by Vales Point Power Station. However, currently all available water is consumed in the Vales Point Power Station operations.

7.0 SITE WATER MANAGEMENT PLAN

The Colliery's existing WMP, prepared in accordance with the requirements of Conditions 28 to 33 Schedule 3 of Project Approval MP 10_0161, was completed by GSSE in August 2012, in consultation with NOW, Division of Resources and Energy, the Department of Trade and Investment, Regional Infrastructure and Services and Wyong Shire Council, This WMP has been provided in **Appendix B** and incorporates:

- An existing site Water Balance;
- An Erosion and Sediment Control Plan;
- A Surface Water Management Plan;
- A Groundwater Monitoring Program; and
- A Surface and Ground Water Response Plan.

The site water balance presented in the existing WMP is a summary of the water balance completed for the Colliery's existing operations (AECOM, 2011). This water balance has been updated for this SWA and is presented in **Section 5.0**.

The Erosion and Sediment Control Plan (ESCP) was developed to minimise soil erosion and the potential discharge of sediment to downstream waters during mining. It recommends ESC Structures (refer to **Appendix B)** in accordance with best management practices and the requirements of Managing Urban Stormwater: Soils and Construction (the Blue Book), Volume 1 and Volume 2E – Mines and Quarries (Landcom, 2004 and Department of Environment and Climate Change (DECC), 2008).

The WMP also outlines the water management currently undertaken at the Colliery and documents potential methods for minimising potable water consumption, increased recycled water use, and improved management of surface rainfall runoff and wastewater; and includes a detailed monitoring program for both surface and underground waters. These programs include a method for the development and maintenance of baseline water quality data, a review of site appropriate assessment criteria and a program to monitor mining related impacts on the receiving environment.

A review of the existing WMP will be undertaken in line with the findings of this SWA should the Proposal be approved, with further updates to be undertaken on the basis of operational experience, monitoring results and the determination of site discharge assessment criteria

8.0 SURFACE WATER MONITORING PROGRAM

8.1 Introduction

A Surface Water Monitoring Program (SWMP) was completed by GSSE in August 2012 as part of the Colliery's WMP. This SWMP was developed to ensure the continued functionality of the surface water management system and to assist LakeCoal in identifying any potential issues with the system. It was prepared in accordance with Schedule 3, Condition 31 of MP10_0161 and includes:

- baseline data on surface water flows;
- surface water impact assessment criteria;
- a program to monitor the impact of the project approval under MP10_0161 on surface water flows and quality; and
- procedures for reporting the results of this monitoring.

The Proposal is not expected to require changes or upgrades to the existing surface water management structures, i.e. with the exception of potential methods to increase the storm surge capacity at the pit top area and the provision of new truck washing facilities, if required. As such, the SWMP detailed in the WMP is still applicable to the Proposal and is summarised in the following sections.

8.2 Baseline Data

The baseline water quality data available for the site is presented in **Section 3.5.2**. The amount of baseline data available is limited, as no baseline water quality data was collected prior to the previous project application. Since 2008 regular water quality samples have been taken from LDP 1 and since September 2011 this sampling was expanded to include upstream and downstream monitoring.

8.3 Surface Water Impact Assessment Criteria and Trigger Levels

The Colliery is in the process of collecting baseline water quality monitoring data, for parameters documented in EPL 1770, with the view of determining site-appropriate trigger values for discharges at the LDP. The Australian Government's *National Water Quality Management Strategy* outlines the procedure for establishing water quality trigger values. The strategy suggests that a minimum of two years of continuous monthly data at a reference site is required for a valid, site-appropriate trigger to be established. During the collection of this baseline data, water quality data is assessed to determine if it is generally in accordance with (ANZECC 2000) 'trigger' values.

When considering assessment criteria and trigger levels, it is important to note that historic industrial activities and catchment development within Lake Macquarie have resulted in significant heavy metal contamination of the Lake Macquarie waters and sediments. Sediments on the seabed of Lake Macquarie have been found to contain elevated concentrations of cadmium, lead, mercury, selenium, silver and zinc, with the greatest contamination found near the power stations in the northern areas of the Lake (Roach, 2005). Sediments sampled from the southern areas, including Chain Valley Bay, have also reported concentrations significantly above background levels, indicating lake-wide contamination. Arsenic and copper concentrations have also been identified at elevated concentrations in sediments throughout the Lake, suggesting impacts typical of diffuse sources (Roach, 2005). Additionally, with the industry located upstream of LDP 1, including the sewerage works and Mannering Colliery, specific trigger values for heavy metal concentrations cannot be prescribed until such time that site-appropriate trigger values are established.

As recommended by the above *National Water Quality Management Strategy*, exceedances of the ANZECC (2000) trigger values should be taken as an 'early warning' mechanism to alert managers of

a potential impact which may require mitigation. Until such time as appropriate trigger levels are established, exceedances of the ANZECC (2000) trigger values, with the exception of metals, will result in an investigation being undertaken into the source of the exceedance. Monitoring values for metals shall be investigated if the analysis reveals a value of two standard deviations from the mean of the historical monitoring data from August 2011. Assuming normal distribution, two standard deviations from the mean will account for 95% of the range of historical values. This value will become more appropriate as monitoring continues.

The Colliery's response plan is contained within the WMP provided in **Appendix B**. This plan states that following notifications of an incident, site personnel at Chain Valley will immediately focus on the mitigation of any potential environmental harm. Should potential or actual harm to the environment be identified, the appropriate regulatory authority (ARA) shall be immediately notified and remediation measures applied. Where ameliorative actions may reduce the threat or harm to the environment, action will be undertaken immediately to mitigate or rectify the issue. These actions will be followed by an investigation into the cause of the incident.

Table 12 provides a list of trigger values already utilised by the Colliery in addition to the pH and TSS limits within EPL 1770. These values typically represent the 95% marine protection values from the ANZECC water quality guidelines.

Table 12 – Pollutant Trigger Values for Chain Valley Colliery

Indicator	Trigger Value (µg/L)
Other	
Total phosphorus	30 (µg/L)
Total nitrogen	300 (µg/L)
Surfactant[1] (MBAS)	200 (µg/L)
Biologicals	
Faecal coliforms	Median < 1000 faecal coliforms per 100 mL, with 4 out of 5 samples < 4000/100 mL
Enterococci	Median < 230 Enterococci per 100 mL (maximum number in any one sample: 450-700 organisms/100 mL).

1. *ANZECC guidelines for recreational purposes adopted.*

8.4 Surface Water Monitoring and Frequency

The Colliery's existing water monitoring program is not expected to require amendment as a result of the Proposal. Water monitoring will continue to be undertaken in accordance with EPL1770 and the WMP, which includes monitoring of parameters and locations above and beyond those required by EPL 1770. The monitoring locations, pollutants to be monitored and the required frequency are detailed in **Table 13** with the position of these monitoring locations shown on **Figure 8.1**.

All monitoring of waters will be undertaken in accordance with *Approved Methods for Sampling and Analysis of Water Pollutants in NSW* (DECCW, March 2004). Additionally, pollutant concentration measurements will be reported in micrograms per litre (ug/L) and within ANZECC detection limits as required.



LEGEND:

SURFACE WATER MONITORING SITE

0 50 100 150m

Scale 1:2500

FIGURE 8.1

SURFACE WATER MONITORING LOCATIONS

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg8.1_EMG00-008_Water_Management_System_130206

Projection:
GDA 94 MGA Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	28/08/2012	MS	DB	AB
2	06/02/2013	LH	DB	AB

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Environmental, Land and Project Management Consultants

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Table 13 – EPL 1770 Surface Water Monitoring Locations and Frequency

Identification	Type of Monitoring Point	Pollutants (µg/L)[1]	Frequency	Sampling Method
Dam 10 Outlet	Outlet of Final Sedimentation Dam	Aluminium (dissolved) Aluminium (total) Arsenic (dissolved) Arsenic (total) Beryllium (dissolved) Beryllium (total) Cadmium (dissolved) Cadmium (total) Chromium (dissolved) Chromium (total) Cobalt (dissolved) Cobalt (total) Conductivity (µS/cm) Copper (dissolved) Copper (total) Lead (dissolved) Lead (total) Mercury (dissolved) Mercury (total) Molybdenum (dissolved) Molybdenum (total) Nickel (dissolved) Nickel (total) Nitrogen (ammonia) pH (pH) Phosphorus (mg/L) Selenium (dissolved) Selenium (total) Silver (dissolved) Silver (total) Total suspended solids (mg/L) Vanadium (dissolved) Vanadium (total) Zinc (dissolved) Zinc (total) Anionic Surfactants as MBAS (mg/L) $BOD^{5(2*)}$(mg/L) Faecal Coliforms(*)(cfu/100ml) Enterococci(*)(cfu/100ml) Total Oil and Grease (mg/L)	Monthly (min 4 weeks)	Grab sample
LDP1	Licensed Discharge Point			
USSP	Baseline Data (Upstream of Site)			
RW1	Baseline Data (Downstream of Site)			
Lake Macquarie	Water Quality	Temperature (°C) pH (pH) Turbidity (NTU) Dissolved Oxygen (%) Total phosphorus (mg/L) Total nitrogen (mg/L)	Six Monthly	In Situ In Situ In Situ In Situ Grab sample Grab sample
AWTS Effluent Stream	Water Quality	Total suspended solids (mg/L) Total Dissolved solids (mg/L)	Quarterly	Grab sample Grab sample

Identification	Type of Monitoring Point	Pollutants (µg/L)[1]	Frequency	Sampling Method
		Total phosphorus (mg/L) Total nitrogen (mg/L) Total Oil and Grease (mg/L) $BOD^{5(2)}$ (mg/L) pH (pH) Faecal Coliforms (cfu/100ml) SAR (√ me/L)		Grab sample Grab sample Grab sample Grab sample Grab sample Grab sample Grab sample

1. *Pollutant concentration measurements will be determined in micrograms per litre and within ANZECC concentration limits unless noted otherwise.*
2. *BOD^5 – 5 day Biological Oxygen Demand.*

* *These values are specifically for monitoring effluent, if effluent is not irrigated or discharged they would not be required.*

8.5 Additional Operational Monitoring

In addition to the required monitoring described in **Section 8.4,** additional monitoring is undertaken by the Colliery as described below.

8.5.1 Effluent Monitoring

Currently, the classification and quantity of effluent from the AWTS and septic water treatment systems is unknown. Additionally, the characteristics of the soils receiving the effluent through irrigation are also unknown. Both of these properties are required to determine the appropriate management targets and practices. **Table 13** outlines the monitoring parameters required for the effluent stream and **Table 14** outlines the monitoring parameters required for assessing the characteristics of the soils. The *Environmental Guidelines use of Effluent by Irrigation, Department of Environment and Conservation*, nominate weekly monitoring for faecal coliforms. However, if the effluent stream reveals a low number of faecal coliforms, as is the case with the administration effluent stream, quarterly monitoring is appropriate.

Currently, it is assumed that the effluent being disposed of through irrigation, is being applied to an appropriate area, However, once the effluent is characterised the appropriateness of the existing irrigation area can be determined.

Table 14 – Recommended Soil Monitoring Strategy

Constituent	Frequency of Sampling	
	Surface Soil	Soil Profile
pH	Annually	Annually
Electrical Conductivity EC (dS/m)	Annually	Annually
Nitrate-N	Annually	Annually
Total N	After 3 years	Every 3 years
Available P	Annually	N/a
Total P	After 3 years	Every 3 years
Exchangeable Sodium Percentage	Annually	Every 3 years
Heavy Metals & Pesticides	After 10 years	N/a
P sorption	After 3 years	Every 3 years

8.5.2 Stream Health Channel Flow and Riparian Vegetation Monitoring

A program to monitor creek line channel stability and the health of riparian vegetation within Swindles Creek to the east of the pit top area will be undertaken throughout the life of the mine, although no adverse impacts are expected associated with the Proposal. The monitoring will be undertaken along a short length of the downstream watercourse. General observations of stream health will be recorded during the quarterly water quality monitoring for this watercourses and comprise:

- Documenting general observations of water quantity and quality;
- Documenting locations and dimensions of significant erosive or depositional features so that any subsequent changes can be evaluated quantitatively;
- Establishing multiple photographic points at representative locations, so that photos can be taken over multiple inspections in a repeatable manner;
- Providing written descriptions of the stream at each of the photographic points, focussing on evidence of erosion and exposed soils; and
- Documenting general indicators of stream health, including abundance of flora and fauna.

Monitoring will be recorded on a specific field sheet to be developed and included within the WMP or Biodiversity Management Plan. Results of monitoring data will be reviewed and compared to previous rounds of monitoring to assess whether there is any degradation of the riparian vegetation or stream channel. Where degradation or adverse erosion is occurring, additional investigations will be undertaken to assess whether the impacts are associated with the operation of the mine and ameliorative actions undertaken as required.

Further stream health and riparian vegetation monitoring will be undertaken as part of the Biodiversity Management Plan (EMP-D-16372) which is typically undertaken as a random transect monitoring program. The recording of an elevated or abnormal result (where triggers outlined as part of the monitoring program are exceeded) may result in an investigation into the surface water components related to the result. For further information on trigger and response protocol refer to the colliery's WMP in **Appendix B**.

8.6 Reporting of Monitoring Data

Recording of monitoring data will be undertaken in accordance with the requirements outlined within the Colliery WMP and EPL 1770. LakeCoal will collate and maintain an up-to-date database of surface water quality monitoring data for all sampling at the Colliery inclusive of a hard copy (laboratory results) and an electronic (results) database. Monitoring results will be interpreted as they are received in order to ensure appropriate operational guidance on maintaining water quality within the desired parameters.

The results will also be assessed in terms of relevant site operations and meteorological conditions to enhance further interpretation. This comparison between samples, sampling periods and against other factors will assist in identifying whether the activities at the Colliery are affecting the water quality of the local environment.

Results of surface water quality monitoring will be reported in the Annual Review. The results will also be made available to the Community Consultative Committee (CCC) on a regular basis as part of the environmental monitoring and reporting process, as well as to the Wyong Shire and Lake Macquarie City Councils.

In accordance with amendments to Section 148 of the *POEO Act*, EPL holders are required to publish monitoring data that has been collected as a result of a licence condition. To comply with this

amendment and as required under condition 11, schedule 5 of MP10_0161, LakeCoal will continue to publish relevant monitoring data on their website within 14 days of obtaining the data.

9.0 CONCLUSION

This SWA has assessed the potential impacts to surface water from the Proposal in accordance with the DGRs. Given the minimal disturbance proposed to the surface areas, potential impacts to surface water are limited. The Proposal's greatest potential to impact on surface water is from the increased underground water make expected from the proposed extension of underground mining activities. Therefore, management predominately focussed on this element of the Proposal.

The Groundwater Assessment undertaken for this Proposal predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day over the life of the Proposal, without any significant change to the quality of water extracted from the Fassifern Seam. The detailed 'daily time-step' water balance model developed in GoldSim utilised the results of the Groundwater Assessment and commitments made by LakeCoal regarding groundwater management. It indicated that a combination of underground storage utilisation, an amendment to the daily discharge volume condition within EPL 1770 and limiting the maximum daily pump rate to 10.5 ML/day is required to effectively manage water at the pit top area..

It is therefore proposed to utilise existing storage capacity in both the Wallarah and Great Northern Seams to mitigate the effects of peak groundwater inflow rates and significant rainfall events at the pit top area in order to reduce the potential for exceedance of the 12.161 ML/day LDP1 daily discharge limit. LakeCoal have indicated that these seams have a combined storage capacity of approximately 3-4 weeks (based on a 10.5 ML/day inflow) which GSSE believes is sufficient to adequately manage the predicted increase in water make expected as a result of the Proposal.

The water balance also estimated that the potable water used in the pit top area may be reduced by 32.3 kL/day (11.8 ML/year) as a result of proposed water saving measures at the Colliery, including the use of rainwater tanks and the reuse of water within the sedimentation ponds for dust suppression purposes.

As a result of the SWA, including the site water balance, a number of recommendations have been identified including the below.

- Investigate the actual available underground storage capacity should be due to the importance of this storage in regards to the management of water during the life of the Proposal;
- Seek an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours.
- Limit the maximum pump out rate from underground to 10.5 ML/day, within 12 months of the Proposal being approved, in order to adhere to aforementioned proposed EPL amendment. The timing of this commitment is due to the substantial upgrades involved with fully automating the pumps and having them controlled by a SCADA system.
- Collect more extensive baseline water quality data to aid the development of appropriate pollutant trigger values.
- Engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and issue this assessment to the EPA by the 31st December 2013.

No adverse impacts to the surrounding environment are expected as a result of the Proposal since the water make from underground is not expected to change in terms of either discharge flow rates (i.e. quantity) or water quality.

10.0 REFERENCES

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Water Management Act 2000



APPENDIX A

Appendix A

Table 21 – Baseline Site Water Quality LDP1 Oct 09 – Dec 10

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point LDP1															Receiving Water Quality Results - Sept 2010	
		Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	RW1 Chain Valley Bay	RW2 Marks Point
Total Oil and Grease Creek		<2		<2		5		<2	<2	3	<2							
Aluminium (total)	ID	350	510	380	310	720	510	480	560	520	890	370	550	1100	490	340	40	120
Aluminium (soluble)												170	190	67	290	110	<10	40
Ammonia as N	910 µg/L	<0.05	0.1	0.67	0.07	0.24	0.02	0.08	0.12	0.05	0.05	0.24	0.0019	0.017	0.045	<0.1		
Arsenic (total)		0.7	<0.05	0.7	0.9	<0.5	0.9	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	1.9
Arsenic (soluble)	ID											<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2
Beryllium (total)	ID											<1	<1	<1	<1	0.2	<0.1	<0.1
Beryllium (soluble)	ID											<1	<1	<1	<1	0.1	<0.1	<0.1
Boron	ID	273	268	255	266	730	264	253	234	238	388							
Cadmium (total)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<1	<1	<1	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L											<0.05	<1	<1	<1	<0.2	<0.2	0.4
Chromium (total)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.5	<0.05	<0.05	<0.05	<0.05	<2	<2	<2	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L											<0.05	<2	<2	<2	<0.5	<0.5	<0.5
Cobalt (total)												7	<2	<2	<2	1.3	<0.2	<0.2
Cobalt (soluble)	1 µg/L											7	<2	<2	<2	1.3	<0.2	<0.2
Conductivity		18500	21800	19300	22600	27100	21200	21500	21400	13900	15300	17600	20900	20900	9500	12800		
Copper (total)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3	0	3	<1	<1	4
Copper (soluble)	1.3 µg/L											<0.05	3	0	3	<1	<1	2
Lead (total)	4.4 µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2	3	2	0.4	<0.2	1.2

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point LDP1															Receiving Water Quality Results - Sept 2010	
		Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	RW1 Chain Valley Bay	RW2 Marks Point
Lead (soluble)												<0.05	2	3	2	<0.2	<0.2	0.4
Manganese	ID	<0.05	<0.05	0.13	<0.05	0.06	<0.05	0.05	0.06	0.05	0.1							
Mercury (total)		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.1	<0.5	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L											<0.5	<0.5	<0.5	<0.5	<0.0001	<0.1	<0.1
Molybdenum (total)	ID											19	9	8	4	3.4	2.4	12
Molybdenum (soluble)	ID											11	9	7	4	2.7	2.5	11.6
Nickel (total)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2	<2	<2	5.6	0.8	0.7
Nickel (soluble)	7 µg/L											<0.05	2	<2	<2	4.5	<0.5	<0.5
pH		7.9	7.8	7.4	8	7.4	7.9	7.8	7.6	7.3	6.9	7.4	7.9	7.3	7.2	7.09		
Selenium (total)								<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2	<2	<2
Selenium (soluble)	ID											<0.5	<0.5	<0.5	<0.5	<2	<2	<2
Silver (total)								3	6	3	4	1	4	4	1	<0.1	<0.1	0.4
Silver (soluble)	1.4 µg/L											1	3	4	<1	<0.1	<0.1	0.1
Sus.Solids								17	8	16	14	14	12	15	6	<5		
Total Phosphorus	30 µg/L							<0.05	0.7	<0.05	<0.05	0.08	0.007	0.011	0.013	<0.01	40	80
Vanadium (total)												0.01	<0.01	<0.01	<0.01	<0.5	<0.5	1.6
Vanadium (soluble)	100 µg/L											0.02	<0.01	<0.01	<0.01	<0.5	<0.5	1.6
Zinc (total)								<0.05	<0.05	<0.05	<0.05	<0.05	10	9	11	13	15	19
Zinc (soluble)	15 µg/L											<0.05	10	9	11	10	8	18
Anionic Surfactants as MBAS																		
Faecal Coliforms																		

Table 22 – Baseline Site Water Quality LDP1 Jan 11 – March 12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point LDP1															Receiving Water Quality Results - Sept 2010	
		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Aluminium (total)	ID	540	360	450	419	310	513	260	10	30	20	33	40	20	37	<10	40	120
Aluminium (soluble)		460	120	170	374	280	454	70	<10	20	<10	<25	<10	<10	<10	18	<10	40
Ammonia as N	910 µg/L	<0.1	<0.1	<0.1					<0.1	<0.1	<0.1	<0.10	<0.10	0.03	<0.10	<0.10		
Arsenic (total)		<0.5	<0.5	1.2	1	1	0.8	<0.5	<0.5	<0.5	<0.5	<1.0	1	1	<0.5	<0.5	<0.5	1.9
Arsenic (soluble)	ID	<0.5	<0.5	0.8	0.8	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<1.0	0.8	1	<0.5	<0.5	<0.5	2
Beryllium (total)	ID	0.1	<0.1	<0.1	0.2	<0.1	0.2	0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium (soluble)	ID	0.1	<0.1	<0.1	0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (total)		<0.2	<0.2	<0.2	0.07	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.26	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L	<0.2	<0.2	<0.2	0.07	<0.2	<0.05	<0.2	<0.2	<0.2	<0.2	<0.25	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Chromium (total)		<0.5	<0.5	<0.5	0.3	<0.5	0.4	<0.5	<0.5	<0.5	<0.5	<1.0	0.9	<0.5	0.6	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L	<0.5	<0.5	<0.5	0.07	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<1.0	0.8	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (total)		0.6	0.8	0.5	1	0.7	1.4	0.9	<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt (soluble)	1 µg/L	0.7	<0.5	0.5	1.1	0.6	1.2	1.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Conductivity		12500	23400	28800	20900	24600	11400	20000	33900	33900	33901	33300	32700	33700	32100	32900		
Copper (total)		<1	<1	1	0.7	<1	1	1	<1	<1	<1	<2.6	<1	<1	<1	<1	<1	4
Copper (soluble)	1.3 µg/L	<1	<1	<1	0.6	0.6	1.4	1.2	<0.2	<1	<1	<2.5	<1	1	<1	<1	<1	2
Lead (total)		<0.2	<0.2	0.3	1.8	<0.2	0.7	0.3	0.4	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	1.2
Lead (soluble)	4.4 µg/L	<0.2	<0.2	<0.2	1.2	<0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Mercury (total)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Molybdenum (total)	ID	8.2	10.7	24.2	6.1	16.9	5.2	13.2	2.1	1.6	2.1	2.3	2.5	3.1	0.8	2.5	2.4	12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point LDP1															Receiving Water Quality Results - Sept 2010	
		Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Molybdenum (soluble)	ID	6.1	11.3	24.3	5.7	15	4.8	13.2	<0.1	1.8	1.8	2.2	2.1	3.2	0.5	2.3	2.5	11.6
Nickel (total)		7.8	6.4	9.1	7.6	8.5	6.6	7.8	1	<0.5	1.1	<2.6	0.6	0.6	1	<0.5	0.8	0.7
Nickel (soluble)	7 µg/L	6.9	7.2	9.1	6.1	8.6	5.7	7.3	<0.5	<0.5	<0.5	<2.5	0.7	0.8	<0.5	0.5	<0.5	<0.5
pH		7.75	7.52	8	7.16	7.73	6.89	7.45	7.85	7.89	7.93	8.01	7.94	7.87	7.89	7.91		
Selenium (total)		<2	<2	<2	0.3	<2	0.2	<2	<2	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Selenium (soluble)	ID	<2	<2	<2	0.2	<2	<2	<2	<2	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Silver (total)		<0.1	<0.1	<0.1	2.2	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.4
Silver (soluble)	1.4 µg/L	<0.1	<0.1	<0.1	1.4	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sus.Solids		<5	<5	<5	<5	<5	5	<5	5	<5	<5	10	<5	14	8	10		
Total Phosphorus	30 µg/L	<0.02	0.1	<0.1					<0.1	0.06	<0.01	<0.01	0.02	0.05	<0.01	<0.01	40	80
Vanadium (total)		<0.5	<0.5	<0.5	0.8	<0.5	1.6	<0.5	<0.5	<0.5	<0.5	1.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Vanadium (soluble)	100 µg/L	0.7	0.5	<0.5	0.8	<0.5	1.8	<0.5	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Zinc (total)		<5	10	10	10	10	27	14	14	17	11	13	16	29	32	17	15	19
Zinc (soluble)	15 µg/L	6	<5	5	9	8	22	12	<5	12	8	8	43	24	11	14	8	18
Anionic Surfactants as MBAS									0.3		<0.1	<0.1	0.1	0.1	<0.1	0.1		
Faecal Coliforms									38		10	54	200	~2	760	~2		

Table 23 – Baseline Site Water Quality Dam 10 Outlet Nov 10 – July 11

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Dam 10 Outlet									Receiving Water Quality Results - Sept 2010	
		Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	RW1 Chain Valley Bay	RW2 Marks Point
Aluminium (total)	ID	0.1	0.04	<0.01	0.1	0.05	40	60	70	80	40	120
Aluminium (soluble)		0.029	<0.01	<0.01	<0.1	0.04	40	80	80	20	<10	40
Ammonia as N	910 µg/L	0.1	<0.1		<0.1	<0.1						
Arsenic (total)		0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.9
Arsenic (soluble)	ID	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2
Beryllium (total)	ID	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium (soluble)	ID	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (total)		<1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L	<1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	0.4
Chromium (total)		<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L	<2	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (total)		<2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt (soluble)	1 µg/L	<2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Conductivity		31300	35000	13200	33800	35100	33700	35300	36300	35000		
Copper (total)		3	<0.1	<0.1	<0.1	3	<1	<1	<1	<1	<1	4
Copper (soluble)	1.3 µg/L	3	<0.1	<0.1	<0.1	<0.1	<1	<1	<1	<1	<1	2
Lead (total)		5	0.3	<0.2	<0.2	0.6	<0.2	<0.2	0.3	<0.2	<0.2	1.2
Lead (soluble)	4.4 µg/L	6	<0.2	<0.2	<0.2	0.4	<0.2	0.4	0.2	<0.2	<0.2	0.4
Mercury (total)		<0.5	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L	<0.5	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Molybdenum (total)	ID	2	1.9	1.1	2.1	1.9	1.1	2.7	2.2	2.6	2.4	12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Dam 10 Outlet									Receiving Water Quality Results - Sept 2010	
		Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	RW1 Chain Valley Bay	RW2 Marks Point
Molybdenum (soluble)	ID	2	2.8	1.3	3.2	2.2	1.6	1.3	1.5	2.6	2.5	11.6
Nickel (total)		<2	1.4	0.5	,0.5	3.5	1.6	1.4	2.1	1	0.8	0.7
Nickel (soluble)	7 µg/L	<2	0.8	0.6	0.6	0.8	0.5	2.7	1.7	1.1	<0.5	<0.5
pH		7.8	7.95	7.96	7.9	8.01	7.73	7.9	7.82	7.89		
Selenium (total)		<0.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium (soluble)	ID	<0.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Silver (total)		4	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.4
Silver (soluble)	1.4 µg/L	3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sus.Solids		19	<5	<5	21	<5	8	<5	<5	17		
Total Phosphorus	30 µg/L	0.008	<0.01	<0.01	0.04	0.02					40	80
Vanadium (total)		<0.01	<0.5	0.5	<0.5	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	1.6
Vanadium (soluble)	100 µg/L	<0.01	5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Zinc (total)		13	8	<5	10	33	9	13	35	24	15	19
Zinc (soluble)	15 µg/L	13	<5	<5	7	<5	9	16	28	18	8	18
Anionic Surfactants as MBAS												
Faecal Coliforms												

Table 24 – Baseline Site Water Quality Dam 10 Outlet August 11 – March 12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Dam 10 Outlet								Receiving Water Quality Results - Sept 2010	
		Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Aluminium (total)	ID	10	20	50	36	90	20	<10	44	40	120
Aluminium (soluble)		2	30	<10	<25	<10	<10	<10	<10	<10	40
Ammonia as N	910 µg/L	<0.1	<0.1	<0.1	<0.1	<0.10	0.02	<0.10	<0.10		
Arsenic (total)		<0.5	<0.5	<0.5	<1.0	1.1	1.6	<0.5	<0.5	<0.5	1.9
Arsenic (soluble)	ID	<0.5	<0.5	<0.5	<1.0	1	1.4	<0.5	<0.5	<0.5	2
Beryllium (total)	ID	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium (soluble)	ID	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (total)		<0.2	<0.2	<0.2	<0.26	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L	<0.2	<0.2	<0.2	<0.25	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Chromium (total)		<0.5	<0.5	<0.5	<1.0	0.7	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L	<0.5	<0.5	<0.5	<1.0	0.7	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (total)		<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt (soluble)	1 µg/L	<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Conductivity		33800	33900	34300	33400	33200	33400	32200	32600		
Copper (total)		<1	<1	<1	<2.6	<1	<1	<1	<1	<1	4
Copper (soluble)	1.3 µg/L	<1	<1	<1	<2.5	<1	<1	<1	1	<1	2
Lead (total)		0.4	<0.2	0.2	<0.5	<0.2	<0.2	<0.2	<0.2	<0.2	1.2
Lead (soluble)	4.4 µg/L	<0.2	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	0.3	<0.2	0.4
Mercury (total)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Molybdenum (total)	ID	2.1	1.6	2	2.4	2.5	3	1.8	2.5	2.4	12
Molybdenum (soluble)	ID	<0.1	1.8	1.8	2.1	2.3	2.8	0.8	2.3	2.5	11.6

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Dam 10 Outlet								Receiving Water Quality Results - Sept 2010	
		Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Nickel (total)		1	<0.5	1.3	<2.6	0.7	<0.5	0.6	0.5	0.8	0.7
Nickel (soluble)	7 µg/L	<0.5	0.7	<0.5	<2.5	0.9	0.6	<0.5	1	<0.5	<0.5
pH		7.75	7.82	7.84	7.94	7.83	7.95	7.8	7.75		
Selenium (total)		<2	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Selenium (soluble)	ID	<2	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Silver (total)		<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.4
Silver (soluble)	1.4 µg/L	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sus.Solids		6	<5	<5	12	<5	20	12	10		
Total Phosphorus	30 µg/L	0.02	<0.01	<0.01	<0.01	0.02	0.26	<0.01	<0.01	40	80
Vanadium (total)		<0.5	<0.5	<0.5	1.6	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Vanadium (soluble)	100 µg/L	<0.5	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Zinc (total)		18	22	14	22	27	74	36	22	15	19
Zinc (soluble)	15 µg/L	18	20	12	<5	28	65	19	30	8	18
Anionic Surfactants as MBAS		0.4		<0.1	<0.1	0.1	0.1	<0.1	0.2		
Faecal Coliforms		~12		~2	~3	26	~2	20	~6		

Table 25 – Baseline Site Water Quality Downstream Sept 11 – March 12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Downstream							Receiving Water Quality Results - Sept 2010	
		Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Aluminium (total)	ID	160	280	144	100	560	74	322	40	120
Aluminium (soluble)		<10	<10	<25	30	<10	12	96	<10	40
Ammonia as N	910 µg/L	<0.1	<0.1	<0.10	<0.10	0.03	<0.10	<0.10		
Arsenic (total)		1.4	1	1.3	0.8	2.1	<0.5	0.7	<0.5	1.9
Arsenic (soluble)	ID	1.3	0.9	<1.0	0.6	1.6	<0.5	<0.5	<0.5	2
Beryllium (total)	ID	<0.1	0.2	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium (soluble)	ID	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium (total)		0.3	<0.2	<0.26	<0.2	0.3	<0.2	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L	0.3	<0.2	<0.25	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Chromium (total)		<0.5	0.6	<1.0	<0.5	0.8	<0.5	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (total)		<0.2	<0.2	<0.5	<0.2	0.3	<0.2	0.2	<0.2	<0.2
Cobalt (soluble)	1 µg/L	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	0.3	<0.2	<0.2
Conductivity		50500	39200	39500	32200	38000	27800	29600		
Copper (total)		1	2	<2.6	<1	3	<1	<1	<1	4
Copper (soluble)	1.3 µg/L	1	<1	<2.5	2	2	<1	1	<1	2
Lead (total)		0.6	1	<0.5	<0.2	0.7	<0.2	<0.2	<0.2	1.2
Lead (soluble)	4.4 µg/L	0.4	<0.2	<0.5	0.2	<0.2	<0.2	0.3	<0.2	0.4
Mercury (total)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Molybdenum (total)	ID	10.1	5.2	7.5	3.7	6.5	1.2	3.2	2.4	12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Downstream							Receiving Water Quality Results - Sept 2010	
		Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Molybdenum (soluble)	ID	11.1	6	6.9	3.4	6.4	<0.1	3	2.5	11.6
Nickel (total)		<0.5	2.1	<2.6	0.7	1	0.7	1.1	0.8	0.7
Nickel (soluble)	7 µg/L	<0.5	<0.5	<2.5	1	<0.5	<0.5	1.4	<0.5	<0.5
pH		7.86	7.98	7.99	7.85	8.12	7.78	7.76		
Selenium (total)		<2	<2	1.2	<2	<2	<2	<2	<2	<2
Selenium (soluble)	ID	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Silver (total)		<0.1	<0.1	<0.5	<0.1	<0.1	0.1	<0.1	<0.1	0.4
Silver (soluble)	1.4 µg/L	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sus.Solids		38	16	18	<5	64	8	18		
Total Phosphorus	30 µg/L	<0.01	<0.01	<0.01	0.01	0.09	<0.01	<0.01	40	80
Vanadium (total)		1.7	1	2.2	<0.5	4.7	<0.5	0.9	<0.5	1.6
Vanadium (soluble)	100 µg/L	1.5	1	1	0.5	3	<0.5	<0.5	<0.5	1.6
Zinc (total)		6	16	6	9	10	11	14	15	19
Zinc (soluble)	15 µg/L	<5	<5	<5	19	<5	<5	18	8	18
Anionic Surfactants as MBAS			<0.1	0.1	0.1	0.1	<0.1	0.2		
Faecal Coliforms			110	~14	180	~2	570	250		

Table 26 – Baseline Site Water Quality Upstream Sept 11 – March 12

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Upstream							Receiving Water Quality Results - Sept 2010	
		Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Aluminium (total)	ID	280	180	282	160	160	414	222	40	120
Aluminium (soluble)		140	100	73	100	60	56	96	<10	40
Ammonia as N	910 µg/L	<0.1	<0.1	<0.10	<0.10	0.02	<0.10	<0.10		
Arsenic (total)		<0.5	<0.5	<1.0	0.6	0.8	0.6	<0.5	<0.5	1.9
Arsenic (soluble)	ID	<0.5	<0.5	<1.0	<0.5	0.6	<0.5	<0.5	<0.5	2
Beryllium (total)	ID	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium (soluble)	ID	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Cadmium (total)		<0.2	<0.2	<0.26	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Cadmium (soluble)	0.7 µg/L	<0.2	<0.2	<0.25	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Chromium (total)		<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium (soluble)	4.4 µg/L	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cobalt (total)		0.5	0.6	0.8	0.6	0.6	0.8	0.9	<0.2	<0.2
Cobalt (soluble)	1 µg/L	0.4	0.6	0.7	0.5	0.6	0.2	0.9	<0.2	<0.2
Conductivity		20400	17000	19700	13300	20700	11900	11900		
Copper (total)		<1	<1	3	<1	<1	<1	<1	<1	4
Copper (soluble)	1.3 µg/L	<1	<1	<2.5	<1	<1	<1	1	<1	2
Lead (total)		<0.2	<0.2	<0.5	0.3	0.5	0.3	<0.2	<0.2	1.2
Lead (soluble)	4.4 µg/L	<0.2	<0.2	<0.5	<0.2	<0.2	<0.2	0.4	<0.2	0.4
Mercury (total)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Mercury (soluble)	0.1 µg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.1	<0.1
Molybdenum (total)	ID	15.6	12	14.1	5.7	12.4	5.4	5.7	2.4	12
Molybdenum (soluble)	ID	16.8	13.2	13.5	5.1	11.4	2.7	5	2.5	11.6

Tested Pollutant	ANZECC (2000) Values (95%) Marine Environment	Water Quality Sample results from Sampling Point Upstream							Receiving Water Quality Results - Sept 2010	
		Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	RW1 Chain Valley Bay	RW2 Marks Point
Nickel (total)	7 µg/L	5.1	5.5	6.2	4.8	6.4	4.1	4.2	0.8	0.7
Nickel (soluble)		5.3	5.7	5.8	4.6	5.8	<0.5	4.8	<0.5	<0.5
pH		7.86	7.65	7.87	7.86	7.87	7.74	7.54		
Selenium (total)	ID	<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Selenium (soluble)		<2	<2	<1.0	<2	<2	<2	<2	<2	<2
Silver (total)	1.4 µg/L	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.4
Silver (soluble)		<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sus.Solids		8	5	7	<5	8	12	<5		
Total Phosphorus	30 µg/L	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01	40	80
Vanadium (total)	100 µg/L	<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Vanadium (soluble)		<0.5	<0.5	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Zinc (total)	15 µg/L	9	7	11	14	6	11	9	15	19
Zinc (soluble)		6	6	6	8	<5	<5	15	8	18
Anionic Surfactants as MBAS			<0.1	<0.1	0.1	0.1	<0.1	0.1		
Faecal Coliforms			570	460	1300	5200	430	570		



APPENDIX C



LakeCoal Pty Ltd

Chain Valley Mining Extension 1 Project

Environmental Impact Assessment:-

Water Balance

March 2013

EMG00-008

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

EXECUTIVE SUMMARY

LakeCoal is seeking an approval under Part 4, Division 4.1 of the Environmental Planning and Assessment Act 1979 to extend the currently approved extraction area at Chain Valley Colliery to allow underground mining of the Fassifern Seam, with all secondary extraction to occur beneath Lake Macquarie. This extension would allow continuation of mining operations at the Colliery (by a further 14 years) and would increase the maximum approved rate of production from 1.2 million tonnes per annum (Mtpa) to 1.5 Mtpa ROM coal. The additional 300,000 tonnes per annum would continue to be transported back to the existing pit top facilities by conveyor where it would be processed and then transported via private roads to Vales Point Power Station.

GSS Environmental (GSSE) was commissioned by EMGA Mitchell McLennan (EMM), on behalf of LakeCoal Pty Ltd, to prepare a Surface Water Assessment (SWA) to fulfil the requirements detailed in the Director-General's Requirements relating to the preparation of an Environmental Impact Statement (EIS) to accompany the Part 4 application. As part of the SWA a detailed daily time step water balance was undertaken in GoldSim in order to understand water demands and flows around the pit top area. It was developed to demonstrate that future water management at the mine is sustainable during the Mine Extension 1 Project.

A water balance was previously undertaken for Chain Valley Colliery by AECOM in July 2011. The water balance investigation for the SWA was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance also investigated the pit top water use in more detail to aid the future decision making process in regards to water management at the site.

Key findings from this site water balance investigation include the following:

- Potable water used in the pit top area may be reduced by 32.3 kL/day (11.8 ML/year) as a result of proposed water saving measures at the Colliery, including the use of rainwater tanks and the reuse of water within the sedimentation ponds for dust suppression purposes;
- An investigation into the actual available underground storage capacity should be undertaken due to the importance of this storage in regards to the management of water during the life of the Proposal;
- LakeCoal should seek an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours; and
- LakeCoal should commit to limiting the maximum pump out rate from underground to 10.5 ML/day, within 12 months of the Proposal being approved, in order to adhere to aforementioned proposed EPL amendment. The timing of this commitment is due to the substantial upgrades involved with fully automating the pumps and having them controlled by a SCADA system.

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1.0 INTRODUCTION

1.1 Background

Chain Valley Mine is located in the Newcastle coalfields, at the southern end of Lake Macquarie. The mine was established in 1960 to extract coal from the Wallarah, Fassifern and Great Northern coal seams. Extraction of the Wallarah seam has been completed, with extraction currently underway in the Fassifern Seam.

Mining of the existing coal resources already approved under MP 10_0161 are expected to be completed around October 2013 or shortly thereafter. LakeCoal Pty Ltd is therefore seeking to obtain approval under the Environmental Planning and Assessment Act 1979 (EPA Act), to permit mining of additional coal resources within the Fassifern seam with all secondary extraction to be undertaken beneath Lake Macquarie. Secondary extraction within the Project Area will be undertaken using the miniwall method of mining and would provide resources to facilitate mining for approximately 14 years at a rate of 1.2 million tonnes per year (ROM).

LakeCoal have engaged EMGA Mitchell McLennan (EMM) to prepare the Environmental Impact Statement (EIS) for this proposed mining and GSS Environmental (GSSE) was subsequently engaged by EMM as a sub-consultant to undertake the Surface Water Assessment (SWA) component of this EIS.

As part of this SWA it is necessary to demonstrate that the current water management practices should continue to comply with licence conditions with respect to discharge, or if this is determined to be unachievable, recommend mitigation and/or management measures for the mine. A site water balance has been developed to understand water demands and flows around the pit top area (surface component of the mine). This site water balance is used to demonstrate that future water management at the mine is sustainable.

A water balance was previously undertaken for the site by AECOM in July 2011. The water balance described in this report was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance investigated the pit top water use in more detail to aid the future decision making process in regards to water management at the site.

1.2 Scope of Work

Developing the site water balance involved the following key tasks:

- Reviewing existing information including current flow records;
- Identifying inputs/outputs for the site water balance;
- Developing a water balance model in GoldSim to quantify the site water balance; and
- Recommending future water management practices.

This report summarises the key outcomes from the site water balance together with any major assumptions made in modelling undertaken.

2.0 SITE CHARACTERISTICS

2.1 Location and Site Operations

Chain Valley Mine is an underground coal mine located on the southern end of Lake Macquarie with the pit top (i.e. surface facilities) positioned adjacent to the Vales Point Power Station in Mannering Park. The site is approximately 60 km south of Newcastle and within the Swansea-North Entrance Mine Subsidence District. Chain Valley Mine was established in August 1960, with a licence to extract coal from the Wallarah, the Great Northern and the Fassifern Seams. Extraction is currently being undertaken from the Fassifern Seam. The proposed permit for mining additional reserves within the Fassifern seam is expected to facilitate mining for an additional 14 years at a rate of 1.2 million tonnes per year (ROM).

A plan showing the location of Chain Valley Colliery is shown in **Figure 1**.

2.2 Climate / Rainfall

The Lake Macquarie region has a borderline oceanic/humid subtropical climate like much of central and northern NSW. Summers tend to be warm and winters are generally mild. Precipitation is heaviest in late autumn and early winter.

A review of the Bureau of Meteorology (BOM) website indicated that there were no weather stations located in the immediate vicinity of the Site, however, numerous stations were identified in the general Lake Macquarie region. All of these weather stations contain similar average annual rainfall statistics. Together, these weather stations contain over 100 years of complete daily rainfall data which made it suitable for use in this water balance described in **Section 3.4.1**.

2.3 Topography

The Colliery's pit top area is relatively flat with the majority of the runoff flowing east into the sedimentation ponds, prior to discharge. Earthen diversion drains exist on the northern and eastern boundaries and help to convey this runoff into the ponds. Overflow from the sedimentation pond system discharges to a nearby creek which flows into Lake Macquarie.

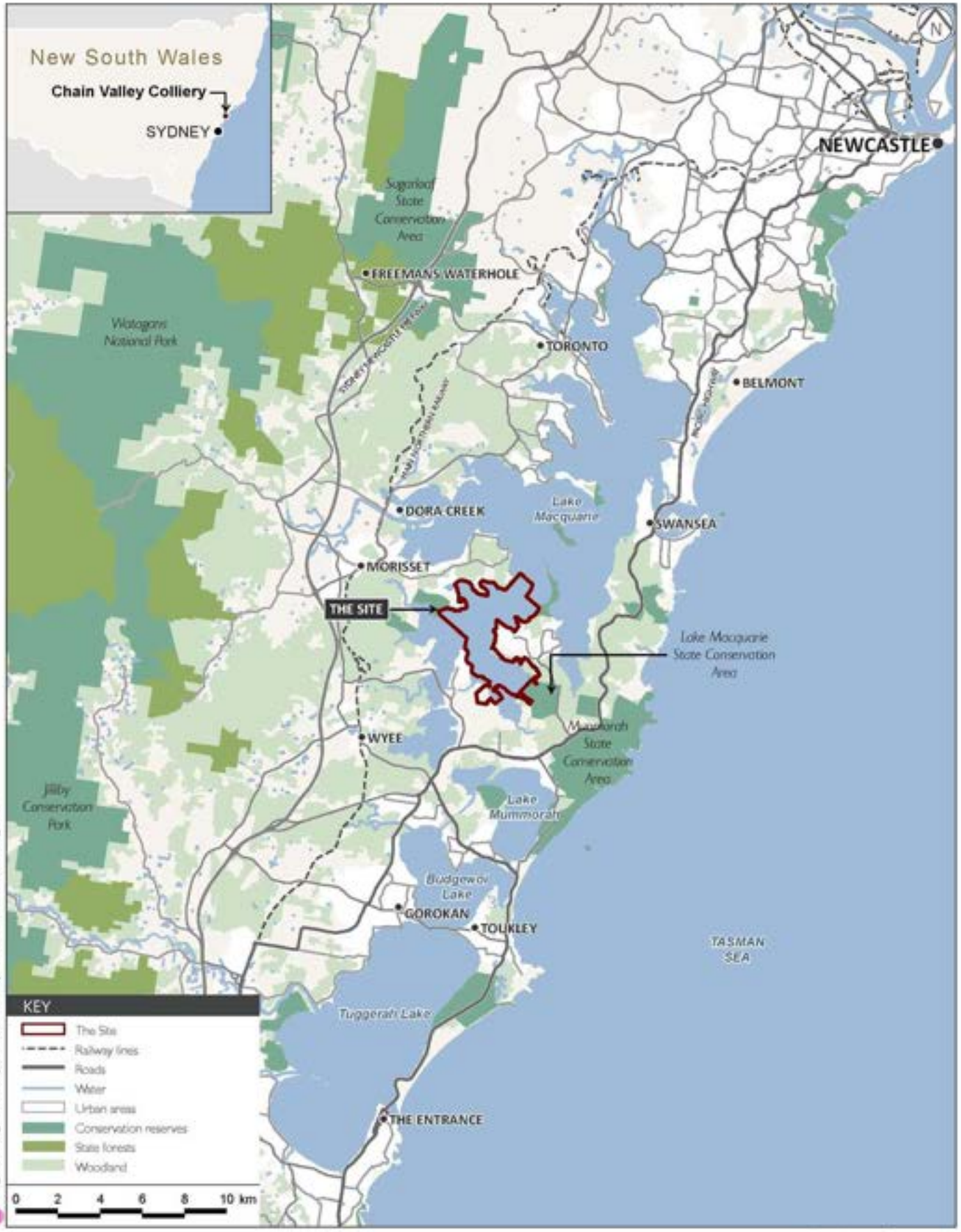
The car park and the adjacent access road are the only areas where the runoff does not discharge into the sedimentation ponds and is conveyed directly off-site. Management of the carpark runoff has recently been reviewed at the Colliery with recommendations and commitments provided within the Colliery's Water Management Plan (WMP). No watercourses traverse through the pit top facilities.

2.4 Surrounding Land Uses

The Colliery's pit top area is located on the western side of Chain Valley Bay, on relatively flat land, largely devoid of vegetation. It is situated in an existing industrial area accessed from Ruttleys Road.

The existing ventilation shaft and fan are located on freehold land at Tiembula Road, Summerland Point, on the eastern side of Chain Valley Bay. Parts of the Lake Macquarie State Conservation Area are located on both the eastern and western sides of the lake, which provide bushland and open space along the foreshore.

Neighbouring industrial facilities comprise Mannering Colliery to the south and Vales Point Power Station to the west. The nearest residential areas are Kingfisher Shores and Chain Valley Bay to the south-east, Mannering Park to the north-west, and Summerland Point and Gwandalan to the north-east.



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Regional context

EMM

Chain Valley Colliery Mining Extension 1 - Environmental Impact Statement

Figure 1

The area surrounding the colliery is also used for a number of recreational purposes. Fishing and sailing are popular on Lake Macquarie, along with other water based recreational activities. Camping facilities, walking tracks and picnic areas are available within the Lake Macquarie State Conservation Areas.

2.5 Soils/Geology

The Colliery's surface facilities are situated on the shore of Lake Macquarie. This area principally comprises the Doyalson soil landscape with small parts on the Wyong soil landscape. The Doyalson soil landscape is characterised by gently undulating rises on Munmorah Conglomerate with broad crests, ridges and long gently inclined slopes. Local relief is up to 30 metres and slope gradient is less than 10%. Doyalson soils are strongly acidic, of low fertility and exhibit slight to high erodibility. The Wyong soil landscape is characterised by broad, poorly drained deltaic floodplains and alluvial flats of Quaternary sediments. Local relief is less than 10 metres and slope gradient is less than 3%. Wyong soils are strongly acidic, poorly drained impermeable, of very low fertility and contain saline subsoils.

2.6 Pit Top Catchment Areas

For the purpose of the water balance, runoff from the pit top area has been assessed in terms of four main catchment areas (shown in **Figure 2)** including:

- Catchment 1 – The carpark, office building and partial runoff from the workshop roof;
- Catchment 2 – The rear storage yard and oil water separator and the remaining workshop roofed area;
- Catchment 3 – The stockpile, entry road and bathhouse; and
- Catchment 4 – The sedimentation ponds.

Runoff from Catchment 1 has historically been considered clean catchment and is conveyed to the north of the pit top area with no runoff from this catchment reporting to the sedimentation ponds. As such, this catchment was not included in the water balance model.

The majority of runoff from Catchment 2 currently drains east into the sedimentation ponds via a pit and pipe network and earth bunding. The majority of the storage yard is gravelled hardstand, however, there are some exposed disturbed areas due to regular heavy vehicle movement resulting in runoff also containing sediment. This runoff is captured within the pollution control dams (dams D11, D12 and D13 shown in **Figure 2**) which function as primary settling ponds prior to discharge into the main sedimentation ponds D7 and D9.

Runoff from Catchment 3 is contained by two main drainage channels that surround the coal stockpile and report to the sedimentation ponds (Catchment 3). Runoff from this area contains a significant amount of coal fines. The runoff from the area adjacent to the weigh bridge currently collects and pools in an adjacent drainage channel. Runoff from the main entry/haul road contains coal fines and a small component of this catchment has been reporting to the clean water carpark catchment (Catchment 1). The majority of the runoff from Catchment 3 reports to sedimentation dams D1 to D6. These dams also function as primary settling ponds before discharging into the main mine water sedimentation ponds. A small portion of the area surrounding the Run-of-Mine (ROM) bin and bathhouse, reports to the storage yard area (Catchment 2).

The WMP includes measures to improve water management on site and ensure water management structures comply with industry best practice. The minor upgrades and modifications to infrastructure proposed at the pit top area will not increase volumes of stormwater runoff from the Site.

N
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AREA TO BE REGRADED
VEGETATED AREA
WET AREA TO BE REHABILITATED
APPROX. LOCATION OF 330KV TRANSMISSION LINES
OIL STORAGE BAY
GPT
APPROX. BOUNDARY VEGETATED AREA
POWERLINES EASEMENT
DOWN CAST SHAFT
THE STORAGE YARD CATCHMENT (#2)
GPT
THE CARPARK CATCHMENT (#1)
COMPRESSOR OIL SEPERATOR
SUMP
SURFACE WATER SILT TRAP DAM
REHABILITATED AREA
APPROX. LAKE MACQUARIE WATER MONITORING POINT
ENTRY GATE TO COLLIERY
D11
D12
D13
APPROX. OUTLINE PROTECTED WETLAND AREA
THE STOCKPILE CATCHMENT (#3)
D8
SETTLING AND DIFFUSING POND
APPROX. LOCATION OF DOWNSTREAM SAMPLING POINT RW1
D7
FILTRATION WALL
D9
SUBMERGED SPILLWAY
D10
LOWLYING MARSHLANDS EVAPORATION AREA
OVERFLOW
D6
OVERFLOW PIPE
D1
D5
D4
D3
D2
MAIN SPILLWAY
COAL STOCKPILE AREA
OVERFLOW PIPE
EPL 1770 LDP1
TIDAL CREEK
SURFACE WATER FILTRATION DAMS
SEDIMENTATION POND CATCHMENT (#4)
WATERCART REFILL LOCATION
APPROX. LOCATION OF UPSTREAM SAMPLING POINT USSP

LEGEND:

- STOCKPILE AREA
- EXISTING BUND LOCATION
- WATER BASIN
- CLEAN WATER DIVERSION CHANNEL
- DIRTY WATER DIVERSION CHANNEL
- CLEAN WATER FLOW ARROWS
- DIRTY WATER FLOW ARROWS
- BUND/CHANNEL CATCHMENT SEPARATION
- CATCHMENT BOUNDARIES
- POWER LINES
- PROPOSED BUND LOCATION
- VEGETATED AREA
- PROTECTED WETLAND AREA
- SURFACE MAINTENANCE STRATEGY AREA
- IRRIGATED TREATED WASTE WATER AREA

0 50 100m
Scale 1:2500

FIGURE 2

WATER MANAGEMENT SYSTEM (INCLUDING PROPOSED STRUCTURES)

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg2_EMG00-008_Water_Management_System_130206

Projection:
GDA 94 MGA Zone 56

Version:	Date:	Author:	Checked:	Approved:
1	20/11/2012	MS	DB	AB
2	06/02/2013	LH	DB	AB

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2.7 Water Management

2.7.1 Potable Water Supply

2.7.1.1 Existing Potable Water Use

Potable water, obtained from the Wyong Shire Council, provides the water required to support the Colliery's operation. Information supplied by LakeCoal indicates that approximately 132 ML/year of portable water is used by the Colliery. Potable water is consumed in the following processes:

- When cutting coal at the coal face - to reduce respirable dust and propensity for frictional ignition of coal dust and methane gas;
- When transferring coal along the underground conveyor system and at transfer points - to reduce dust make;
- In cleaning;
- In equipment;
- For drinking water supply
- For emergency fire fighting purposes; and
- Pit top amenities, wash down and dust suppression activities.

It is estimated that approximately 20 ML/year (15%) is used for pit top operations and 112 ML/year (85%) is used in the underground operations. As required by Schedule 3, Condition 31(d) of MP10_0161, practical measures to minimise potable water consumption and maximise recycled water use have been and continue to be investigated by LakeCoal, as discussed in the WMP. Potential initiatives currently being investigated include;

- Reuse of dirty water contained within the sedimentation ponds for dust suppression purposes;
- Using the water cart for dust suppression of the ROM stockpile instead of the existing sprinkler system which is less efficient with water and is currently not operational; and
- Installing rainwater tanks on the operations block and workshop area including plumbing to the bathhouse.

However the use of non-potable water in all operational activities is not possible due to its quality, work health and safety and equipment requirements.

2.7.1.2 Future Changes to Potable Water Use

Since the introduction of the miniwall mining method, the demand for potable water in underground operations has increased. An additional amount of potable water used in the underground operations is therefore likely due to the Proposal. From discussions with LakeCoal, it was estimated that this increase could be as high as 25%. Although this increase was incorporated into the site water balance, it should be noted that this increase is very much an upper limit estimate and is considered conservative for the proposed works at the Colliery.

Potable water is an increasingly valuable and scarce resource and stakeholder concerns have been raised regarding the volume of potable water being consumed on-site. Therefore, LakeCoal is committed to trying to minimise their potable water use at the site. As part of the EA (AECOM, 2011), LakeCoal made a number of commitments including the installation of rainwater tanks on two

buildings at the pit top area. These rainwater tanks, which would collect runoff from the workshop and old bath house roof areas, were included in the water balance investigation.

LakeCoal also intend on reducing the potable water consumption at the site by drawing water from the sedimentation ponds to use on-site for dust suppression purposes. LakeCoal has indicated that Pond D6 is practically the most appropriate pond to draw the water from, although the surrounding ponds D1-D5 could also be used if required. This water use for dust suppression purposes was also included in the water balance modelling of the site.

2.7.2 Water Storage and Treatment

With the exception of the carpark stormwater runoff, all of the Colliery's 'dirty' water including surface water runoff, septic treated bathhouse wastewater, treated water from the oil water separator and underground mine water is conveyed into the sedimentation ponds (shown in **Figure 2**) prior to discharge under Environment Protection Licence (EPL) 1770. These ponds treat the collieries wastewater and runoff quality through the settlement of fines and suspended solids. In addition, they also prevent hydrocarbon spills from discharging off-site and into Lake Macquarie. They have been constructed with a mixture of earth, crushed rock, crushed recycled brick and stone and are interconnected through a series of overflow pipes and spillways.

Water is directed through the ponds from a number of inlet locations. A detailed survey of the ponds was undertaken by Pearson and Associates in 2009 with the relative storage capacities provided in **Table 4**. Runoff from the stockpile area is collected primarily by ponds D1, D2 and D6 and is combined into D4 and D5 before flowing into D9. Runoff from the storage yard is directed to D11, D12 and D13 before also overflowing into D9.

The underground mine water is pumped to a pit adjacent to the compressor house and is combined with the septic treated wastewater from the bathhouse, the treated compressor condensate water and runoff from the ROM bin area. From this pit the water is piped to D8 for settling and diffusion. Water within D8 spills into D7 via a spillway at the southern end of the pond however due to the leaky nature of the ponds an unknown amount of water diffuses through the pond wall. The water in D7 flows into D9 in a similar manor. In D9 the underground water is combined with the pit top runoff.

The primary spill from D9 to D10 is at the northern end of D9. Once in D10, the water travels over a shallow buffer spillway to the main discharge spillway and offsite at LDP 1. Currently the main discharge from the LDP is un-metred and the quantity of water discharged from site is calculated from continuous monitoring of the underground pumping rates and surface flow meters. As noted in the SWA report LakeCoal are committed to upgrading Sedimentation Pond D10 including upgrades to the spillway, metering and embankments.

2.7.3 Licensed Discharge Points

The discharge of excess mine water from the sedimentation and pollution control ponds is licensed under the *POEO Act* by the Environment Protection Authority (EPA) through the Chain Valley Colliery EPL 1770. Under EPL 1770 there is a single licensed discharge point for the Colliery (LDP 1) shown in **Figure 2**. The EPL has been modified a number of times, most recently in December 2011. A draft variation to EPL 1770 was also issued by LakeCoal to the EPA on 7th February 2012. The EPA subsequently issued a draft variation to LakeCoal on 14th November 2012 which LakeCoal responded to with comments on 3rd December 2012. At the time that this SWA was finalised (February 2013) LakeCoal had not received any further feedback from the EPA and had not been issued with the EPL variation.

LDP 1 has a daily discharge limit of **12,161 kL/day** and a limit for pH and TSS as shown in **Table 1**.

Table 1: Concentration Limits for LDP 1 (EPL 1770)

Pollutant	Unit of Measure	100th percentile Concentration Limit
pH	pH	6.5-8.5
TSS	Milligrams per litre (mg/L)	25

Currently, discharge from Site is un-metred and is calculated from continuous monitoring of the underground pumping rates and surface flow meters. Water currently leaks from Pond D10 as per **Figure 2** and much of this water does not pass through LDP 1. LakeCoal is committed to rectifying LDP 1 and (as described in **Section 2.7.2**) has engaged a dam engineer to design a metred spillway to be able to obtain direct measurements of the daily discharge from Site. LakeCoal is committed to upgrading the main embankment and discharge monitoring point of the final sediment dam as part of the Proposal.

EPL 1770 initially contained two discharge points, one at the pit top area (current) and a second at the Ventilation Shaft Site. These two points had individual discharge limits of 8161 kL/day and 4000 kL/day respectively. The separate discharge points related to the workings in both the Wallarah and Great Northern Seams, which had different pumps and pump out lines. With the cessation of mining in the Wallarah Seam (1997), the subsequent construction of a dewatering borehole from the Wallarah to the Great Northern Seam, and decommissioning of the pump out line leading to the Ventilation Shaft Site in 2003, the EPL was amended to combine the discharge volume limit (12,161 kL/day) to the single point at the pit top area as is currently contained in EPL 1770. It is expected that these volumes were originally based on mine dewatering data, with no consideration given to surface water runoff volumes.

2.7.4 Site Water Management Overview

A schematic representation of both the existing and proposed water management system at the Colliery is shown in **Figures 3** and **4** respectively. **Figure 4** includes measures that LakeCoal have previously committed to (including rainwater tanks and dust suppression using water from the sedimentation ponds). The mine water balance has been developed by considering the major inputs and outputs in the mine water cycle. Major inputs include:

- Groundwater inflow into the underground mining areas;
- Potable Water; and
- Runoff from the catchments at the pit top area.

The major outputs and discharges from the Chain Valley water cycle include:

- Discharge from the sedimentation ponds via LDP 1;
- Evaporation, primarily from free water surfaces such as the sedimentation ponds;
- Runoff from the carpark and access road; and
- A relatively small amount of water contained in the export coal.

GROUND WATER SEEPAGE

POTABLE

CONVEYOR WASHDOWN

WORKSHOP SINK

WASH DOWN

BOOT WASH

NEW BATH HOUSE

OLD BATH HOUSE

MAIN OFFICE

SEPTIC

SEPTIC

IRRIGATION

COMPRESSORS

CONDENSATE

ROOF RUNOFF

OIL WATER SEPARATOR

UNDERGROUND WATER USE

MINE DE WATERING SUMP GNS

PUMP 1

PUMP 2

U/G DE WATERING PIT

OIL WATER SEPARATOR CATCHMENT RUNOFF

OIL WATER SEPARATOR

SETTLING & DIFFUSING POND D8

PIT TOP STORAGE YARD RUNOFF

SETTLING POND D11

SETTLING POND D12

SETTLING POND D13

POLLUTION CONTROL POND D7

WATER CART DUST SUPPRESSION

SETTLING POND D6

SETTLING POND D5

CHP STOCKPILE RUNOFF

SETTLING POND D1

SETTLING POND D4

POLLUTION CONTROL POND D9

SETTLING POND D3

SETTLING POND D2

RUNOFF

CARPARK

POLLUTION CONTROL POND D10 A

POLLUTION CONTROL POND D10 B

EVAPORATION

OFFSITE DISCHARGE

OVERFLOW

SEEPAGE

SEEPAGE

EXPORT COAL MOISTURE CONTENT

LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- MECHANICAL FLOW METER
- MAGNETIC FLOW METER
- FLOW DIRECTION

FIGURE 3

EXISTING WATER MANAGEMENT SYSTEM SCHEMATIC

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

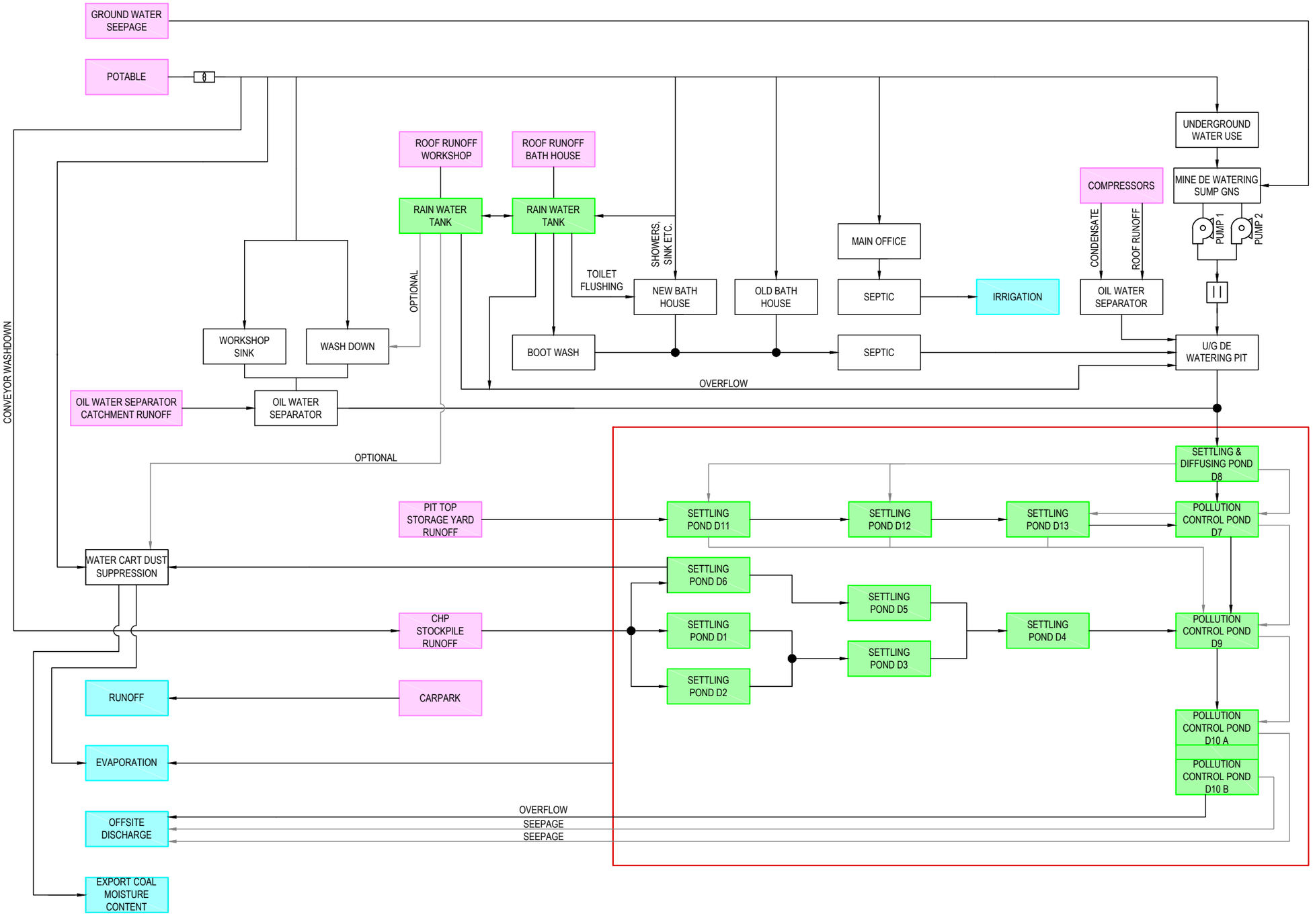
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Projection:
MGA_94 - ZONE 56

Version:	Date:	Author:	Checked:	**Approved:**
A	28/08/2012	MS	DB	AB
B	20/11/2012	MS	DB	AB

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LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- MECHANICAL FLOW METER
- MAGNETIC FLOW METER
- FLOW DIRECTION

FIGURE 4

PROPOSED WATER MANAGEMENT SYSTEM SCHEMATIC

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg4_EMG00-008_Water_Management_System_121120

Projection:
MGA_94 - ZONE 56

Version:	Date:	Author:	Checked:	**Approved:**
A	28/08/2012	MS	DB	AB
B	20/11/2012	MS	DB	AB

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3.0 METHODOLOGY

3.1 Goldsim

The model used to represent the Colliery water balance was GoldSim Version 10.50 (GoldSim Technology Group LLC). This software is a graphical, object oriented system simulation software for completing either static or dynamic systems. It is like a “visual spreadsheet” that allows one to visually create and manipulate data and equations.

Simulation, in this context, is defined as a process of creating a model of an existing or proposed system (such as a mine water management system) in order to identify and understand the factors that control the system performance or predict (forecast) the future behaviour of the system.

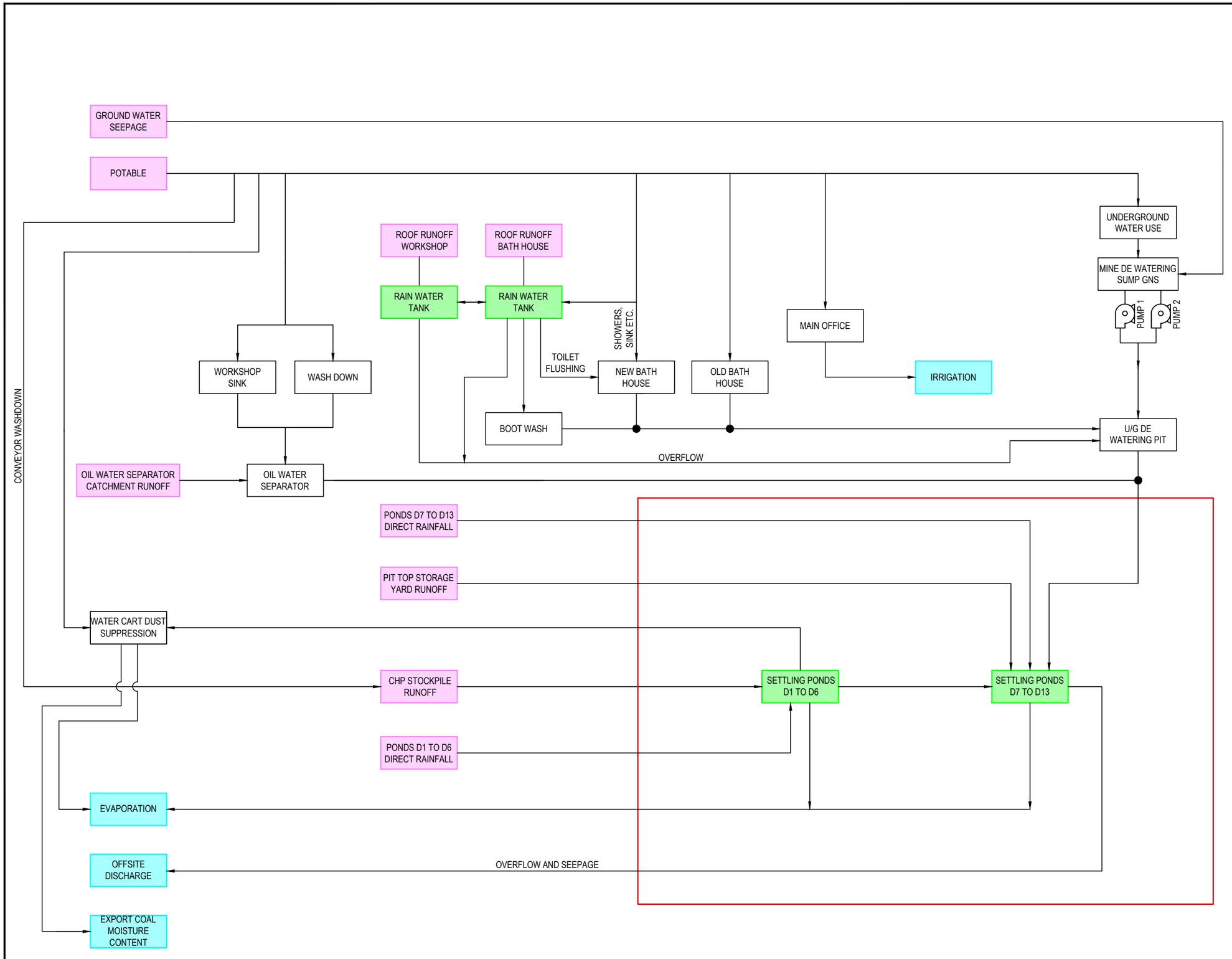
3.2 Previous Water Balance Investigations

A water balance was undertaken for the site by AECOM in July 2011. The water balance investigation documented in this report was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance included a more detailed investigation of the pit top water use to aid the future decision making process in regards to water management at the colliery.

3.3 Model Representation and Accuracy

The Colliery water cycle, as proposed (including increased quantities of water make from underground, rainwater tanks, reuse dirty water from dams for dust suppression purposes etc.) is shown in **Figure 2**, with a schematic water flow diagram provided in **Figure 4**. This system was simplified and modelled in GoldSim as shown in **Figure 5**. The following simplifications were incorporated in the model:

- Daily time steps over a simulation length of over 100 years were used for the analysis – daily rainfall data was the shortest data period available;
- A monte carlo (probabilistic) simulation with 100 realisations to simulate the uncertainty in the model results brought about by the variation in pumped flows from underground and a deterministic simulation to model water processes at the site when pumping at the maximum pump rate from underground (worst case scenario);
- The underground storages within the Wallarah and Great Northern Seams were not modelled in the water balance due to operational uncertainties and uncertainties regarding the actual size of these storages. Based on information provided by LakeCoal these underground storages were assumed to be sufficient to store water during periods of wet weather;
- The carpark catchment runoff was not included in the water balance as it does not report to the sedimentation ponds;
- Runoff from catchments was represented by an initial loss/runoff factor, as described in **Section** Error! Reference source not found.;
- The compressors at the site were not included for simplicity as their contribution to the overall water cycle was considered to be negligible;
- Operating rules/precedents were established within the model in accordance with advice from LakeCoal. In reality the same decisions may not be made by staff due to influences outside the model;



LEGEND

- WATER STORAGE
- WATER INPUTS
- WATER OUTPUTS
- PUMPS
- FLOW DIRECTION

FIGURE 5

WATER BALANCE SCHEMATIC
AS MODELLED IN GOLDSIM

Project:
CHAIN VALLEY COLLIERY
SURFACE WATER ASSESSMENT

Client:
CHAIN VALLEY COLLIERY

File:
Fg5_EMG00-008_Water_Management_System_121120

Projection:
MGA_94 - ZONE 56

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Environmental, Land and Project Management Consultants

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- Rainwater tanks collecting runoff from the workshop and old bath house roofed areas were modelled as an individual tank. Overflow from this combined tank was modelled as occurring when the capacity of the tank exceeded 80% of the overall capacity. Similarly, the tank was filled up with potable water when the capacity dropped below 20% of the overall capacity to ensure water was always available for proposed uses (toilet flushing and bootwash etc.);

- Ponds D1 to D6 and Ponds D7 to D13 were each modelled as single storages to simplify the water balance processes at the site;

- No amenity potable water used (sinks, showers, toilets, etc.) was assumed to be lost from the water balance system. In reality a small fraction of this water may be lost (e.g. through consumption, etc.) however this loss was considered to be negligible in regards to the overall site water balance; and

- Daily dust suppression was modelled to occur on days when less than 5mm of rain fell on the site. This dust suppression water was then modelled as leaving the site via either evaporation or within the exported coal.

The accuracy of the model and results are limited by the following factors:

- Lack of sub metering data regarding pit top and specific areas of underground usage of potable water;

- Lack of water cart usage records to calculate seasonal dust suppression rates. Records from Summer and Autumn were available and an average daily dust suppression rate from these records was calculated and used in the water balance; and

- Distance between Peats Ridge BOM weather station (used for pond evaporation rates) and the site of 33km.

The effect of these errors is considered to be negligible in comparison to the variation in the daily volumes of water being extracted from the underground workings. It is also important to note that the volumes of water discharged via LDP 1 are not currently metered and hence the extent of any errors cannot be verified. Reference should be made to the Groundwater Assessment Report (Geoterra, 2012) regarding the accuracy of the expected volumes of water make as a consequence of underground mining that must be pumped to the surface and, ultimately, to the LDP.

Calibration of the model parameters was not possible in this investigation due to the lack of downstream monitoring information at LDP 1. A broad brush validation of the model results was undertaken based on a range of Average Recurrence Interval (ARI) rainfall events, a generalised estimate of storage capacity available within the sedimentation ponds, pumping rates, catchment areas and runoff coefficents. This ‘sanity check’ of the results demonstrated a strong correlation between the site discharges calculated for certain rainfall events and within the GoldSim model.

Where assumptions have been made, they have generally been conservative. Therefore, results presented in this section are considered to represent potential worst case impacts.

3.4 Data (Node Inputs and Outputs)

3.4.1 Rainfall

There are no long term weather stations located in the immediate vicinity of the Site, however numerous stations are located in the general Lake Macquarie region. Rainfall data was obtained from the BOM’s website for these stations. A comparison of the average annual rainfalls at these stations is provided in **Table 2**. Rainfall information for a weather station at Mannering Colliery was also obtained. However, only 14 months of data was available. It was therefore excluded from the water balance model.

Table 2: Average Annual Rainfall Comparison of Nearby Weather Stations

Weather Station ID	Weather Station Number	Average Annual Rainfall (mm)
Norah Head AWS	61366	1212
Wyee (Wyee Farms Rd)	61082	1171
Swansea (Catherine St)	61377	1292
Gorokan (Goobarabah St)	61387	1175
Morisset (Balcolyn (Bay Street))	61041	1000
Bolton Point (The Ridge Way)	61133	1090
Williamtown RAAF	61078	1127

The dataset developed for the water balance used information from the Wyee and Norah Head stations. There are other stations in the general vicinity however these stations (Wyee and Norah Head) were selected due to their proximity to the Colliery and length and completeness of the data, which together, provide over 100 years of rainfall data. A summary of the annual rainfall data used in the water balance is provided in **Figure 6**.

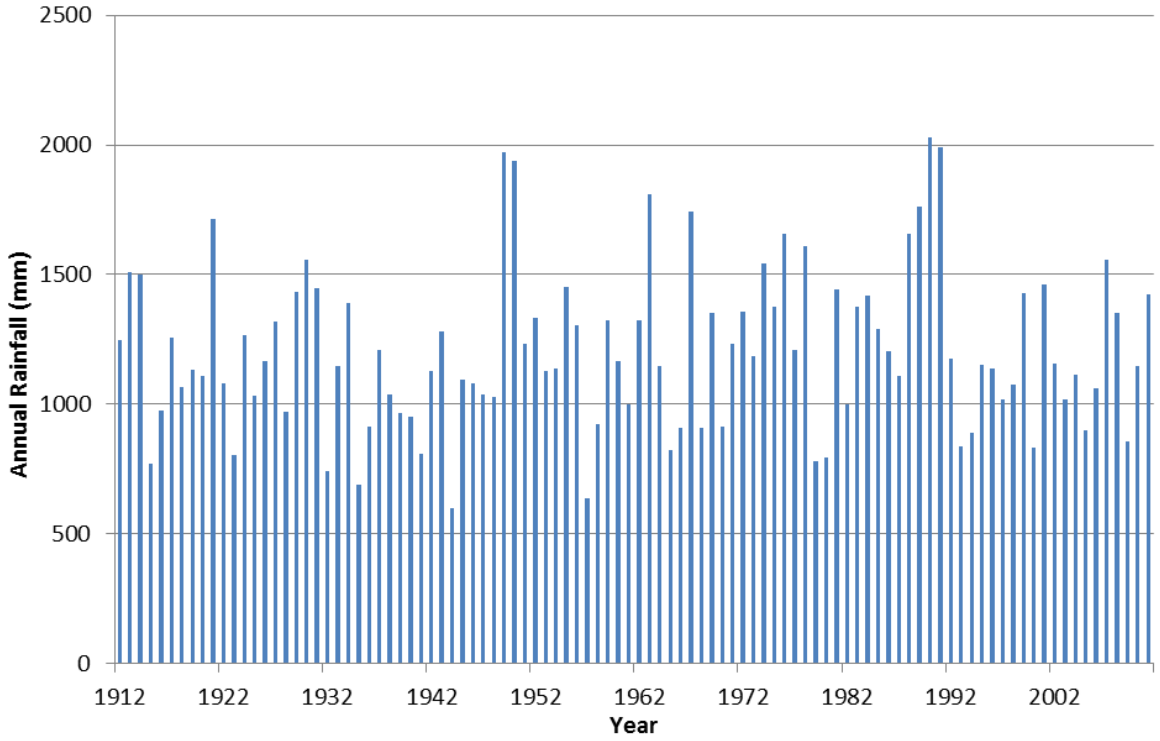


Figure 6 – Annual Rainfalls in Chain Valley Region

Figure 6 demonstrates the variability in the annual rainfall at the site. Rainfall statistics for this data includes:

- Minimum annual rainfall – 600mm in 1944;
- Average annual rainfall – 1206mm;

- Median annual rainfall – 1155mm; and
- Maximum annual rainfall – 2031 in 1990.

3.4.2 Surface Runoff Calculations

Runoff volumes from the pit top areas were estimated using the rainfall data described above. The pit top area was segregated into four distinct catchments (as summarised in **Section 2.6**) using contour information provided by LakeCoal, information from the EA (AECOM 2011) and observations made by GSSE personnel during previous site inspections. These catchments were further broken up into eight sub-catchments for the purpose of the Colliery's water balance, as shown in **Table 3**.

With the exception of the carpark, runoff from each of these sub-catchments is directed to the sedimentation ponds. LakeCoal has committed to installing rainwater tanks connected to the workshop and old bath house roofs. As such, these were included in the GoldSim model. Runoff from the car park discharges directly off-site, hence it is not part of the mine water cycle. Management of this carpark runoff has recently been reviewed at the Colliery with proposed water quality control measures contained within the WMP.

The daily step GoldSim model was used to estimate the surface water runoff from different sub-catchments at the pit top area. An initial loss and runoff factor was assigned to each sub-catchment. This was used to convert daily rainfalls into surface runoff values when the daily rainfall exceeded the initial loss of rainfall.

All hardstand areas were assigned an initial loss value of 2mm and a runoff factor of 0.9 which equates to a high proportion of rainfall/runoff. These runoff coefficients are considered conservative but reflect the large impermeable area in the catchment which includes laydown areas, compacted roads and coal stockpile areas. The free water surfaces of the sedimentation ponds and the roofed areas were modelled as completely impervious areas, capturing all precipitation.

Catchment areas and the estimated average annual runoff volumes estimated from the GoldSim model are provided in **Table 3.** This table also indicates which of the four main catchments (as shown in **Figure 2**) that these more specific areas fall within.

Table 3: Pit Top Catchment Areas, Soil Loss Parameters and Estimated Average Annual Runoff Volumes

Major Catchment Name	Sub-Catchment Name	Catchment Area (ha)	Initial Soil Loss (mm)	Runoff Factor	Average Annual Runoff Volume (ML/year)
Carpark (Catchment 1)	Carpark (not modelled)	NA	NA	NA	NA
Storage Yard (Catchment 2)	Oil Water Separator	0.15	2	0.9	1.40
	Workshop (Roof)	0.24	2	0.9	2.82
	Old Bath House (Roof)	0.11	2	0.9	1.29
	Pit Top Storage Yard	3.03	2	0.9	27.63
Stockpile (Catchment 3)	CHP Stockpile	5.34	2	0.9	48.70
Sedimentation Ponds (Catchment 4)	Ponds D1 to D6	0.41	0	1.0	4.93
	Ponds D7 to D13	1.97	0	1.0	23.54
Total Catchment reporting to Sedimentation Ponds (excluding carpark)		**11.25**	**-**	**-**	**110.31**

3.4.3 Evaporation

Evaporation data was obtained from the BOM's station at Peats Ridge on Waratah Road (station number 61351), approximately 33km south-west of the mine. This was the closest meteorological weather station to the Colliery with over 25 years of evaporation information. Evaporation data from this weather station was adjusted for the change in site conditions from the measuring site to the sedimentation ponds by multiplying the average monthly rates by a pan coefficient of 0.7.

Figure 7 provides a representation of the adjusted average monthly evaporation at this weather station.

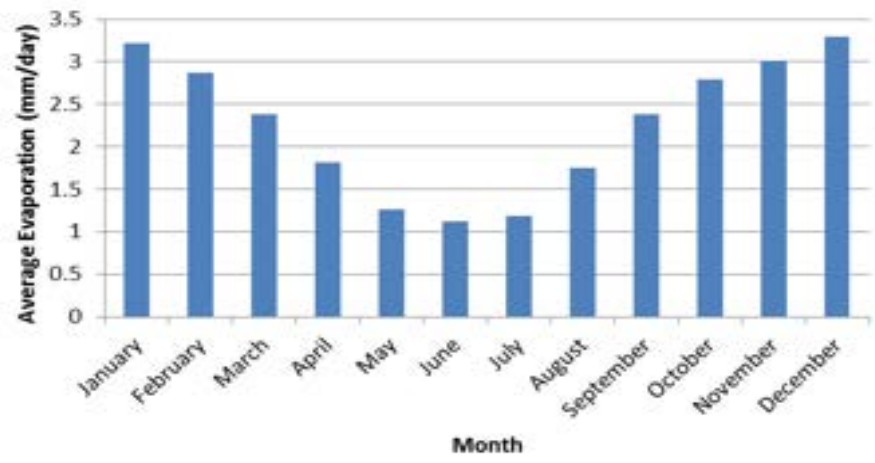


Figure 7 – Average Adjusted Monthly Evaporation Rates

The average annual evaporation rate was approximately 824mm as compared to the annual average rainfall of approximately 1206mm giving an annual surplus (difference between annual rainfall and annual evaporation) of approximately 382mm.

Evaporation from the sedimentation ponds was calculated using a daily step within the GoldSim model similar to the runoff model calculations. This model used the evaporation rate, modified by the pan coefficient, and the surface area of the ponds, which was calculated using survey data provided by LakeCoal. Modelling in GoldSim indicated that approximately 19.2 ML of water would evaporate out of the sedimentation ponds on average every year.

3.4.4 Underground Water Extraction

The Groundwater Assessment (Geoterra, 2012) undertaken for this Proposal predicted that the average daily water volumes pumped from the coal face would increase from approximately 7.3 ML/day to 10.5 ML/day as a result of the Proposal. This estimated pumping rate is an average value and therefore pumped flow rates may exceed this value on occasions. It should be noted however, that this average daily volume was calculated as an 'end of mining' estimate and can be considered a 'worst case' prediction of groundwater inflow rates and is not expected to occur for the majority of the Proposal life.

Pump rate information provided by LakeCoal indicates that the two existing underground dewatering pumps from the Great Northern Seam sump have a maximum pumping rate of 72 L/sec and 64 L/sec respectively. This equates to a total maximum pumping rate from underground of approximately 11.75 ML/day. However, within 12 months of the Proposal being approved LakeCoal are committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day (equivalent to the predicted average daily volume that will need to be pumped from the coal face during the later stages of the Proposal). The timing of this commitment to limit the pumped volume from underground is due to the substantial upgrades required to fully automate the pumps and have them controlled by a SCADA system.

It is noted that a number of storages exist in both the Great Northern and Wallarah Seams. As such, it would be possible to turn these pumps off during periods of high rainfall in order to stay within the LDP discharge limit of 12.161 ML/day.

3.4.5 Sedimentation Pond Characteristics

Information pertaining to the GoldSim modelling of the sedimentation ponds was obtained from survey data supplied by LakeCoal. This information is shown in **Table 4**. It should be noted that the volume of Pond D6 was not available and was estimated based on a 1m depth, the surface area and standard stage/storage relationships. Ponds D1 to D6 and D7 to D13 were each modelled as single storages to simplify the water balance processes at the Site.

Table 4: Sedimentation Pond Parameters

Pond	Surface Area (m^2)	Volume (m^3)
D1	201	80
D2	178	51
D3	317	284
D4	1153	547
D5	726	770
D6	568	568[1]
Total Ponds D1 to D6	**3143**	**2300**
D7	3323	3856
D8	3423	2933
D9	3287	3796
D10	3707	4802
D11	391	297
D12	523	229
D13	370	168
Total Ponds D7 to D13	**15 024**	**16 081**

1. *Calculated using surface area and assumptions from LakeCoal based on site observations.*

3.4.6 Loss of Water through Coal Export

During mining and conveying, the moisture content in the coal increases due to the use of water sprays at the coal face and at transfer points along the conveyor system. A review of the Colliery's coal analysis data indicates that the inherent (air dried) moisture content of the coal from underground is approximately 2.7%. This same data indicates that the total moisture of the Colliery's coal that is exported from the Colliery is approximately 7.3% which means that around 4.6% of this total moisture content is added to the coal prior to export. This equates to 69,000 tonnes of additional water at the proposed maximum rate of production of 1.5 Mtpa. Therefore, approximately 69.0 ML of water is exported from the Colliery every year, or 188.9 kL/day.

3.4.7 Additional Data Supplied by LakeCoal

A limited amount of water usage and flow monitoring data at Colliery was available for this water balance investigation. However, where historic information was lacking, data and operational information was made available to best derive estimates of the respective water balance parameters (flow rates, water usage, etc.). Additional data supplied by LakeCoal, as used in the water balance model, is shown in **Table 5**, as well as comments/assumptions on how this data was derived.

Table 5 – Supplied and Derived Data

Parameter	Value	Comments/Assumptions
Potable Water: Underground (includes increase of 25% to account for any additional underground potable water demand)	139.583 ML/yr	Average of underground potable water from March and April 2012 (monitored water use) with an additional 25% to account for increased potable water used underground as a result of the Proposal.
Potable Water: Main Office	211 L/day	Includes shower, sink and toilet facilities. Shower (26 L/day): Assumes 9L/min, 10 min/person, 2 showers per week. Toilet (154 L/day): Assumes 12 employees, employees at work 5 days/week, 6 L/toilet flush, average employee flushes 3 times/day (at work). Sink (31 L/day): Assumes 12 employees, 1.2 L/wash, employees at work 5 days/week, employees use sink 3 times/day.
Potable Water: Workshop	3724 L/day	Includes equipment washdown and sink use. Equipment Washdown (3712 L/day): Assumes 1 hour wash/day, 1.031 L/sec flow rate. Sink (12 L/day): Assumes 1.2 L/wash, 1 sink used 10 times per day.
Potable Water: Old Bath House	24 L/day	Includes sinks facilities. Sinks (24 L/day): Assumes 1.2 L/wash, 2 sinks each used 10 times per day.
Potable Water: New Bath House (Showers, Sink)	8519 L/day	Includes shower and sink facilities (assumes rainwater tank water used for toilets flushing). Shower (8190 L/day): Assumes 9L/min, 10 min/person, average of 91 shift ends / day (calculated from shift information provided by LakeCoal). Sink (329 L/day): Assumes 160 employees, 1.2 L/wash, employees at work 4 days/week, employees use sink 3 times/day.
Potable Water: Conveyor Washdown	11.135 kL/day	Assumes it is used 3 hrs/day, 1.031 L/s flow rate.
Bootwash Water Demand	273 L/day	Assumes it is used 3 L/person/shift, average of 91 shift ends / day (calculated from shift information provided by LakeCoal).
New Bath House Toilet Flushing Demand	1097 L/day	Assumes 160 employees, employees at work 4 days/week, 4 L/toilet flush (reduced for urinals), average employee flushes 3 times/day (at work).
Dust Suppression Demand	11.28 ML/yr	Calculated from available water cart records (3/01/2012 to 11/05/2012).
Combined Rainwater Tank Capacity	30 kL	Proposed rainwater tank capacity from discussions with LakeCoal and commitments made in the WMP.

4.0 MODELLING RESULTS

4.1 Expected Discharge from Chain Valley Colliery

The probabilistic GoldSim simulation indicated that when applying the historic variation in pumping rates from underground to the predicted 'worst case' average of 10.5 ML/day, the corresponding 95th percentile average daily discharge volume of 13.171 ML/day (including pit top runoff) exceeds the daily discharge limit of 12.161 ML/day. The greatest volume calculated in GoldSim using this probabilistic analysis was 14.394 ML/day.

However, as noted in **Section 3.4.4**, LakeCoal are committed to limiting the main underground pumps to a maximum pump out rate of 10.5 ML/day within 12 months of the Proposal being approved. As such, the GoldSim model was run (using a deterministic simulation) assuming that the pumps from the Great Northern Seam sump were constantly pumping at this 10.5 ML/day rate. This scenario assumes that adequate capacity is available in the underground workings to effectively store water during periods when the groundwater inflow rate exceeds the underground dewatering rate. It should be noted that assuming a constant underground pump rate of 10.5 ML/day is a 'worst case' scenario and is only predicted to occur, on occasions, near the end of the Proposal's life.

The daily discharge through LDP1 predicted by GoldSim assuming a constant underground pumping rate of 10.5 ML/day is shown in **Figure 8**.

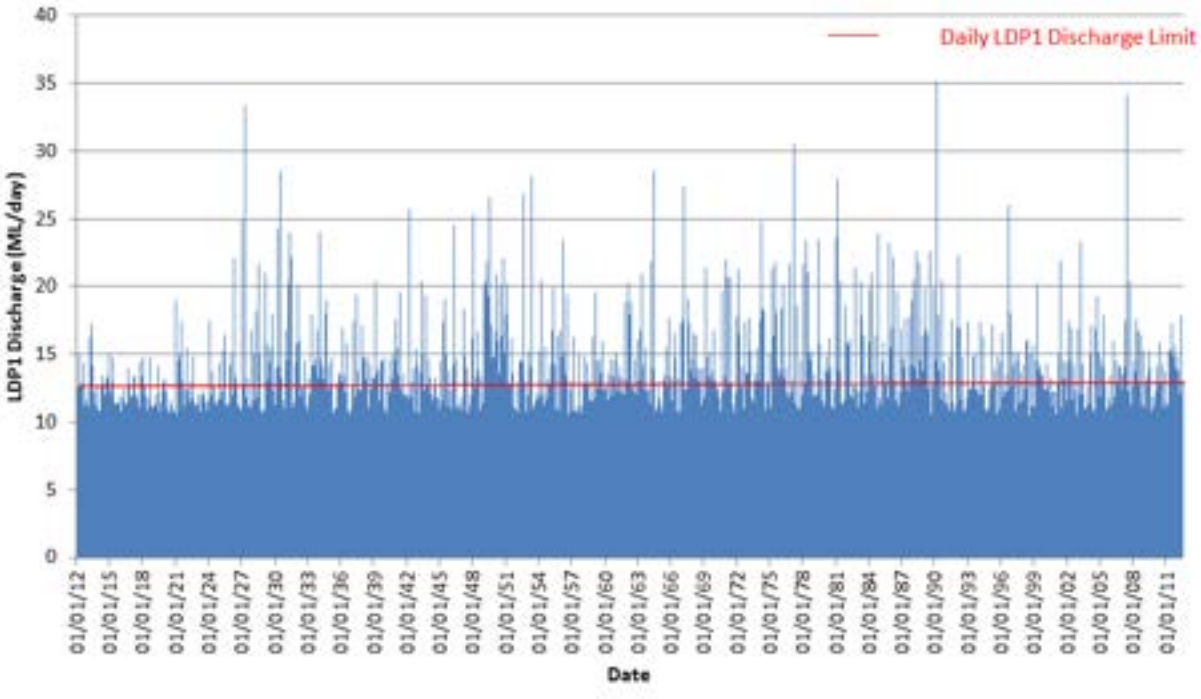


Figure 8 – LDP1 Discharge Results Assuming Constant Maximum Pumping Rate from Underground

The results shown in **Figure 8** indicate that if water make from underground is constantly pumped to the surface at 10.5 ML/day then exceedances of the LDP1 limit of 12.161 ML/day will occur regularly.

Key statistics from this GoldSim modelling, assuming a constant discharge from underground of 10.5 ML/day, include:

- Daily average discharge through the LDP1 of 10.716 ML/day;
- Maximum discharge through LDP1 of 35.124 ML/day; and
- Likelihood of LDP1 exceedance on any given day of 4% (or approximately 15 times per year).

These results indicate that underground storages within the Great Northern and Wallarah Seams are required to mitigate peak groundwater inflow rates. In addition, the results indicate that additional storm surge storage capacity is required at the pit top area to effectively mitigate peak runoff flow rates during large rainfall events, even when no pumping from underground occurs during such an event. It is recommended that this issue be managed by the combination of limiting the pump rate from the underground workings to 10.5 ML/day and by seeking an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours. These issues are further described in the SWA report for the Mine Extension 1 Project.

4.2 Potable Water Use

4.2.1 Potable Water Verification

The total potable water usage, calculated without the proposed water saving measures and from the information provided by LakeCoal, was compared to actual potable water usage records to verify that the assumptions made in these calculations correspond well with the actual usage rates and trends. Results from these calculations indicate that the calculated total potable water use of 132.1 ML/yr compares relatively well to the recent recorded potable water usage (February 2012 to April 2012) of 139 ML/yr. Total potable water usage data from early 2004 was made available for this water balance investigation however only recent usage was used to verify the accuracy of the model assumptions because in recent years the overall usage has been steadily rising as a result of recent miniwall mining methods.

All potable water usage calculations made to verify the model assumptions were associated with the existing operations at Chain Valley Colliery so that the calculated and recorded potable water usage rates could be comparatively compared.

The calculated total potable water used in the pit top area was also compared to the values adopted by AECOM in the previous water balance undertaken for Chain Valley Colliery in 2011. This previous water balance made a 32.7 ML/yr allowance for (the then) future mining activities which are currently undertaken at the mine. The results of this comparison can be seen in **Table 6**.

Table 6: Comparison of Calculated Total Pit Top Potable Water Usage

Parameter	Previous (AECOM) Water Balance Value	GSSE Water Balance Value Calculated
Pit Top Potable Water Used (ML/yr)	18.1	20.4
Underground Potable Water Used (ML/yr)	105.0	111.7
Total Potable Water Used (ML/yr)	123.1	132.1
Percentage of Pit Top Potable Water to Total Potable Water Used	14.7%	15.4%

Table 6 demonstrates that the values adopted in this water balance are similar to those adopted in the previous water balance undertaken by AECOM in 2011. It should be noted that the underground potable water value used in the water balance has no impact on the flow rates discharging from site as this water is accounted for in the metered pumped flows from underground.

4.2.2 Potable Water Savings

The total amount of potable water used at the colliery was investigated in the GoldSim model, with and without the committed water savings measures (as described in **Sections 2.7.1.2**) in order to quantify how much potable water these measures are likely to save at the site. GoldSim modelling estimates that the potable water used in the pit top area will be reduced from 55.9 kL/day to 23.7 kL/day with an overall saving of 32.3 kL/day (11.8 ML/year) as a result of water saving measures being implemented.

This equates to an approximate reduction in total potable water of 8.9% (for current levels of potable water use) and 7.4% (allowing for a 25% increase in the underground potable water use as a result of the proposed future mining works).

Since the potable water used underground is much higher than the potable water used in the pit top area (approximately 85% of the total potable water use) a reduction of the potable water used in the underground mining operations will have more of an effect on the overall potable water used at the site. Such underground potable water saving measures should be investigated to minimise the amount of potable water required from Wyong Council. The potable water saving measures committed to at the pit top area are easily implemented and will also reduce this potable water demand.

4.3 Sensitivity Analysis

A number of assumptions were made in developing the water balance model. This was necessary due to uncertainty associated with the parameters. If available, data from the current operations would normally be used to calibrate the model in order to minimise the uncertainty associated with assumptions. However, as data was not available, a sensitivity analysis was performed on the model to test the impact of potential variability in the assumptions.

The sensitivity analysis entailed varying the value of significant model inputs, such as the water pumped to the surface from underground and the hardstand runoff coefficients at the pit top area. The variability in the model outputs were then observed as a result of these changes to the model inputs. The model outputs which were chosen as indicators were the average and maximum daily discharges as well as the predicted number of LDP1 volume exceedances per year. The results of the sensitivity analysis are provided in **Table 7**.

Table 7: Sensitivity Analysis Results

Parameter tested	Lower Bound	Model Value	Upper Bound	Units
Pump rate from underground	7.3 (existing average pump rate)	10.5 (maximum pump rate committed to)	11.75 (current maximum pump rate)	ML/day
- Average Daily Discharge	7.5	10.7	11.9	ML/day
- Maximum Daily Discharge	31.9	35.1	36.3	ML/day
- Estimated Annual Exceedances	3	16	41	Number/year
Hardstand Runoff Coefficient	0.8	0.9 (used in model)	1.0	Dimensionless
- Average Daily Discharge	11.9	11.9	12.0	ML/day
- Maximum Daily Discharge	34.3	36.3	38.5	ML/day
- Estimated Annual Exceedances	39	41	43	Number/year

The results of the sensitivity analysis demonstrate that the relative variability in the hardstand runoff coefficient had little effect on the overall model results. Lowering the constant pumping rate below the maximum possible rate from underground had a significant effect on both the predicted number of exceedances and the average daily discharge from site. It can be seen that the expected average discharge from site dropped at a similar rate to the reduction in the pumping rate which highlights the significance of the pumping rate from underground on the discharges from site and the risk of exceedances. It should be noted however, that the sensitivity analysis did not take into account any operational procedure documenting pumping rules during significant rainfall events. It can also be seen that at the current pumping rate from underground some exceedances of the LDP1 criteria are predicted.

Table 7 also shows that reducing the pump rate from underground does not have a significant impact on the predicted maximum discharge from site. This indicates that the majority of water discharging from site during these 'extreme' occurrences is due to surface runoff as a result of large rainfall events. As such, LakeCoal should seek an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours.

5.0 CONCLUSION

The detailed daily time step water balance was undertaken in GoldSim in order to understand water demands and flows around the pit top area. It was developed to demonstrate that future water management at the mine is sustainable during the Mine Extension 1 Project. A water balance was previously undertaken for the site by AECOM in July 2011. The water balance described in this report was undertaken independently from this previous water balance with only some model inputs compared for verification. This new water balance utilised the outcomes of the Groundwater Assessment Report (Geoterra, 2012) undertaken for the Mine Extension 1 Project and investigated the pit top water use in more detail to aid the future decision making process in regards to water management at the site.

Key findings from this site water balance investigation include the following:

- Potable water used in the pit top area may be reduced by 32.3 kL/day (11.8 ML/year) as a result of proposed water saving measures at the Colliery, including the use of rainwater tanks and the reuse of water within the sedimentation ponds for dust suppression purposes;
- An investigation into the actual available underground storage capacity should be undertaken due to the importance of this storage in regards to the management of water during the life of the Proposal;
- LakeCoal should seek an amendment to EPL 1770 to include a condition that allows exceedances of the daily discharge volume limit when 10mm of rainfall has fallen on the premises within the preceding 24 hours; and
- LakeCoal should commit to limiting the maximum pump out rate from underground to 10.5 ML/day, within 12 months of the Proposal being approved, in order to adhere to aforementioned proposed EPL amendment. The timing of this commitment is due to the substantial upgrades involved with fully automating the pumps and having them controlled by a SCADA system.

6.0 REFERENCES

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LakeCoal (2012) – Water cart usage records

LakeCoal (2012) – Water quality database March 2012 spreadsheet

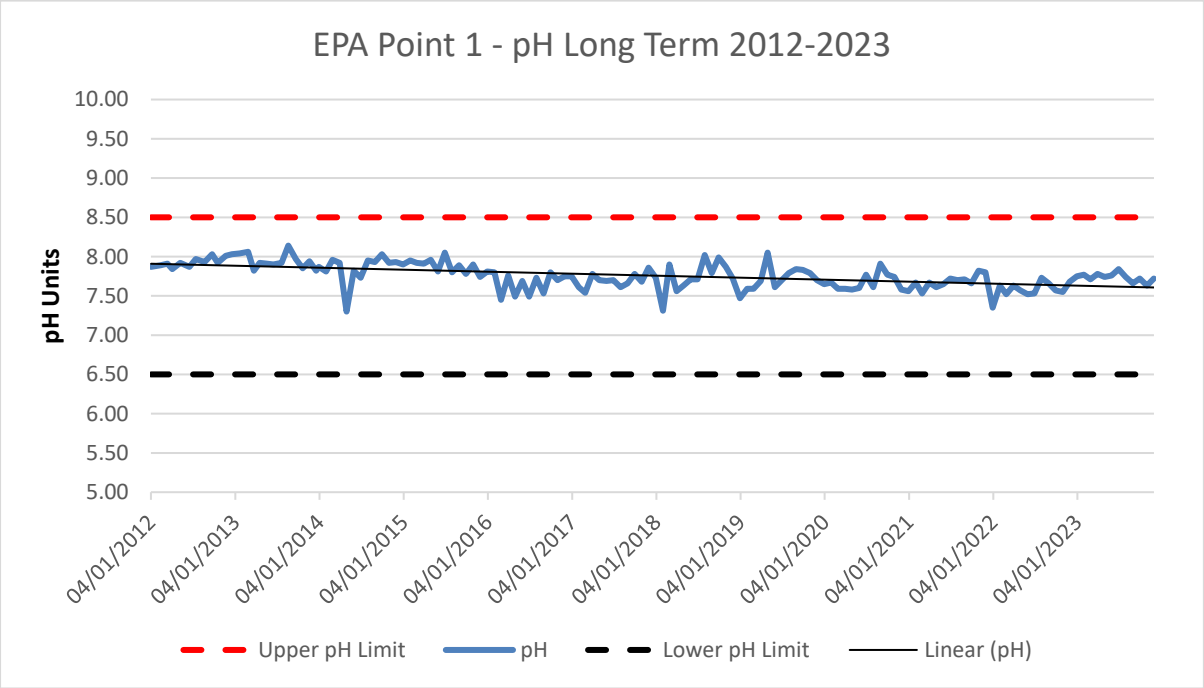
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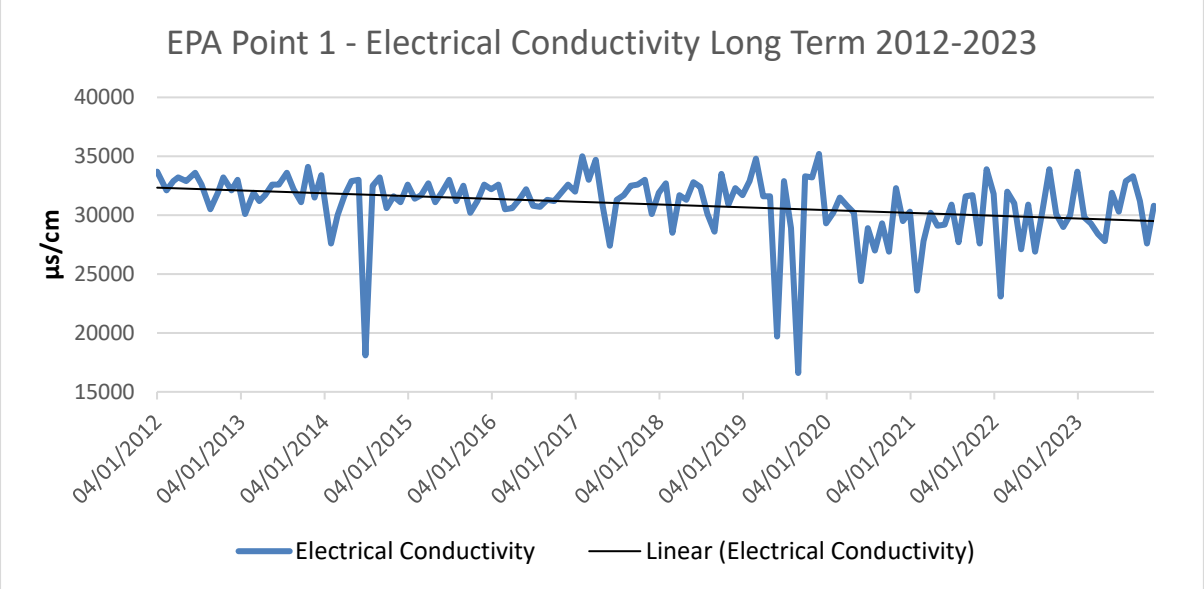
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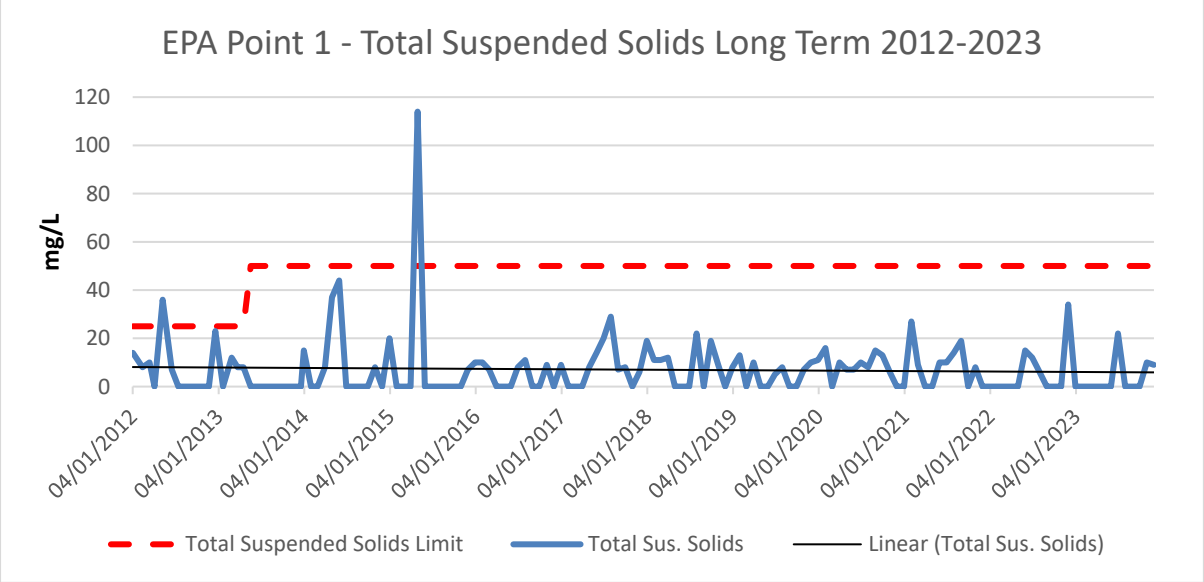
Appendix 7: EPL 1770 Water Quality Monitoring Results

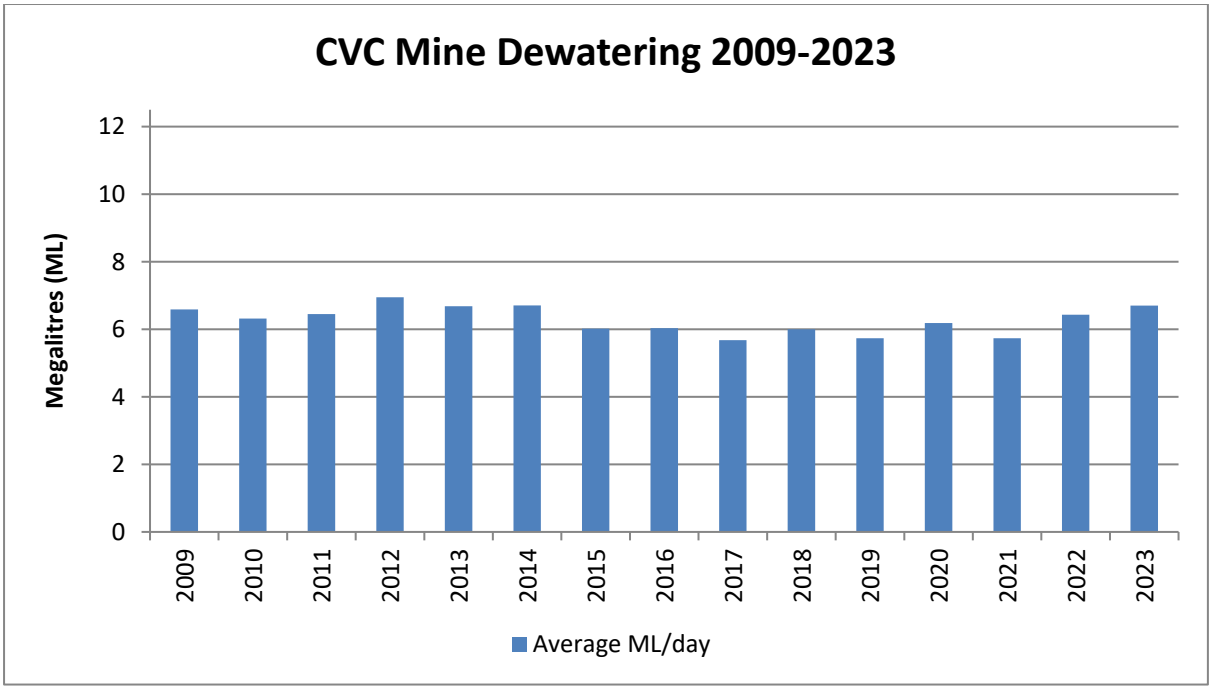
Long term monitoring results from the 2023

Annual review are detailed below.






EPA Point 1 - Total Suspended Solids Long Term 2012-2023
mg/L
120
100
80
60
40
20
0
04/01/2012
04/01/2013
04/01/2014
04/01/2015
04/01/2016
04/01/2017
04/01/2018
04/01/2019
04/01/2020
04/01/2021
04/01/2022
04/01/2023
Total Suspended Solids Limit
Total Sus. Solids
Linear (Total Sus. Solids)


CVC Mine Dewatering 2009-2023
Megalitres (ML)
12
10
8
6
4
2
0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Average ML/day

Appendix 8: 2010-2015 Licensed Discharge Point Water Quality Monitoring

WMP Appendix 8
Chain Valley Colliery LDP1
Water Quality Monitoring Data

	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12
pH	7.40	7.90	7.30	7.20	7.09	7.75	7.52	8.00	7.73	7.90	7.82	7.89	7.75	7.82	7.84	7.94	7.83	7.95	7.80	7.75
Total Suspended Solids	14.00	12.00	15.00	6.00	5.00	5.00	5.00	5.00	8.00	5.00	5.00	17.00	6.00	5.00	5.00	12.00	5.00	20.00	12.00	10.00
Conductivity	17600.00	20900.00	20900.00	9500.00	12800.00	12500.00	23400.00	28800.00	33700.00	35300.00	36300.00	35000.00	33800.00	33900.00	34300.00	33400.00	33200.00	33400.00	32200.00	32600.00
Total Oil and Grease																				
Faecal Coliforms													12.00		2.00	3.00	26.00	2.00	20.00	6.00
Enterococci																				
Nitrate + Nitrate as N																				
Total Kjeldahl Nirotgen as N																				
Total Nitrogen as N																				
Total Phosophorus	0.08	0.01	0.01	0.01	0.01	0.02	0.10	0.10					0.02	0.01	0.01	0.01	0.02	0.26	0.01	0.01
Total Phosphorus as P																				
Biochemical Oxygen Demand																				
Aluminium (total)	0.37	0.55	1.10	0.49	0.34	0.54	0.36	0.45	0.04	0.06	0.07	0.08	0.01	0.02	0.05	0.04	0.09	0.02	0.01	0.04
Aluminium (soluble)	0.17	0.19	0.07	0.29	0.11	0.46	0.12	0.17	0.04	0.08	0.08	0.02	0.00	0.03	0.01	0.03	0.01	0.01	0.01	0.01
Ammonia as N	0.24	0.00	0.02	0.05	0.10	0.10	0.10	0.10					0.10	0.10	0.10	0.10	0.10	0.02	0.10	0.10
Arsenic (total)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0012	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0011	0.0016	0.0005	0.0005
Arsenic (soluble)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0008	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0010	0.0014	0.0005	0.0005
Beryllium (total)	0.0010	0.0010	0.0010	0.0010	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.0001	0.0001	0.0001
Beryllium (soluble)	0.0010	0.0010	0.0010	0.0010	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.0001	0.0001	0.0001
Cadmium (total)	0.0010	0.0010	0.0010	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002
Cadmium (soluble)	0.0010	0.0010	0.0010	0.0010	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002
Chronium (total)	0.0500	0.0020	0.0020	0.0020	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0007	0.0005	0.0005	0.0005
Chronium (soluble)	0.0500	0.0020	0.0020	0.0020	0.0005	0.0005	0.0005	0.0005	0.0006	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0007	0.0005	0.0005	0.0005
Cobalt (total)	0.0070	0.0020	0.0020	0.0020	0.0013	0.0006	0.0008	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002
Cobalt (soluble)	0.0070	0.0020	0.0020	0.0020	0.0013	0.0007	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002
Copper (total)	0.0500	0.0030	0.0300	0.0030	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0026	0.0010	0.0010	0.0010	0.0010
Copper (soluble)	0.0500	0.0030	0.0300	0.0030	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.0010	0.0010	0.0010	0.0010
Lead (total)	0.0500	0.0020	0.0030	0.0020	0.0004	0.0002	0.0002	0.0003	0.0002	0.0002	0.0003	0.0002	0.0004	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002
Lead (soluble)	0.0500	0.0020	0.0030	0.0020	0.0002	0.0002	0.0002	0.0002	0.0002	0.0004	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0003
Mercury (total)	0.0005	0.0005	0.0011	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Mercury (soluble)	0.0005	0.0005	0.0005	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Molybdenum (total)	0.0190	0.0090	0.0080	0.0040	0.0034	0.0082	0.0107	0.0242	0.0011	0.0027	0.0022	0.0026	0.0021	0.0016	0.0020	0.0024	0.0025	0.0030	0.0018	0.0025
Molybdenum (soluble)	0.0110	0.0090	0.0070	0.0040	0.0027	0.0061	0.0113	0.0243	0.0016	0.0013	0.0015	0.0026	0.0001	0.0018	0.0018	0.0021	0.0023	0.0028	0.0008	0.0023
Nickel (total)	0.0500	0.0020	0.0020	0.0020	0.0056	0.0078	0.0064	0.0091	0.0016	0.0014	0.0021	0.0010	0.0010	0.0005	0.0013	0.0026	0.0007	0.0005	0.0006	0.0005
Nickel (soluble)	0.0500	0.0020	0.0020	0.0020	0.0045	0.0069	0.0072	0.0091	0.0005	0.0027	0.0017	0.0011	0.0005	0.0007	0.0005	0.0025	0.0009	0.0006	0.0005	0.0010
Selenium (total)	0.0005	0.0005	0.0005	0.0005	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0010	0.0020	0.0020	0.0020	0.0020
Selenium (soluble)	0.0005	0.0005	0.0005	0.0005	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0010	0.0020	0.0020	0.0020	0.0020
Silver (total)	0.0010	0.0040	0.0040	0.0010	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.0001	0.0001	0.0001
Silver (soluble)	0.0010	0.0030	0.0040	0.0010	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0005	0.0001	0.0001	0.0001	0.0001
Vanadium (total)					0.0005	0.0005	0.0005	0.0005	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0016	0.0005	0.0005	0.0005	0.0005
Vanadium (soluble)					0.0005	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0005	0.0005	0.0005	0.0005
Zinc (total)	0.0500	0.0100	0.0090	0.0110	0.0130	0.0050	0.0100	0.0100	0.0090	0.0130	0.0350	0.0240	0.0180	0.0220	0.0140	0.0220	0.0270	0.0740	0.0360	0.0220
Zinc (soluble)	0.0500	0.0100	0.0090	0.0110	0.0100	0.0060	0.0050	0.0050	0.0090	0.0160	0.0280	0.0180	0.0180	0.0200	0.0120	0.0050	0.0280	0.0650	0.0190	0.0300
Anionic Surfacants as MBAS													0.40		0.10	0.10	0.10	0.10	0.10	0.20

Delta coal

WMP Appendix 8
Chain Valley Colliery LDP1
Water Quality Monitoring Data

	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14
pH	7.73	7.82	7.74	7.89	7.77	8.01	7.82	7.91	7.95	7.97	7.97	7.63	7.82	7.77	7.72	7.70	8.01	7.83	7.71	7.75	7.69	7.73	7.54	7.84		7.75
Total Suspended Solids	5.00	20.00	7.00	5.00	5.00	5.00	5.00	5.00	42.00	5.00	8.00	12.00	8.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Conductivity	32700.00	32900.00	33500.00	32700.00	30500.00	31900.00	32900.00	32100.00	32700.00	30200.00	31500.00	31100.00	31700.00	32700.00	32800.00	33600.00	32100.00	31200.00	32900.00	31600.00	33400.00	32700.00	28900.00	29900.00	26100.00	32900.00
Total Oil and Grease					5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Faecal Coliforms	46.00	18.00	50.00	26.00	37.00	12.00	28.00	19.00	1.00	23.00	14.00	28.00	4.00	38.00	63.00	96.00	120.00	18.00	22.00	32.00	7.00	25.00	250.00	3.00	180.00	9.00
Enterococci						8.00	14.00	10.00	5.00	14.00	64.00	33.00	100.00	90.00	380.00	440.00	830.00	110.00	56.00	50.00	17.00	13.00	150.00	8.00	130.00	9.00
Nitrate + Nitrate as N						0.25	0.30	0.29	0.22	0.31	0.14	0.13	0.14	0.24	0.22	0.50	4.33	0.38	0.43	0.37	0.35	0.34	0.18	0.18	0.44	0.39
Total Kjeldahl Nirotgen as N						0.40	0.20	0.20	0.10	0.10	0.20	0.60	0.10	0.20	0.10	0.50	0.50	0.10	0.20	0.40	0.70	0.50	0.50	0.20	0.50	0.50
Total Nitrogen as N						0.60	0.50	0.50	0.30	0.30	0.10	0.70	0.20	0.40	0.30	0.50	4.30	0.40	0.60	0.80	1.00	0.30	0.50	0.20	0.40	0.50
Total Phosophorus	0.30	0.04	0.01	0.01	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10	0.01	0.01	0.05	0.05	0.01	0.01	0.02	0.14	0.05	0.05	0.02	0.05	0.05
Total Phosphorus as P						0.01	0.01	0.01	0.01	0.01	0.01	0.26	0.01	0.01	0.01	0.05	0.05	0.01	0.01	0.02	0.14	0.05	0.05	0.02	0.05	0.05
Biochemical Oxygen Demand						2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Aluminium (total)	0.03	0.03	0.01	0.03	0.08	0.05	0.06	0.06	0.04	0.05	0.02	0.03	0.03	0.06	0.05	0.04	0.07	0.02	0.04	0.09	0.02	0.10	0.09	0.05	0.08	0.06
Aluminium (soluble)	0.01	0.01	0.01	0.01	0.01	0.18	0.01	0.01	0.04	0.01	0.03	0.01	0.01	0.01	0.05	0.01	0.07	0.02	0.04	0.01	0.01	0.10	0.02	0.01	0.01	0.01
Ammonia as N	0.08	0.14	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.05	0.05	0.08	0.06	0.18	0.11		0.11	0.16	0.10	0.09	0.12	0.06	0.06	0.12
Arsenic (total)	0.0005	0.0005	0.0005	0.0005	0.0006	0.0005	0.0005	0.0006	0.0005	0.0015	0.0005	0.0005	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0020	0.0000	0.0000	0.0030	0.0020	0.0010
Arsenic (soluble)	0.0005	0.0005	0.0005	0.0005	0.0007	0.0005	0.0005	0.0006	0.0005	0.0013	0.0005	0.0005	0.0007	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Beryllium (total)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Beryllium (soluble)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Cadmium (total)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001
Cadmium (soluble)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001
Chronium (total)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0100	0.0010	0.0010	0.0020	0.0010
Chronium (soluble)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0010	0.0100	0.0010	0.0010	0.0010	0.0010
Cobalt (total)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Cobalt (soluble)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Copper (total)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0030	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Copper (soluble)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0020	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Lead (total)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Lead (soluble)	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0010	0.0000	0.0000	0.0010	0.0010	0.0010
Mercury (total)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
Mercury (soluble)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
Molybdenum (total)	0.0022	0.0032	0.0027	0.0024	0.0022	0.0026	0.0024	0.0028	0.0014	0.0026	0.0029	0.0025	0.0030	0.0029	0.0026	0.0029	0.0024	0.0021	0.0019	0.0043	0.0040	0.0000	0.0000	0.0060	0.0070	0.0030
Molybdenum (soluble)	0.0018	0.0028	0.0028	0.0028	0.0024	0.0022	0.0023	0.0028	0.0017	0.0024	0.0029	0.0026	0.0024	0.0024	0.0026	0.0027	0.0024	0.0021	0.0016	0.0038	0.0030	0.0000	0.0000	0.0050	0.0060	0.0030
Nickel (total)	0.0005	0.0005	0.0010	0.0010	0.0009	0.0005	0.0006	0.0008	0.0007	0.0012	0.0010	0.0009	0.0018	0.0011	0.0015	0.0017	0.0014	0.0014	0.0012	0.0014	0.0010	0.0100	0.0020	0.0020	0.0040	0.0030
Nickel (soluble)	0.0005	0.0009	0.0006	0.0014	0.0009	0.0006	0.0005	0.0009	0.0007	0.0014	0.0009	0.0009	0.0012	0.0014	0.0012	0.0016	0.0016	0.0009	0.0011	0.0015	0.0010	0.0100	0.0020	0.0020	0.0040	0.0030
Selenium (total)	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0130	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0300	0.0001	0.0100	0.0400	0.0100	0.0100
Selenium (soluble)	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0080	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0100	0.0001	0.0100	0.0300	0.0100	0.0100
Silver (total)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0100	0.0000	0.0000	0.0060	0.0010	0.0020
Silver (soluble)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0100	0.0000	0.0000	0.0060	0.0010	0.0040
Vanadium (total)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0015	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0020	0.0009	0.0100	0.1000	0.0100	0.0100	0.0100	0.0100
Vanadium (soluble)	0.0005	0.0011	0.0005	0.0005	0.0005	0.0016	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0007	0.0100	0.1000	0.0100	0.0100	0.0100	0.0100
Zinc (total)	0.0150	0.0160	0.0160	0.0180	0.0250	0.0220	0.0200	0.0190	0.0220	0.0360	0.0160	0.0260	0.0390	0.0330	0.0470	0.0460	0.0530	0.0490	0.0640	0.0540	0.0640	0.0500	0.1020	0.0360	0.0420	0.0240
Zinc (soluble)	0.0110	0.0100	0.0140	0.0110	0.0180	0.0230	0.0180	0.0160	0.0190	0.0320	0.0150	0.0310	0.0320	0.0250	0.0500	0.0410	0.0570	0.0530	0.0560	0.0490	0.0350	0.0500	0.0860	0.0260	0.0360	0.0450
Anionic Surfacants as MBAS	0.10	0.10	1.30	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.40	0.10	0.10	0.10	0.10	0.10	0.20	0.10	0.30	0.40	0.60	0.40

WMP Appendix 8
Chain Valley Colliery LDP1
Water Quality Monitoring Data

	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Count	Avg	Min	Max
pH		7.81	7.83	7.81	7.90	7.92	7.80	7.66	7.83	7.81	7.75	7.8	7.81	8.05	58	7.78	7.09	8.05
Total Suspended Solids	42.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5	106	5	5	60	9.70	5.00	106.00
Conductivity		31100.00	32600.00	33400.00	30200.00	31100.00	31200.00	32800.00	31400.00	31700.00	32700	31200	32000	33000	59	30425	9500.00	36300.00
Total Oil and Grease	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5	5	5	5	35	5.0000	5.00	5.00
Faecal Coliforms	16.00	12.00	100.00	40.00	4.00	4.00	2.00	5.00	11.00	7.00	9	27	47	2	47	32.4681	1.00	250.00
Enterococci	180.00	50.00	150.00	23.00	220.00	11.00	2.00	13.00	35.00	60.00	18	44	56	5	35	97.0857	2.00	830.00
Nitrate + Nitrate as N	0.56	0.60	0.48	0.46	0.54	0.30	0.42	0.39	0.44	0.38	0.37	0.38	1	0.56	35	0.4860	0.13	4.33
Total Kjeldahl Nirotgen as N	0.02	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.2	0.2	0.2	0.5	35	0.2777	0.02	0.70
Total Nitrogen as N	0.60	0.60	0.50	0.50	0.50	0.30	0.40	0.40	0.40	0.40	0.4	0.4	1.2	1.1	35	0.6029	0.10	4.30
Total Phosophorus	0.02	0.02	0.05	0.02	0.02	0.06	0.02	0.02	0.02	0.12	0.02	0.04	0.02	0.02	56	0.0402	0.01	0.30
Total Phosphorus as P	0.02	0.02	0.05	0.02	0.02	0.06	0.02	0.02	0.02	0.12	0.02	0.04	0.02	0.02	35	0.0377	0.01	0.26
Biochemical Oxygen Demand	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2	2	2	2	35	2.0286	2.00	3.00
Aluminium (total)	0.01	0.08	0.08	0.10	0.10	0.10	0.03	0.10	0.05	0.10	0.1	0.1	0.1	0.1	60	0.1196	0.01	1.10
Aluminium (soluble)	0.01	0.01	0.01	0.10	0.10	0.10	0.01	0.10	0.06	0.01					56	0.0554	0.00	0.46
Ammonia as N	0.17	0.09	0.08	0.05	0.09	0.03	0.04	0.03	0.01	0.05	0.01	0.08	0.04	0.07	55	0.0861	0.00	0.24
Arsenic (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0023	0.00	0.01
Arsenic (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0080	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0022	0.00	0.01
Beryllium (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0020	0.00	0.01
Beryllium (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0019	0.00	0.01
Cadmium (total)	0.0010	0.0001	0.0002	0.0010	0.0010	0.0010	0.0001	0.0010	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	60	0.0004	0.00	0.00
Cadmium (soluble)	0.0010	0.0001	0.0001	0.0010	0.0010	0.0010	0.0001	0.0010	0.0005	0.0001	0.0010	0.0010	0.0010	0.0010	60	0.0004	0.00	0.00
Chronium (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0033	0.00	0.05
Chronium (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0010	0.0010	0.0010	0.0010	0.0010	60	0.0025	0.00	0.05
Cobalt (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0100	0.0010	0.0010	0.0010	0.0010	60	0.0016	0.00	0.01
Cobalt (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0010	0.0010	0.0010	0.0010	0.0010	60	0.0015	0.00	0.01
Copper (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0200	0.0630	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0051	0.00	0.06
Copper (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0140	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0040	0.00	0.05
Lead (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0030	0.00	0.05
Lead (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0010	0.0100	0.0050	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0028	0.00	0.05
Mercury (total)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	60	0.0001	0.00	0.00
Mercury (soluble)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	60	0.0001	0.00	0.00
Molybdenum (total)	0.0100	0.0020	0.0060	0.0100	0.0100	0.0100	0.0050	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0051	0.00	0.02
Molybdenum (soluble)	0.0100	0.0020	0.0040	0.0100	0.0100	0.0100	0.0040	0.0100	0.0080	0.0020	0.0100	0.0100	0.0100	0.0100	60	0.0045	0.00	0.02
Nickel (total)	0.0100	0.0020	0.0030	0.0100	0.0100	0.0100	0.0020	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0042	0.00	0.05
Nickel (soluble)	0.0100	0.0020	0.0020	0.0100	0.0100	0.0100	0.0020	0.0100	0.0070	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0041	0.00	0.05
Selenium (total)	0.1000	0.0200	0.0100	0.1000	0.1000	0.1000	0.0100	0.1000	0.0500	0.1000	0.1000	0.1000	0.1000	0.1000	60	0.0212	0.00	0.10
Selenium (soluble)	0.1000	0.0100	0.0100	0.1000	0.1000	0.1000	0.0100	0.1000	0.0500	0.0100	0.1000	0.1000	0.1000	0.1000	60	0.0190	0.00	0.10
Silver (total)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0100	0.0100	0.0050	0.0100	0.0100	0.0100	0.0100	0.0100	60	0.0025	0.00	0.01
Silver (soluble)	0.0100	0.0010	0.0010	0.0100	0.0100	0.0100	0.0100	0.0100	0.0050	0.0010	0.0100	0.0100	0.0100	0.0100	60	0.0024	0.00	0.01
Vanadium (total)	0.0100	0.0100	0.0100	0.1000	0.1000	0.1000	0.0100	0.1000	0.0500	0.1000	0.1000	0.1000	0.1000	0.1000	56	0.0208	0.00	0.10
Vanadium (soluble)	0.0100	0.0100	0.0100	0.1000	0.1000	0.1000	0.0100	0.1000	0.0500	0.0100	0.1000	0.1000	0.1000	0.1000	56	0.0191	0.00	0.10
Zinc (total)	0.0520	0.0330	0.0560	0.0500	0.0790	0.0500	0.0380	0.1040	0.1310	0.0550	0.1470	0.0940	0.0940	0.0500	60	0.0404	0.01	0.15
Zinc (soluble)	0.0500	0.0340	0.0400	0.0500	0.0570	0.0500	0.0440	0.0750	0.0400	0.0470	0.1120	0.0680	0.0680	0.0500	60	0.0336	0.01	0.11
Anionic Surfacants as MBAS	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.1	0.1	0.1	0.1	47	0.1702	0.10	1.30

Appendix 9: Water Management TARP

Delta coal	Trigger Action Resp Plan CVC Water Management	TARP 00089 - CVC Water Management

TARP TITLE	TARP 00089 Water Management

	Normal	Trigger 1	Trigger 2
1. FASSI PRODUCTION FACE OR PANEL WATER MAKE	• Face water make normal and able to be managed with existing panel pumping arrangements	• Face water make excessive / unable to be managed with existing panel pumping arrangements	• Uncontrollable ingress of water likely to cause serious injury to persons or damage to equipment
ACTIONS	Manage face water via relevant panel tarps – continue mining activities in compliance with Roadway TARP Ensure pumping equipment is available for use	1. Cease production 2. Ensure mobile and fixed plant is in a safe location where possible (remove/ isolate from potential flooding locations) 3. Withdraw affected persons to a safe location 4. Mobilise sufficient pumping equipment 5. Set up / monitor pumping equipment to manage water make 6. Notify CRO and Shift Undermanager	1. Initiate emergency response plan as required, including withdrawal of workers to a place of safety 2. Initiate the IMT 3. Notify Mine Manager and Production Manager
	Normal	**Trigger 1**	**Trigger 2**
2. FASSIFERN SEAM (OUTBYE) WATER MAKE	• Outbye areas of water make able to be managed via existing pumping arrangements, AND • Fassifern Seam daily average not exceeding long term trend (<1000 kL daily average)	• Signs of localised increased water make, unable to be managed with existing pumping arrangements OR • Fassifern Seam daily average exceeding long term trend of 1000 kL daily average but able to be managed with existing system	• Fassifern Seam water make unable to be managed with existing pumping system AND • There is an immediate risk to the safety of workers and the mine.
ACTIONS	1. Real time monitoring of Fassi total pump out 2. Weekly / Daily inspections 3. Weekly pumping work order including CVB1 pressure reading 4. Weekly review of UG daily dewatering volumes against averages (Work Order System)	1. Notify CRO and Undermanager 2. Increase inspection frequency in affected area(s) 3. Review requirements for additional pumping equipment or storage areas	1. Inform Production Manager and Mine Manager 2. Cease production 3. Ensure face equipment is in a safe location where possible (away from potential flooding locations) 4. Withdraw affected persons to a safe location 5. Mobilise sufficient pumping equipment 6. Set up / monitor pumping equipment to manage water make 7. Initiate the IMT

	Normal	Trigger 1	Trigger 2
3. CHAIN VALLEY BAY (CVB) GOAF WATER STORAGE	• <38kPa static borehole pressure, AND • No evidence of water accumulation around CVB1 seals, AND • >200mm roof gap above water level in CVB1 gate road (ventilation) , AND • No increasing water make around Fassifern seam Mains and Nth headings , AND • Mine pumping system operating effectively	• >38kPa and <40kPa static borehole pressure, OR • Notable increase in water accumulation in CVB1 & 2 gate roads, OR • Oxygen deficiency or loss of ventilation in CVB gate roads, OR • Visible water leakage around borehole standpipe or adjacent strata, OR • Failure of borehole valves, OR • Water accumulation in Fassi Mains headings, OR • Failure of 1 or more pumps at Fassi pit bottom, or loss of power to the Fassi pit bottom pumps resulting in water inflows greater than pumping capability.	• Significant water accumulation and/or uncontrolled water make from CVB1 goaf leading to flooding on Fassi Mains, OR • Foreseeable extended mine dewatering outage
ACTIONS	1. Weekly roadway goaf seal inspections and daily pressure gauge reading (static). 2. Daily measurement of water level indicator (pogo stick) in CVB1 gate road 3. Weekly review of UG daily dewatering volumes against averages (Work Order System)	1. Notify CRO and Undermanager 2. Undermanager to consult Production Manager 3. For oxygen/ loss of ventilation, restrict access to area and take steps to re-establish ventilation in CVB2 in consultation with the ventilation officer 4. Take steps to increase CVB1 water output to drop water level in CVB1 gate road and goaf 5. Consider diverting CVB1 water input 6. Increase inspection frequency in affected area(s) 7. Review requirements for additional pumping equipment or storage areas 8. Where a failure of 1 or more pumps at Fassi pit bottom occurs, or where power to these pumps is lost and water is not controlled, isolate the CVB1 boreholes.	1. Notify Mine Manager 2. In the event of Significant water accumulation and/or uncontrolled water make from CVB1 goaf leading to flooding on Fassi Mains, consider withdrawal of affected persons to a safe location 3. Initiate the IMT 4. Take the necessary steps to re-establish the mine dewatering system as soon as possible

	Normal	Trigger 1	Trigger 2
1. WALLARAH BOREHOLE PRESSURE AND FLOW	• Borehole pressures <290Kpa (static reading), AND • No increased water make evident at Wallarah seals, AND • Wallarah Discharge levels consistent with long term trends (<4500 kL daily average)	• Borehole pressures 290-310Kpa (static reading), OR • Long term average trend from borehole 4500-6000kL/day, OR • Wallarah Borehole closed for water management or maintenance > 24hr, OR • Unplanned reduction of water flow (< 35 l/s)	• Borehole pressures >310Kpa (static reading), OR • Borehole flow >6000kL daily average during normal operations, OR • Increased water make evident at Wallarah seals, OR • Failure of Wallarah borehole and/or pipeline
ACTIONS	1. Real time monitoring of Wallarah borehole flow 2. Wallarah borehole pressure (static) to be read weekly as per Work Order 3. Wallarah seals inspected weekly 4. Weekly review of UG daily dewatering volumes against averages (Work Order System) 5. Mining operations continue to normal standards	1. Notify CRO and Undermanager 2. Inspect Wallarah seals for signs of increased water make daily 3. Inspect Wallarah borehole and pump line for signs of leakage 4. Daily pressure reading of Wallarah borehole whilst borehole closed / pressure above 290kpa 5. Ensure both REES pumps at the GTN Dewatering Dam / Weirs are available for operation	1. If Wallarah borehole fails, then cease production and consider withdrawal of workers to a place of safety 2. Notify Mine Manager 3. As per trigger 1 4. Resume dewatering of Wallarah Borehole, with consideration of GTN Dewater dam levels, GTN water make / storage and production requirements 5. Review need for additional pumping at Wallarah seals to prevent flow to interseam bin 6. Review need for additional pumping capacity at GTN Dewatering Dam / Weirs

	Normal	Trigger 1	Trigger 2
6. Great Northern Seam PIT BOTTOM PUMP / DAM	• Discharge consistent with long term trend (approx. <1100 kL per day), normal operation of pumps from shaft headings and pit bottom (P/B)	• Discharge above long term trend (1100 - 1600kL per day) OR • Signs of increased water make in P/B area, dam level rising OR • Shaft headings pump off for > 1 week	• Discharge (>1600 kL per day) OR • Significantly increased water make in P/B area, dam level rising (ie unable to dewater Pit Bottom Dams with current pumping capacity) OR • Significantly increased water level in shaft headings
ACTIONS	1. Real time monitoring of Pit Bottom discharge volumes 2. Daily inspections (stat inspections) 3. Weekly pumping inspection (work order) 4. Weekly review of UG daily dewatering volumes against averages (Work Order)	1. Notify CRO and Undermanager 2. Undermanager to consult Production Manager 3. Isolate shaft headings pump if necessary to prevent overflowing of P/B dam walls 4. Daily pumping inspections and weekly review of dewatering volumes 5. Restart shaft headings pump as necessary	1. Notify Undermanager 2. As per trigger level 1 3. Review requirements for additional air pumps in P/B areas 4. Review need for additional capacity to dewater P/B dam (larger or more electric pumps) 5. Consider diversion of Shaft Headings pump delivery directly to GTN Dewater Dams
7. Great Northern Seam SIPHON LINE/ Sump headings	**Normal**	**Trigger 1**	**Trigger 2**
	• Discharge consistent with Long term trend (<2000 kL per day)	(a) Discharge <600kL/day, or (b) Discharge trend >2000kL/day	• Signs of significantly increased water make or failure of existing pumping system to control water make
ACTIONS	1. Real time monitoring of Siphon line discharge volumes 2. Weekly pumping inspection work order for levels, signs of increased water make 3. Weekly review of UG daily dewatering volumes against averages (Work Order System)	For (a) Increase inspections of pumps to daily and review requirements for additional pumping in GNS (localised water make) For (b) Inspect for other sources of water make and integrity of Wallarah borehole line	1. Notify Undermanager 2. As per trigger 1 3. Inspect Siphon line for flow / blockages 4. Review requirement for additional pumping infrastructure

	Normal	Trigger 1	Trigger 2
8. GTN MAIN DEWATER DAM LEVEL AND OUTPUT (REES PUMPS)	• Dam Level <60% (Pump Capacity sufficient to make headway on water make), AND • Weekly UG dewatering avg pump consistent with long term averages out <6500 kL day	• Dam Level >60% and rising (Insufficient pumping capacity to maintain dewatering rate against water inflow) , OR • Dam level > 80%, OR • Daily UG dewatering avg >8000 kL/day and dam levels able to be managed with available pumping capacity	• Dam Level >90% and rising, OR • Daily UG dewatering avg >9500 kL/day and dam level rising, OR • Long term UG discharge volume increasing
ACTIONS	1. Real time dam level and flow monitoring 2. Weekly review of UG daily dewatering volumes against averages (Work Order System)	1. Notify CRO and Undermanager 2. Undermanager to consult Production Manager 3. Confirm Wallarah Borehole flow and pressure daily 4. If Wallarah Borehole < 300Kpa turn off until dam level lowers <60% 5. Operate 2nd REES pump as required	1. If Wallarah borehole pressures <300kPa turn off until dam level Lowers to <60%. Continue monitoring pressure daily. 2. Initiate Incident Management Team (IMT) and review risk of Main dam overflow and impact to Fassi seam drifts/workings. Implement controls as required (including Withdrawal Conditions / Inrush management) 3. Implement action plan for managing GTN Dewater Dams, considering: • Status / capacity of water make/storage areas at the operation • Potential source of additional water make. • Weather forecast and status of surface water in • relation to discharge capabilities • Any requirement for additional pumping capacity • Potential emergency discharge increase (surface dams) 4. Assess potential risks to underground workers. Consider withdrawal to a place of safety.

	Normal	Trigger 1	Trigger 2
9.Surface Water / Dam Discharges	Weekly weather forecast is to be checked daily by the Control Room Operator (CRO) at the commencement of day shift, where greater than 20 mm of rainfall is anticipated at any time, the CRO and Environmental Compliance Coordinator will monitor the forecast and plan appropriately in accordance with Trigger 1 and Trigger 2 below. Rain forecast is to be determined by: • Review of BOM for Mannering Park (http://www.bom.gov.au/places/nsw/mannering-park/) • If >20mm rain has been forecast for any 24-hr period, check detailed forecast and determine total potential rainfall (25% chance) by calculating the total rainfall presented in the "25% chance of more than (mm)" for a 24-hour period. • Compare total of 25% chance of more to Trigger 1 and Trigger 2 Actions		
	• 0mm to 25mm rainfall 24 hr forecast	• 25mm to 40mm rainfall 24 hr forecast/actual	• >40mm rainfall 24 hrs forecast/actual
CHAIN VALLEY COLLIERY ACTIONS	Both REES pumps can run normally 1. Automated 10 500 kL limit on pumping system in 24 hrs 2. Real time dam level and flow monitoring 3. Weekly review of UG daily dewatering volumes against averages (WO) 4. Continue to monitor forecast and update Citect accordingly	Single pump only to run, monitor levels of GTN pit bottom dams (this corresponds to approx. 6.5ML/day at current pump capacity). Implement action plan to manage water make, considering (in order of priority) duration of the rainfall event, and the water storage capacity of the following areas: 1. Great North Seam Dams (Siphon) 2. Wallarah Seam 3. Great Northern Sump Headings 4. GNS North East Dams 5. Chain Valley Bay 1	Notify Mine Manager, Technical Services Manager and Environment Coordinator • Consider ceasing pumping to surface if no foreseeable elevated risk to mine and personnel safety Ensure actions are taken as per trigger level 1
MANNERING COLLIERY ACTIONS	Underground pump J135 can run normally	Underground pump J135 can run normally, however, where achievable, ensure underground groundwater storage capacity is maximised in the event of an increase in forecasted rainfall	Consider turning off pump J135 for the period

Appendix 10: Environmental Incident Categories Matrix

Category and definition	Immediate action(s)	Follow-up action(s)
EI1 **Serious environmental issues** Issues classified EI1 include: • a breach of an EPL condition, reporting or other compliance condition where clear documentary or other physical evidence of the breach exists and material harm to the environmental is caused or threatened; • a breach of other environmental regulations where physical evidence exists (e.g. a breach of the POEO Act leading to a Tier 1 or Tier 2 offence prosecution); • an incident requiring mandatory reporting to EPA, such as spills or emissions causing or threatening material harm to the health or safety of human beings or to ecosystems; or • a pollution incident related to DC's operations where actual or potential loss or property damage exceeds $10,000 (including costs to prevent, mitigate or 'make good' the associated harm to the environment).	i) Emergency response Where necessary, emergency response procedures should be invoked to contain, mitigate or 'make good' any associated harm to the environment. ii) Notification In the event of any pollution incident, the Shift Manager, immediately after becoming aware of the incident, will notify the Environment Compliance Coordinator or Mine Manager. When an environmental incident is deemed by the Environmental Compliance Coordinator to be an EI1 incident: • it must be reported immediately to the relevant regulatory authorities in accordance with the PIRMP; and • the Duty Shift Manager or their delegate must immediately implement the PIRMP and notify any other relevant staff as required.	i) Investigation All EI1 incidents are investigated by DC's Environmental Compliance Coordinator using DC's Environmental Incident Investigation Procedure. ii) Internal reporting: A summary report on the incident, subsequent investigations and remedial actions is provided to the Mine Manager as soon as practicable. The Environmental Compliance Coordinator is also responsible for entering the details of the incident into DC's internal Work Management System (WMS). A summary of the incident is included in monthly reports for DC's Executive Strategy Committee and in the quarterly Board Environment Report. iii) External reporting: In addition to immediate notification, all serious environmental issues are reported to EPA as required by the EPL and relevant consent conditions.

Category and definition	Immediate action(s)	Follow-up action(s)
EI2 **Significant environmental issues** Issues classified EI2 include: • a breach of an EPL condition, reporting or other non-compliance condition requiring reporting to the EPA; • a potential breach of an EPL condition or other environmental regulation where there is available physical evidence of a breach and/or pollution control system failure (e.g. significant and/or prolonged events that have caused observable and/or measurable environmental effects or discharges due to a system failure that flows to and is contained within a final holding pond, retention basin or other facility designed as a last line of defence against spills or discharges to the external environment); • a minor technical breach of an EPL condition where no environmental harm has occurred but results in a penalty notice or formal warning being issued by EPA; or • a failure or overload of an activity's upstream pollution control equipment.	i) Emergency response Where necessary, emergency response procedures should be invoked to contain, mitigate or 'make good' any associated harm to the environment. ii) Notification When a breach of regulation is suspected or in the event of any pollution incident, the Shift Manager, immediately after becoming aware of the incident or breach, will notify the Environmental Compliance Coordinator or Mine Manager. If satisfied that the incident or breach is classified EI2 (i.e. not threatening or causing material environmental harm), the Environmental Compliance Coordinator will notify any other relevant personnel as soon as practicable. iii) Adjudication Where there is doubt whether an incident is EI1 or EI2, the matter is referred to the Mine Manager for determination. If considered sufficiently serious, the Mine Manager may establish a formal investigation committee.	i) Investigation The Environmental Compliance Coordinator and a representative from the relevant production group will investigate the cause of the incident and instigate action(s) to prevent recurrence. The investigation will use the Environmental Incident Investigation Procedure. ii) Internal reporting: A summary report on the incident, subsequent investigations and remedial actions will be prepared by the Environmental Compliance Coordinator and communicated to the Mine Manager. The Environmental Compliance Coordinator is also responsible for entering the details of the incident into DC's internal WMS. Where there has been a technical breach of an EPL condition, a review of the breached condition will be undertaken with recommendations for corrective action or amendment to the EPL. A summary of the incident is included in monthly reports for DC's Executive Strategy Committee and in the quarterly Board Environment Report. iii) External reporting: Details of all significant environmental issues are reported in accordance with relevant EPL conditions and/or as directed by EPA.
EI3 **Minor environmental issues** Issues classified EI3 include: • a minor technical breach of an EPL or discharges to the environment that are not included in any of the above categories and where it is confirmed no environmental harm has occurred or was threatened; or • on-site incidents contained locally at the site of the incident	i) Emergency response Where necessary, emergency response procedures should be invoked to contain, mitigate or 'make good' any associated harm to the environment. ii) Notification All minor environmental issues contained on-site should be reported to the Environmental Compliance Coordinator as soon as practicable. In the event of any	i) Investigation The Environmental Compliance Coordinator will investigate the cause of the incident and instigate action(s) to prevent recurrence. The investigation will use the Environmental Incident Investigation Procedure. ii) Internal reporting: The Environmental Compliance Coordinator is also responsible for entering the details of the incident into DC's internal WMS. Details should include any subsequent corrective and

Category and definition	Immediate action(s)	Follow-up action(s)
in accordance with site procedures and controls.	pollution incident threatening environmental harm, the Shift Manager, immediately after becoming aware of the incident or breach, will notify the Environmental Compliance Coordinator or Mine Manager. iii) Adjudication Where there is any doubt as to whether the incident EI2 or EI3, the matter is referred to the Mine Manager for determination.	preventative actions. A summary of the incident will be tabled at quarterly EEC meetings. iii) External reporting: None.

Appendix 6 Biodiversity Management Plan

Delta coal

Environmental Management System

Chain Valley Colliery

Biodiversity Management Plan

Reviewer	Katie Weekes – EMM Consulting
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Authorised by:	
	Delta Coal
Date:	23 November 2022

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1 Introduction

Chain Valley Colliery (CVC) is an underground coal mine on the southern side of Lake Macquarie, approximately 60 kilometres (km) south of Newcastle and 80 km north of Sydney (**Figure 1**). An underground linkage within the Fassifern Seam is approved between CVC and Mannering Colliery (MC), which enables coal extracted at CVC to be transferred to, and handled at, MC where the coal is crushed, screened and transported to Vales Point Power Station via conveyor. Chain Valley Colliery is also approved to undertake haulage up to 660,000 t of product coal directly to Vales Point Power Station per annum via internal haul roads.

Great Southern Energy Pty Ltd, trading as Delta Coal (DC) became the owner and operator of CVC on 1 April 2019. Prior to the purchase by Great Southern Energy Pty Ltd, CVC was owned and operated by LakeCoal Pty Ltd (LakeCoal).

CVC operates under Development Consent SSD-5465, with the most recent modification (Modification 4) granted on the 5th August 2021.

1.1 Purpose

The Biodiversity Management Plan applies to the surface operations at Chain Valley Colliery (CVC), including pit top facilities and lands where additional infrastructure may be constructed.

The purpose of this management plan is to:

- address the requirements for Development Consent SSD-5465, Schedule 3, Condition 20 which specifies that a BMP be prepared;
- Establish baseline data for the existing habitat in the Biodiversity Enhancement Area and elsewhere on site;
- Describe the short medium and long term measures to be implemented to:
    - Manage the impacts of clearing vegetation;
    - Manage the remnant vegetation and habitat in the Biodiversity Enhancement Area and elsewhere on site; and
    - Implement the Biodiversity Enhancement Strategy, including detailed performance and completion criteria;
- Include a program to monitor and report on the effectiveness of these measures, and progress against the detailed performance and completion criteria
- Identify the potential risks to successful implementation of the Biodiversity Enhancement Strategy, and the contingency measures that would be implemented to mitigate these risks;
- Include details of who would be responsible for monitoring, reviewing and implementing the plan;
- provide an overall framework for consultation related to biodiversity;
- set out the rehabilitation objectives for CVC;
- minimise and appropriately control potential impacts to biodiversity from operations;
- minimise potential impacts on biodiversity surrounding the operational areas;
- define specific responsibilities of all stakeholders and function as a management tool for all relevant operational personnel; and
- identify the requirements for review of the document and a procedure for continual improvement.

The BMP includes a Biodiversity Enhancement Strategy (SSD-5465 Schedule 3, Condition 19), which will implement measures to enhance and restore the endangered ecological communities (EECs) in the Biodiversity Enhancement Area, including:

- weed and rubbish removal;
- return of the natural hydrological regime; and
- regeneration with native endemic species.

The overall aim of this management plan is to promote a high level of environmental performance through the minimisation of impacts.

1.2 Consultation

The BMP was originally developed in 2012 and, following some minor changes to the original document as a result of comments from the then Department of Planning and Infrastructure (DPI), the final plan was subsequently approved on 6 November 2012.

This BMP has been subsequently updated to be consistent with the requirements of the most recent development consent (SSD-5465 dated 16 December 2015) and the commitments made within Chain Valley Colliery's Mod 2 Statement of Environmental Effects (SEE). Extensive consultation was undertaken with the then Office of Environment and Heritage (OEH) by LakeCoal during the approvals process.

This BMP, while based substantially on the previously approved LakeCoal BMP (V3), has been updated to reflect the recommendations of the Independent Environmental Audit (IEA) conducted by SLR in June 2019. These updates are administrative only and there are no changes to activities, impacts, the mine footprint or development consent requirements associated with CVC.

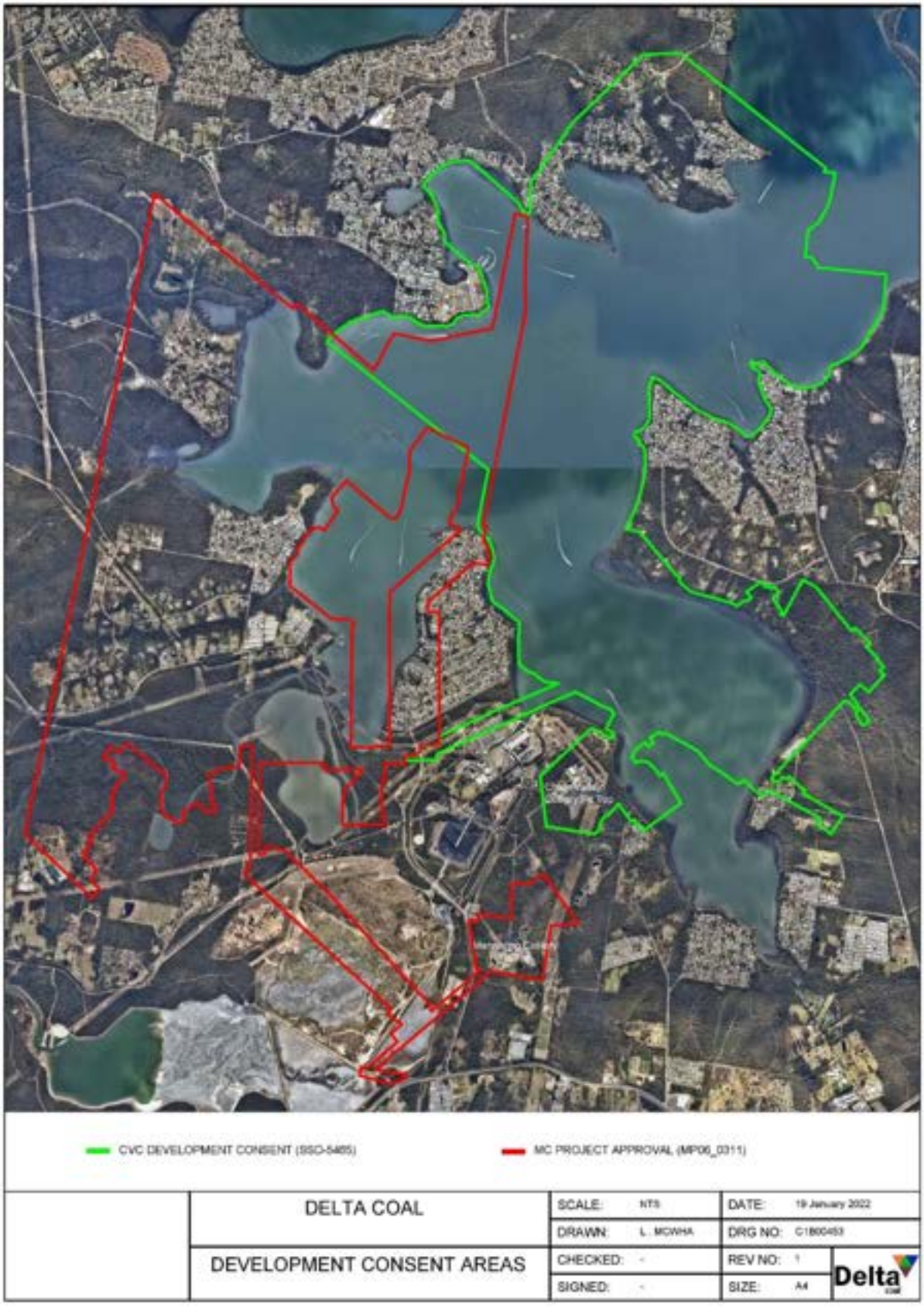
Endorsement of individuals undertaking the review of this management plan was received from DPIE on the14 August 2019 and on the 14 September 2022 for administrative updates.

This BMP was provided to the Environment Protection Authority (EPA), Biodiversity Conservation Division (BCD) and Department of Planning, Industry and Environment (DPIE) on 25 November 2022 for their review and comment. A summary of the comments received, and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**.

Table 1: Consultation Summary

Stakeholder	Comments	Delta Coal Response/Action
NSW EPA	**6th December 2022** • "The EPA has not reviewed and has no comments on the Biodiversity Management Plan."	• Nil.
NSW DPE		
NSW BCD	**9th December 2022** BCD has reviewed the BMP and recommends: 1. That Section 3.2.1 'Native Vegetation' includes photos of Plot 1 and Plot 2 and that the BMP includes a copy of the raw Plot data. If this data has already been presented, say in an Annual Review, the cite that reference instead. 2. Show the location of the Plot 1 and Plot 2 on a map – such as Figure 2 'Pit Top Area Broad Vegetation Types' or Figure 3 ' Ventilation Fan Site Broad Vegetation Types', or in a new map. 3. Clarify whether the 'Native Vegetation Enhancement Area' shown in Figure 4 is the same as the 'Biodiversity Enhancement Area' mentioned elsewhere in the BMP. If so, the title to Figure 4 may need to be changes, if not, then please describe how these two areas differ in Section 3.2.1.	1. Reference has been included within Section 3.2.1 to the monitoring data presented in the annual biodiversity monitoring reports, which are made public on the Delta coal website. 2. Inclusion of a new map, now Figure 2 'Biodiversity Monitoring Plot Locations'. 3. Figure 4 (now Figure 5) updated with revised image showing Biodiversity Enhancement Area as well as revision of figure heading. The areas did not differ.

Figure 1 Regional Context



2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities. Compliance with State regulations requires the implementation of activities ranging from the control of priority weeds (*Biosecurity Act 2015*), monitoring for threatened species (*Biodiversity Conservation Act 2016)* and management of forest fuels to prevent fire spread (*Rural Fire Services Act 1997).*

A number of legislative requirements, government policies and guidelines relating to biodiversity are applicable, key items relevant to this BMP are:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Mining Act 1992*;
- *Biosecurity Act 2015* and Biosecurity Regulation 2017;
- *Local Land Services Act 2013*,
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*;
- *Rural Fires Act 1997;*
- Central Coast Council Tree Works Permit (former Wyong Local Government Area); and
- Auld, B. (2009). Guidelines for monitoring weed control and recovery of native vegetation, NSW Department of Primary Industries (DPI).

Delta Coals operational areas are within the Lake Macquarie City Council (LMCC) and Central Coast Council (CCC) local government areas (LGAs).

2.2 Development Consent (SSD-5465) Requirements

Biodiversity related requirements of the development consent (SSD-5465) include specific conditions that are to be addressed within this BMP, **Appendix 1** details where in the BMP they are addressed.

DC will also carry out works generally in accordance with the Environmental Assessment (EA), Statement of Environmental Effects (SEE) (Mod 1), SEE (Mod 2), SEE (Mod 3), SEE (Mod 4), Project Layout Plans, and Statement of Commitments.

3 Existing Environment

3.1 Previous Assessments

Several biodiversity assessments have been undertaken in the Central Coast Local Government Area (LGA), for the nearby VPPS, and for CVC. This section provides a summary of previous assessments in relation to management of biodiversity values within and surrounding the CVC.

Ecotone Ecological Consultants undertook detailed biodiversity surveys within and surrounding the study area in June 1997 and April 2010. Their study area included the CVC pit top area with the following biodiversity values identified:

- Narrow-leaved Scribbly Gum Open Forest in vegetated areas;
- potential habitat for threatened flora listed under the *Threatened Species Conservation Act 1995* (TSC Act): Black-eyed Susan (*Tetratheca juncea*); Leafless Tongue Orchid (*Cryptostylis hunteriana*) and *Angophora inopina*; and
- a record of the threatened Grey-headed Flying-fox (*Pteropus poliocephalus*), listed under the TSC Act and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The CVC EA for continued operations (MP10_0161) identified the following biodiversity values at the pit top and ventilation shaft site at Summerland Point.

- pit top area:
    - Contains remnant and regenerating vegetation including Coastal Plains Smooth-barked Apple Woodland, Riparian Melaleuca Swamp Woodland, and Swamp Mahogany Paperbark Forest. The latter two communities are part of the Swamp sclerophyll forest which is listed as an EEC under the TSC Act.
- ventilation shaft site at Summerland Point:
    - Contains remnant vegetation including Coastal Plains Smooth-barked Apple Woodland, Coastal Wet Sand Cyperoid Heath and some areas of Riparian Melaleuca Swamp Woodland, and Swamp Mahogany Paperbark Forest, which are part of the Swamp Sclerophyll Forest EEC.
- Both sites:
    - contain potential habitat for threatened species: Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Osprey (*Pandion haliaeetus*), Squirrel Glider (*Petaurus norfolcensis*) and Grey-headed Flying-fox (*Pteropus poliocephalus*). An additional ten threatened fauna species may utilise the habitats in the pit top area on occasion.

Under the Central Coast Local Environmental Plan 2022 the pit top area and sediment dams are zoned as SP2 Infrastructure, with the vegetation east of the sediment dams zoned as E2 Environmental Conservation.

The infrastructure area and surrounds of the ventilation shaft site at Summerland Point are zoned E1 National Parks and Nature Reserves under the Central Coast Local Environmental Plan 2022.

3.2 Baseline Monitoring

3.2.1 Native Vegetation

Baseline data on vegetation condition in the area of Swamp oak forest enhancement areas was collected in 2013 in accordance with the monitoring program outlined in this BMP (see **Table 2**).

Table 2 provides baseline data for site attributes for Swamp Oak Forest in the Biodiversity Enhancement Area. It provides the site attribute score (plot score) and calculates the weighted score of each site attribute to give an overall weighted score.

Table 2: Baseline (2013) Swamp Oak Forest Data

Site attribute	Benchmark	Plot 1 score	Plot 2 score	Average	Weighting %	Calculation	Weighted score %
Native plant species richness	>6	4	3	3.5	25	21.875	21.9
Native over-storey cover	5 to 18	3	3	3	10	7.5	7.5
Native mid-storey cover	36 to 48	3	3	3	10	7.5	7.5
Native ground-cover (grasses)	3 to 21	4	4	4	2.5	2.5	2.5
Native groundcover (shrubs)	0 to 0	4	4	4	2.5	2.5	2.5
Native groundcover (other)	1 to 13	4	4	4	2.5	2.5	2.5
Exotic plant cover (all strata)	>66%	3	4	3.5	5	4.375	4.4
Number of trees with hollows	> 0	4	4	4	20	20	20.0
Proportion of over-storey species occurring as regeneration	0	1	2	1.5	12.5	4.6875	4.7
Total length of fallen logs	> 20	3	4	3.5	10	8.75	8.8
Total		34	37	35.5	100		**82.2**

Native vegetation in this area is in good to moderate condition, with an overall weighted score of 82.2%. The trigger value for remedial works is when the weighted score is less than 60%, in 2023 the combined weighted score for the two plots was 67.8%, annual biodiversity monitoring data is presented in the annual biodiversity monitoring reports, made available on the Delta Coal website (www.deltacoal.com.au). Subsequent monitoring events will be compared against these baseline results for Swamp oak forest in the biodiversity enhancement area to monitor the overall weighted score against this trigger value. Photographs of Plot 1 and Plot 2 areas are provided as Plate 1 and Plate 2. **Figure 2** shows the location of Plot 1 and Plot 2.



Plate 1 - Plot 1: CVC Swamp Oak Floodplain Forest



Plate 2 - Plot 2: CVC Swamp Oak Floodplain Forest

Figure 2 - Biodiversity Monitoring Plot Locations



3.2.2 Terrestrial Ecology

Vegetation mapping undertaken during 2012 in areas surrounding the CVC pit top identified the nearby vegetation communities as Coastal Open Woodland, Swamp Oak Forest and Swamp Sclerophyll Forest. Mapping was also undertaken at the ventilation shaft site and identified Coastal Open Woodland, Grassy Open Woodland and Swamp Sclerophyll Forest.

From the above, both the Swamp Oak Forest and Swamp Sclerophyll Forest are listed as Endangered Ecological Communities (EEC s) under the *Biodiversity Conservation Act 2016*.

These vegetation communities are also known to provide habitat for threatened fauna species such as the Squirrel Glider (*Petaurus norfolcensis*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and microbats.

In addition to the natural habitat within the site, built structures are also known to provide potential habitat for a number of fauna species. It is known that threatened microbat populations have inhabited mine portals elsewhere in NSW (Olsen Consulting Group, 2009). In addition, the CVC sediment dams have become used by a number of native fauna species.

3.2.3 Wallum Froglet

A baseline monitoring event was completed to identify the presence of the Wallum Froglet in the pit top area. The survey was completed in accordance with guidelines for the species, described in *Threatened species survey and assessment guidelines: field survey methods for fauna (Amphibians)* (DECCW 2009). The survey was conducted on two separate nights in April 2014, during the breeding and calling season when the species is readily detectable. The surveys were also completed during rain. The survey guidelines note that wet weather conditions are more important for detection of the species than the time of year the survey is completed (DECCW 2009).

The survey was completed by a qualified and experienced ecologist during 2014. Wallum Froglet calls were broadcast at the start of the survey with a five-minute listening period to check for responses. Active searches were then completed with a spotlight and head torch in potential habitat including the Swamp Oak Forest, Swamp Sclerophyll Forest and around the edges of dams.

No Wallum Froglet individuals were identified despite the survey being completed at the correct time of year and in suitable weather conditions. Additionally, the site is not considered to contain optimal habitat for the species which is usually found in acid paperbark swamps. It is not associated with Swamp Oak Forest and only occasionally found in Swamp Sclerophyll Forests (DECCW 2009; OEH 2014). Based on failure to detect the species and sub-optimal nature of the habitat identified, no further monitoring has been conducted.

4 Remnant Native Vegetation

Remnant native vegetation is located within both the CVC pit top area and ventilation shaft site (see **Figure 3** and **Figure 4**). Vegetation in these areas has been subject to a number of influences from the surrounding areas and uses, including clearing for powerline easements, mine activities and associated infrastructure, and encroachment from adjacent residential areas. However, in general, the native vegetation within the study area is in reasonable condition and is known to contain EECs and threatened fauna species including Squirrel Gliders and microbats. A description of these vegetation communities is provided in the following sections.

4.1 Coastal Open Forests

Coastal open forests (Coastal Open Woodland and Grassy Open Woodland) occur in both the pit top and ventilation shaft areas. These areas contain a mixture of vegetation types dominated by either Narrow-leaved Scribbly Gum (*Eucalyptus haemastoma*), Red Bloodwood (*Corymbia gumifera*) or Smooth-barked Apple (*Angophora costata*). These communities generally occur above 5 metres AHD in the study area, i.e. above the high-water mark, and are not influenced by tidal movements or inundation by floodwaters.

The vegetation within the coastal open forest areas is not considered to meet the description of any EECs, although it provides important habitat for threatened fauna and contains important habitat features such as large hollow-bearing trees.

4.2 Coastal Swamp Forests

Swamp forests occur generally below 5 m AHD within the study area. Several types occur within the study area, including:

- Mangroves;
- Swamp Sclerophyll Forest; and
- Swamp Oak Forest.

4.2.1 Mangroves

Patches of mangroves occur along Swindles Creek, an unnamed creek and Lake Macquarie foreshore. The creek is subject to tidal flows from the lake, which has influenced the occurrence of the mangroves in this area. Mangrove areas are within the intertidal zone, inundated more frequently than other communities such as saltmarsh and Swamp Oak Forest.

4.2.2 Swamp Sclerophyll Forest

Swamp Sclerophyll Forest occurs on the deeper alluvial soils where drainage is impeded and standing water occurs after rain. These areas are not influenced by saline tidal waters or discharge waters associated with the sediment dams. The community is dominated by Swamp Mahogany (*Eucalyptus robusta*), Broad-leaved Paperbarks (*Melaleuca quinquenervia*), *Melaleuca sieberi*, and Forest Red Gum (*Eucalyptus teriticornis*).

This community is listed as an EEC in NSW under the TSC Act. In the study area, it surrounds some of the ventilation fan site (**Figure 4**). Microclimatic changes to this vegetation could occur from the outputs of the shaft, which could influence the health of the community. Therefore, the health of vegetation in this area will be monitored during operations.

4.2.3 Swamp Oak Forest

Swamp Oak Forest typically occurs in estuaries where tidal influence has created saline groundwater. These areas are not always inundated by saline or freshwater, with the understory within the community determined by the amount of tidal influence and salinity within floodwaters. Within the Lake Macquarie area, this community typically fringes the lake foreshore.

The area to the east of the sediment dams has been mapped as containing Swamp Sclerophyll Forest, a listed EEC. The vegetation in this area is considered to more accurately represent a Swamp Oak Forest community as it is dominated by Swamp Oak (*Casuarina glauca*). Some dead trees do occur in this area and it is likely that it previously contained species such as Swamp Mahogany (*Eucalyptus robusta*) and Broad-leaved Paperbark. These species, when dominant are indicative of Swamp Sclerophyll Forest, though have the potential to also occur in Swamp Oak forest in low quantities or in transitional areas. Regardless, the decline of these species and the lack of subsequent recruitment is a potential indicator that the area has become too saline and/or too waterlogged to provide suitable habitat.

The Swamp Oak Forest is listed as an EEC under the TSC Act and is differentiated from the Swamp Sclerophyll Forest by Swamp Oak being dominant canopy species, the low abundance of eucalypt species and the position of the landscape (where flooding is periodic and soils show some influence of saline groundwater).

The area to the east of the sediment dams is unlikely to be subject to tidal influence. However, saline groundwater from the underground workings is continually discharged (via the sediment dams). This in conjunction with consequential ponding due to the relatively flat nature of the area, is likely to have influenced the vegetation present, increasing the presence of species which are adapted to higher levels of saline inundation (halophytes). Several Saltmarsh species, which tolerate inundation with saline water, occur throughout the Swamp Oak area, including *Selliera radicans*, *Suaeda australis* and *Samolus repens.* Other understory species include sedges and rushes such as *Juncus spp., Schoenus brevifolius*, *Chorizandra cymbaria* and Water Couch (*Paspalum distichum*).

Without the sediment dam discharge water, this area is likely to only be inundated after large flood events by freshwater from Swindles Creek and runoff from other areas associated with the mine. The community present in 2014 therefore appeared to be in transition and generally in poor health as is evident from the presence of weed species, dominance of sedges and rushes, and the density and health of Swamp Oaks.

Any changes to the current hydrological cycle (even though it is not natural), may impact on this community. Too much or not enough water could have effects on future species composition in this area. Changes in the quality and quantity of water discharges from the sediment dams and through seepage from the dam walls could also affect the health of the vegetation in this area.

While Swamp Oak can tolerate saline groundwater, too much saline water may lead to dieback, as is evident from the baseline monitoring in 2013, where the sediment dams have permanently inundated areas of the community. Conversely, too little inundation may cause changes to the composition of the community allowing further invasion of weeds. Changes in the condition and composition of the community present will be monitored during operations to ensure that the vegetation in this area is not negatively impacted by the operation of CVC.

Figure 3: Pit Top Area Broad Vegetation Types

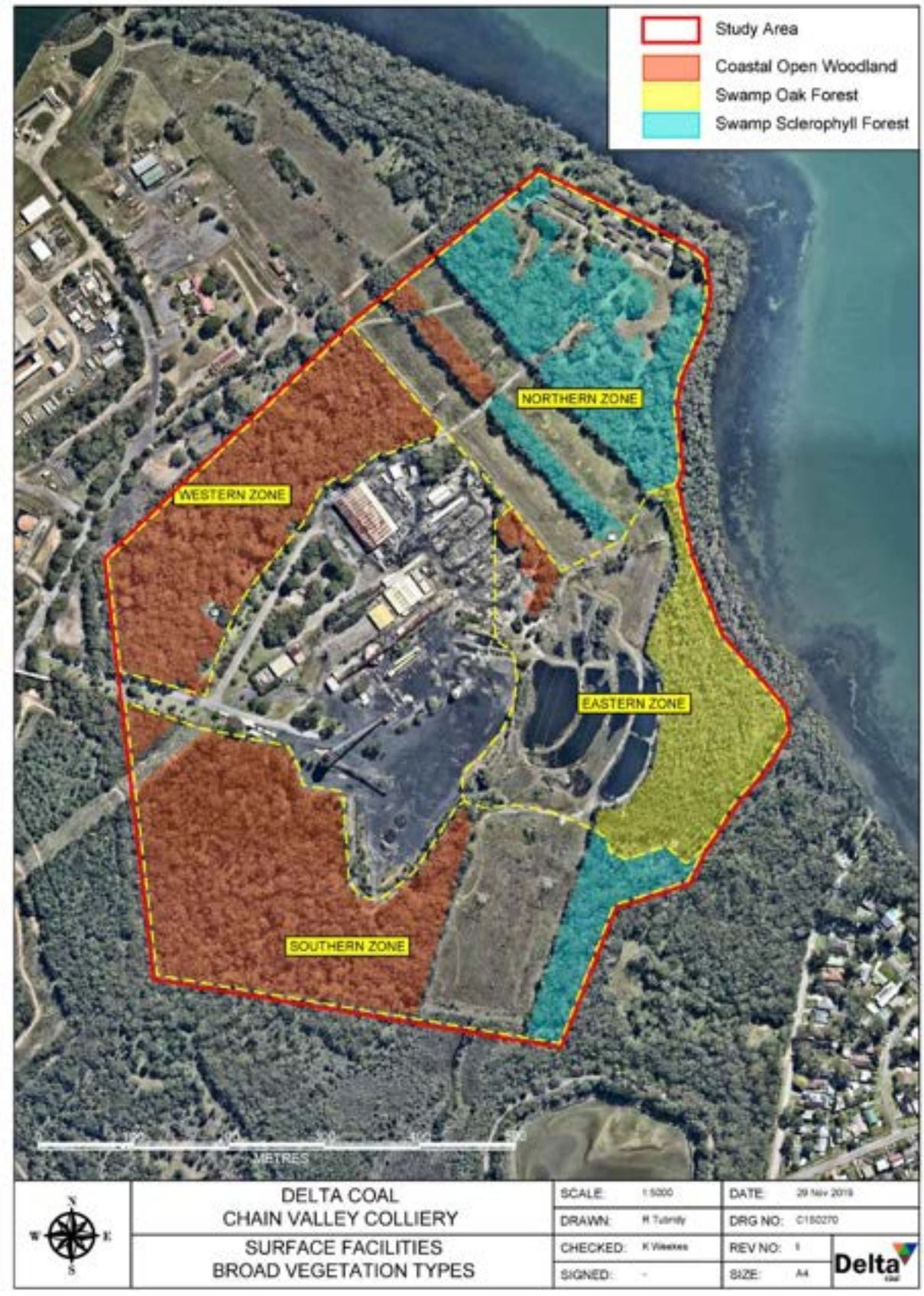


Figure 4: Ventilation Fan Site Ecological Communities



5 Design and Construction Environmental Management

5.1 Construction

No above-ground construction works are planned that would result in significant vegetation changes or removal. As a result of construction, the following biodiversity issues have been identified:

- clearing of vegetation and fauna habitat for water management and maintenance (dams and embankments) works;
- clearing of vegetation and fauna habitat for bushfire management and maintenance (asset protection zone) works; and
- potential for invasion and spread of weeds and soil pathogens into areas of remnant vegetation.

Commitments related to the clearing of fauna habitat and weed management during the ventilation fan augmentation project which was approved under MP10_0161 have already been undertaken during construction under a specific management plan and are therefore not included within this BMP. However, follow-up measures to monitor the effectiveness of these measures and potential impacts post-construction activities have been included within this plan.

5.2 Ecological Inputs to Design

CVC designed the dam embankment and spillway in consultation with an ecologist to minimise potential impacts on the Swamp Oak Forest.

5.3 Pre-clearance Ecological Surveys

Pre-clearance ecological surveys will be undertaken by a qualified ecologist prior to any future construction works. They will clearly identify sensitive fauna habitats and significant vegetation and be undertaken during the appropriate flowering time for the particular flora species. Potential impacts to sensitive features as a result of construction works are to be minimised.

The following activities will be completed during the pre-clearance ecological survey:

- clear delineation of the clearing footprint;
- classification of the surrounding vegetation as a ‘no go zone’ during construction activities;
- installation of protective fencing/markers; and
- designating sites in previously cleared areas for material stockpiles and machinery parking.

5.4 Environmental Management Prior to and Following Construction Activities

The following measures will be implemented prior to and during any construction activities, particularly the maintenance of Asset Protection Zones (APZs) to minimise impacts to native vegetation and fauna habitats:

- installing erosion and sediment controls around any proposed earthworks;
- installation of delineation fencing around threatened flora populations (if found) to ensure their protection during development and maintenance of APZs;
- condition monitoring for threatened flora populations (if found) in APZ areas;
- retention of hollow-bearing trees in the APZs, where possible.;
- installation of nest boxes (or salvaged hollows) under the supervision of a suitably qualified ecologist or wildlife carer to replace hollows where hollow-bearing trees cannot be retained;
- measures for APZ maintenance that include weed control;

- clearing of hollow-bearing trees (if required) under the supervision of a suitably qualified ecologist;
- any injured fauna would be taken to the nearest veterinary hospital for treatment before release;
- felled trees to augment nearby habitat, i.e. woody debris to be placed on the ground to create additional habitat;
- avoiding disturbance to dead standing timber and fallen timber during clearing works, or if required to be removed, timber will be relocated into suitable habitat areas nearby; and
- clearing all earthworks equipment of excess soil, potentially containing pathogens and weed seeds, prior to entering the site.

6 Biodiversity Enhancement Strategy

The development consent and commitments for CVC related to the enhancement of native vegetation comprise:

- the improvement and enhancement of the Swamp Oak Forest and Swamp Sclerophyll Forest to compensate for potential impacts on EECs;
- development of rehabilitation methods in accordance with the Saltwater Wetlands Rehabilitation Manual (DECC 2008), with the methods potentially including:
    - restoration of natural flow regimes;
    - rubbish and litter removal;
    - control and removal of competitive introduced species to allow for regeneration of native species;
    - revegetation where natural regeneration processes are interrupted; and
    - condition monitoring.

The biodiversity enhancement strategy aims to compensate for the potential impacts on the Swamp Oak Forest and Swamp Sclerophyll Forest and covers all the areas identified as these EECs within the pit top area, including those adjacent to the sediment dams and in areas to their north and south.

The strategy builds on existing actions and monitoring programs identified in the previous versions of the BMP to ensure that the Swamp Oak Forest and Swamp Sclerophyll Forest are enhanced and improved. The extent of the Enhancement Area is shown on **Figure 5**.

The main issues in the area adjacent to the sediment dams are:

- continuous presence of standing saline mine discharge water;
- limited canopy regeneration and canopy senescence;
- lack of understory diversity; and
- presence of weeds and rubbish.

In accordance with the SSD-5465 Statement of Commitments for Terrestrial Ecology, upgrade works to the sediment dam (D10) wall, which is located adjacent to the Swamp Oak Forest area, was completed in February 2015 in order to prevent future leakage through the wall. At the same time a new discharge monitoring system and spillway were installed.

Any changes to the hydrological cycle (even though it is not natural), also has the potential to impact on this community.

Table 5 outlines the goals, objectives and actions for native vegetation enhancement.

Figure 5: Biodiversity Enhancement Area



Table 3: Biodiversity Enhancement Strategy

Issue	Goal	Objective	Action
EASTERN ZONE			
Continuous presence of standing saline water from mine discharge	Restoration of natural flow regimes to the EEC areas	Water quality values in the EEC areas are within or better than the trigger values identified in **Table 10** of this BMP.	1. Spillway and improvements to dam wall embankment to direct saline water away from EECs completed; 2. Water quality monitoring undertaken in accordance with the CVC Water Management Plan.
Weed invasion	Weeds are controlled in EEC area	Weeds of national environmental significance are controlled in EEC areas to a level where low maintenance is required.	1. Weed management is completed in line with **Section 7** of this BMP; 2. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.
Presence of rubbish and litter	EEC area is rubbish and litter free	EEC areas are rubbish and litter free and continues to be litter free for the life of the mine.	1. Collection and disposal of rubbish and litter; 2. Type and location of rubbish/litter recorded during compliance monitoring.
Limited canopy regeneration and canopy senescence	Native species regeneration is evident in the EEC areas	Native species regeneration is at least 20% in plots by 2022	1. Annual monitoring of EEC areas downstream of D10 in accordance with **Section 11**, with regeneration values investigated and rehabilitation actions undertaken as required to ensure that the objectives are achieved; 2. Native vegetation monitoring in accordance with **Table 6** to determine if active rehabilitation is required; 3. Weed management is completed in line with **Section 7** of this BMP; 4. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.
Lack of understorey diversity	Ecologically functional and diverse EECs	Final weighted condition criteria from plots in the swamp oak forest are above the trigger value (60%). Condition criteria should increase over time and meet	1. Monitoring EEC areas downstream of D10 in accordance with **Section 11**, to assess condition values against the trigger value and to ensure that the condition of the EEC areas is improving over time; 2. Native vegetation monitoring in accordance with **Table 6** to determine if active rehabilitation is required; 3. Weed management is completed in line with **Section 7** of this BMP; 4. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.

		benchmark conditions for the EECs present.	
SOUTHERN ZONE			
Weed invasion	Weeds are controlled in EEC area	Weeds of national environmental significance are controlled in EEC areas to a level where low maintenance is required.	1. Weed management is completed in line with **Section 7** of this BMP; 2. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.
Presence of rubbish and litter	EEC area is rubbish and litter free	EEC areas are rubbish and litter free and continues to be litter free for the life of the mine.	1. Collection and disposal of rubbish and litter; 2. Type and location of rubbish/litter recorded during compliance monitoring.
NORTHERN ZONE			
Weed invasion	Weeds are controlled in EEC area	Weeds of national environmental significance are controlled in EEC areas to a level where low maintenance is required.	1. Weed management is completed in line with **Section 7** of this BMP; 2. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.
Presence of rubbish and litter	EEC area is rubbish and litter free	EEC areas are rubbish and litter free and continues to be litter free for the life of the mine.	1. Collection and disposal of rubbish and litter; 2. Type and location of rubbish/litter recorded during compliance monitoring.
WESTERN ZONE			
Weed invasion	Weeds are controlled in native vegetation area	Noxious weeds and weeds of national environmental significance are controlled in native vegetation to a level where low maintenance is required.	1. Weed management is completed in line with **Section 7** of this BMP; 2. Weed monitoring is undertaken in accordance with **Section 11** of this BMP.

Active rehabilitation will be undertaken in the EEC areas if condition criteria fall below the trigger values, or if natural regeneration is not occurring sufficiently to meet the objectives nominated in **Table 5**, as determined by the monitoring program. Supplementary planting with suitable species for each of the communities present, where required, would assist to meet the rehabilitation objectives. Suitable species would include:

- Swamp Oak Forest:
    - canopy species: Swamp Oak (*Casuarina glauca*); and
    - understorey and groundcover species: Water Couch (*Paspalum distichum*), *Baumea juncea* and *Selliera radicans*,
- Swamp Sclerophyll Forest:
    - canopy species: Swamp Mahogany (*Eucalyptus robusta*), paperbarks (*Melaleuca sieberi*, *Melaleuca quinquenervia*) and Forest Red Gum (*Eucalyptus tereticornis*); and
    - understory and groundcover species: *Gahnia clarkei*, Bracken (*Pteridium esculentum*), Large-leaf Hopbush (*Dodonaea triquetra*) and Whiteroot (*Pratia purpurascens*).

7 Weed Management

7.1 Background

Weed invasion impacts on species biodiversity and may alter habitats through processes such as competition and erosion. They also have the potential to impact on DC's commercial operations and reputation as a responsible land manager. Biosecurity at the land management level is the protection of environmental, economic and community values from the impacts of invasive weed species.

Some of the most common disturbance triggers are land clearing, soil disturbance, fires or change in fire regimes, and drought.

The greatest threat to the ecological integrity of the threatened ecological communities at CVC is the invasion by weeds, particularly associated with disturbance/construction activities.

7.2 Weed Species

Total Earth Care undertook a weed survey in October 2019 which identified 36 weed species listed under the *Biosecurity Act 2015* and Biosecurity Regulation 2017 (Total Earth Care Weed Action Plan, 2019). Of these, there are various weed species which have been identified as priority species on site. The weeds detailed fall under some of the following categories:

- a declared weed under the *Biosecurity Act 2015* / Biosecurity Regulation 2017;
- listed as a Weed of National Significance (WoNS);
- listed in the Greater Sydney Regional Strategic Weed Management Plan; and
- considered a significant environmental weed which has the ability to spread rapidly and substantially reduce biodiversity.

Table 4 details the priority weed species. The ranking of 1 indicates the highest priority of control required for a weed that is recognised on a national level (WoNS) and is a regionally declared weed. A ranking of 2 indicates that significant management would be required before the next monitoring survey to reduce presence, abundance and spread. Controls should be undertaken with ongoing monitoring to ensure significant reduction in distribution.

Table 4: Priority Weed species

Priority Ranking Category	Weed common name (*scientific name*)	WoNS	State Priority	Regional Priority	Duties for Priority Weeds of Greater Sydney
1	Bitou Bush (*Chrysanthemoides monilifera* subspecies *rotundata*)	Yes	Containment		Prohibition on dealings, B Zone; The Bitou Bush Biosecurity Zone is established for all land within the State except land within 10 kilometres of the mean high water mark of the Pacific Ocean between Cape Byron in the north and Point Perpendicular in the south.
1	Blackberry (*Rubus fruticosis* aggregate species)	Yes			Prohibition on dealings.

Priority Ranking Category	Weed common name (*scientific name*)	WoNS	State Priority	Regional Priority	Duties for Priority Weeds of Greater Sydney
2	Crofton Weed (*Ageratina adenophora*)	-			Potential risk to environment and agriculture.
2	Asparagus Fern (*Asparagus aethiopicus*)	Yes			Prohibition on dealings.
2	Lantana (*Lantana camara)*	Yes	Asset protection		Prohibition on dealings.
1	Pampas Grass (*Cortaderia jubata*)			Asset protection	Regional recommended measure. Land managers mitigate the risk of the plant being introduced to their land or spread from their land where feasible. It should not be bought, sold, grown, carried or released.
1	Fireweed (*Senecio madagascariensis)*	Yes	Asset protection		Prohibition on dealings.
1	Giant Reed (*Arundo donax)*			Asset protection	Regional recommended measure. Land managers mitigate the risk of the plant being introduced to their land. It should not be bought, sold, grown, carried or released.

7.3 Weed Management

For ease of management, monitoring and reporting, areas infested with weeds have been divided into the following zones shown on **Figure 6** and **Figure 7**:

- Northern zone;
- Southern zone;
- Eastern zone;
- Western zone; and
- Ventilation shaft.

Several parties have management interests within the study area. Delta Electricity owns the land while DC manages CVC. TransGrid also has rights over the land in the transmission line easements. Though ultimate legal responsibility for weeds rests with Delta Electricity, as land managers, DC will undertake weed management as part of its operations on Delta Electricity owned land.

The principal objectives of weed management are guided by national, state and local legislation. The guidelines and the legislation used to determine the prioritisation of weed species for targeted control are:

- preventing the introduction of weeds into new and highly desirable areas such as rehabilitation areas, APZs and high biodiversity value areas;

- eradicating high risk infestations that are new and/or have the potential to spread quickly or significantly impact biodiversity is left unmanaged;
- containment and management of WoNs that are widespread; and
- containment and control of environmental weeds that pose a high risk to biodiversity in riparian, bushland and grassland habitats. This includes areas where control measures have already been undertaken.

For areas such as exploration sites and rehabilitation areas, the revegetation programs limit initial weed infestations, however the early control of naturally introduced weeds will minimise competition and maximise early growth and survival of desired species. This can and will be achieved by physical removal, mulching and/or chemical control as required.

When any activity results in vegetation disturbance, DC has committed to undertaking:

- seasonal monitoring and weed control as necessary to minimise the spread of weeds into nearby remnant vegetation;
- delineate the clearance footprint for works and to cordon off all surrounding vegetation as a 'no go' zone; and
- minimising disturbance areas where possible; and
- stockpiling materials, parking machinery etc. in previously cleared areas.

7.4 Weed Control

Table 5 provides recommendations for the control of the priority weed species within the site, i.e. the weeds identified within the study area during site visits, those listed in the Greater Sydney Regional Strategic Weed Management Plan and listed WoNS.

Weed control should minimise the requirements for herbicide usage, particularly given the sensitive location of the infestations and the potential for the spread of herbicides into surrounding water bodies and wetland communities.

Other environmental weeds recorded in the study area include Whisky Grass (*Andropogon virginicus*), Scotch Thistle (*Onopordum acanthium*), Large-leaved Privet (*Ligustrum lucidum*), Cassia (*Senna pendula*), Asparagus Fern (*Asparagus virgatus*), Fishbone Fern (*Nephrolepis cordifolia*), Coral Tree (*Erythrina x sykesii*) and Radiata Pine (*Pinus radiata*).

There is no legal obligation to control these weeds, but in most cases it is good practice to remove them as well as any other weeds of significance to protect the health of native vegetation communities. These infestations will be visually inspected during the weed monitoring program. If infestations increase significantly, appropriate control methods will be implemented in consultation with an approved ecologist and/or Central Coast Council.

Table 5: Recommended Weed Control

Weed	Photo	Control technique	Control priority
Bitou Bush		Hand-weeding and/or cut and paint with Glyphosate in winter. Do not undertake weeding when plants are seeding or bear fruit due to the risk of spread.	High – WoNS
Blackberry		Brush cut. Scrape and paint stem with Glyphosate in spring/summer. N.B. Gloves should be worn during application due to thorns.	High – WoNS
Croton Weed		Hand-weed individual plants.	Moderate – Weed of concern.
Ground Asparagus		Cut underground tubers with secateurs out of ground around root base and remove from site. This is most easily done by cutting a small square of ground around the above ground stems.	Moderate – WoNS which occurs in sensitive EEC areas
Lantana		Cut and paint stem with Glyphosate.	Moderate – WoNS which occurs in sensitive EEC areas

Weed	Photo	Control technique	Control priority
Pampas Grass		Remove seed heads, place in plastic bags and remove from site. Slash/brush cut plant down to bottom of stem and remove from site. Dig out roots with a mattock and remove from site. N.B. Eye protection should be worn during all stages of removal as Pampas Grass contains fine hairs that can irritate the eye.	Moderate
Fireweed		Foliar spraying with Glyphosate, hand pulled and brush cut.	High – WoNS
Giant reed		Cut and paint with neat Glyphosate.	Moderate

Sources: NSW, Australian and QLD Government 2009; DLWBC 2006; NSW Primary Industries Weed Management Unit 2009; Primary Industries (Agriculture) 2012; NSW; Sydney Weeds Committee 2012; Winkler, Cherry and Downey (eds) 2008; Total Earth Care Weed Management Plan 2019.

Weed control is undertaken by a suitably qualified contractor who will undertake mechanical removal, spraying of weeds or other treatment measures in the correct periods to maintain effective control. The contractor will use approved herbicides at the required volumes according to manufacturer's instructions.

Areas that are targeted include predominantly disturbed grassland, fragmented forested and woodland zones in the vicinity of the pit top prior to rehabilitation. These areas exhibit signs of previous agricultural use and mining-related activities. All other areas remain largely undisturbed by DC mining activities.

Figure 6: Pit Top Area Weed Management Zones



Figure 7: Ventilation Shaft Weed Management Zone and Distribution



8 Feral Animal Management

Although there are no specific conditional requirements in SSD-5465 relating to feral animal management, the Statement of Commitments requires the abundance and distribution of feral animals to be identified.

Feral animals and/or evidence of their presence (i.e. tracks and scats) have been observed within the Pit Top and Ventilation Shaft areas at CVC. Feral animals recorded within the area include:

- European Red Fox (*Vulpes vulpes*);
- Feral Rabbit (*Oryctolagus cuniculus*);
- Feral Pig (*Sus scrofa*);
- Feral Cat (*Felis catus);*
- Dog (*Canis lupus familiaris); and*
- Feral Pigeons (*Columba livia*).

The species listed above are of concern through the potential environmental impacts they generate and their capacity to establish quickly from neighbouring areas. The European fox, dogs and feral cats have been identified as the most ecologically damaging species present due to their predation of native species. The most likely prey onsite is frogs, small mammals, birds and small reptiles. A proportion of cats and dogs preying on native species are likely to be domestic pets from adjoining properties.

Feral animals currently (and historically) do not appear to be abundant or causing adverse impacts at CVC. Monitoring is undertaken during monthly inspections and biodiversity monitoring. Only in the event that these species become an issue, or a clear trend if increasing observations become apparent, would control measures be implemented by an appropriated licenced contractor.

Other common pests identified and controlled on site include spiders, rodents (rats and mice), cockroaches, and other invertebrates.

9 Fire Management

9.1 Background

CVC is not a residential development and there are no strict requirements for fire management, with the exception of preventing fires within the project area and their spread to surrounding land. However, Condition 24 within Schedule 3 of SSD-5465 identifies a requirement that DC be sufficiently equipped to respond to fires on site and to assist the NSW Rural Fire Service (RFS) in the event of a fire in the vicinity of the surface facilities.

There is also a statutory responsibility under the *Rural Fires Act 1997* that requires the owners of land to prevent the ignition and spread of bushfires on their land. This act provides for the prevention, mitigation and suppression of bush and other fires in NSW. Section 63(2).

9.1.1 Existing Environment

Topography can have a great impact on bushfire behaviour. For every increase in slope gradient, there is a similar increase in fire intensity and rate of fire spread. The topography of CVC is relatively flat. According to classifications in the PBP guideline, the vegetation surrounding CVC comprises forests and forested wetlands. Forests are particularly vulnerable to bushfire.

9.1.2 Key Stakeholder and Emergency Response Details

The key stakeholder and emergency response details and contacts are contained within the Pollution Incident Response Management Plan (PIRMP) which is retained in the CVC operations room, Control Room and on the DC website.

9.1.3 Bushfire Risk

Bushfire risks have been assessed in accordance with the NSW Rural Fire Service's (RFS) Planning for Bush Fire Protection Guideline (the PBP guideline). The majority of CVC is on land mapped as being in the Vegetation Category 1 on the Wyong Bushfire Prone Land Map, which is considered high risk. Category 1 vegetation comprises areas of forest, woodlands, heaths (tall and short), forested wetlands and timber plantations and requires a 100 m buffer.

As with all rural settings where vegetation is present, there is a risk that bushfires could occur in or near CVC. There is therefore a risk that a bushfire could damage buildings and present a hazard to human life. This was demonstrated in October 2013 when CVC's pit top area was threatened by a bushfire.

9.2 Land Management Zones

Fire management is addressed in this BMP as fire can present a threat to biodiversity at both the pit top and ventilation facility as these areas contain vegetation which is considered to be bushfire prone land (Category 1).

Bushfire prone land surrounding the CVC pit top and ventilation facility are shown in **Figure 8** and **Figure 9** respectively.

Figure 8: Bushfire Prone Land Map for the Pit Top Area (Source: Central Coast Council, 2015)



Figure 9: Bushfire Prone Land Map for the Ventilation Shaft Area (Source: Central Coast Council, 2015).



9.3 Defendable Space

Fire protection zones or defendable space around assets which assist in fire prevention comprise three zones:

1st Zone -APZ (Asset Protection Zone);

2nd Zone -SFAZ (Strategic Fire Advantage Zone); and

3rd Zone - LMZ (Land Management Zone).

The fire protection zones are positioned between a bush fire hazard and the asset and minimise fuel loads via hazard reduction; inhibit a fire path, and reduce the effects of heat, flame, ember and smoke attack.

Following the bushfires which occurred in 2013, DC undertook a risk assessment of bushfire controls across the operation. This review concluded that improvements to the sites APZ's around the pit top area and ventilation fan site were required. The proposed improvements to the existing APZ's were approved as part of the most recent approval modification to SSD-5465 in December 2015. The APZ's as they were approved in December 2015 are shown in **Figure 10**.

9.3.1 Asset Protection Zones

APZs provide fire vehicle access, reduce radiant heat, reduce convection winds, reduce ember attack and allow smoke to disperse. APZs are divided into an inner protection area (IPA) and an outer protection area (OPA) for forest vegetation.

APZs were determined using the PBP guideline which compares the bushfire hazard vegetation classification, bushfire weather and slope classes on bushfire prone land to derive their minimum extent. The vegetation communities and slope classes were characterised in accordance with Appendix 4 of the PBP. CVC is located in the Greater Hunter Fire Weather Area (Fire Danger Index 100).

As the topography around the CVC pit top area is relatively flat, with the primary slope class identified in the PBP guideline as class (ii) (any vegetation greater than 0° and up to 5° downslope vegetation).

The APZs for the pit top infrastructure are 25 m, comprising a 15 m inner protection area (IPA) and a 10 m outer protection areas (OPA), while the APZ for the ventilation fan site is 20 m with no requirement for an OPA. Where unimpeded access is not already available, the IPAs will also include the establishment of a 4 m wide fire trail around certain assets (ie structures, buildings and the ventilation fan site) to enable access for fire fighting vehicles.

A buffer or Asset Protection Zone (APZ) is provided between areas of vegetation and the main offices, workshops and infrastructure at the pit top and, currently, in limited areas around the perimeter of ventilation facility. Within the pit top, the APZ is landscaped to minimise fuel loads and reduce potential radiant heat levels, flame, ember and smoke attack to the buildings.

Figure 10: Asset Protection Zones



An example of the pit top APZ can be seen in **Figure 11**.

Figure 11: Firebreak between CVC Pit Top Area and Surrounding Bush



9.4 Access and Egress

Fire trails and access roads provide an important line of defence for fighting bushfires. An extensive array of fire trails and tracks are located around the pit top area to provide access for emergency services in case of a bush fire. These also provide access to easements throughout the study area which are maintained by TransGrid to provide vertical clearance and buffers for high-voltage transmission lines.

Though there is an existing road access to the ventilation facility and some fire trails, the November 2013 risk assessment and review of the October fires incident identified a risk due to access and an inadequate turnaround for fire tankers at the facility. APZs were approved and established to account for this risk and a clear area maintained around the Ventilation shaft site.

Fire trails will be inspected annually prior to the start of the Bushfire Danger Period.

9.5 Water Supply

Existing fire management infrastructure surrounds the pit top area, with water tanks and a distribution system (100 millimetre diameter water reticulation line). Fire hydrants, fire reels and depots are also placed in strategic positions to enable rapid response to fires on site. Though no reticulated water is available at the ventilation facility, its proximity to Lake Macquarie provides an emergency source of water if required.

CVC has 10 dams which can also be used if required.

Following the cessation of mining and surface operations, DC will consider maintenance of applicable controls during rehabilitation establishment (e.g. maintain APZs or other controls until rehabilitation vegetation is adequately established).

9.6 Prohibition on Hot Work Activities During Extreme and Catastrophic Fire Periods

Welding, cutting, grinding and other within vegetated area activities should not be undertaken on Extreme and Catastrophic fire danger rating days. All site vehicles should carry portable fire extinguishers and be able to communicate with the CVC Control Room in case of an emergency.

9.7 Water Access Points and Fire Fighting Equipment Locations

Existing fire management infrastructure surrounds the MC surface infrastructure areas, with water tanks and a distribution system (100-millimetre diameter water reticulation line). Fire hydrants, fire reels and depots are also placed in strategic positions to enable rapid response to fires on site. An example is shown in **Figure 12**. CVC also has 13 dams, however, due to their saline nature, they would not be an ideal source of water.

Following the cessation of mining and surface operations, DC will consider maintenance of applicable controls during rehabilitation establishment (e.g. maintain APZs or other controls until rehabilitation vegetation is adequately established).

9.8 Controls

The APZs will be managed in accordance with the PBP guideline. Maintenance will be undertaken in a manner that prevents accumulation of fine flammable debris on the ground so that fuel quantities are reduced, thus lessening flame heights and potential crowning. General maintenance guidelines are described in **Appendix 2** of the PBP guideline.

The PBP guideline nominates that APZs should be maintained as follows:

- Inner protection areas (IPAs):
  - canopy cover kept at less than 15% of total surface area and at least 2 m from the roof line of a building;
  - garden beds and shrubs not to be located under trees and sited at least 10 m from any exposed windows or doors; and
  - lower limbs of trees up to 2 m above the ground are removed.
- Outer protection areas (OPAs):
  - canopy cover kept at less than 30% of total surface area; and

- under-story mowed annually before the fire season (usually September) to remove shrubs and long grasses.

Figure 12: CVC Water Access Points



DC has, and will continue to, implement appropriate controls to assist in the management of bushfires that may impact the mining operations, including:

- Defendable Space - A buffer or APZ is provided between areas of vegetation and the main offices, workshops and infrastructure at the pit top and, currently, in areas around the perimeter of ventilation facility. Within the pit top, the APZ is landscaped to minimise fuel loads and reduce potential radiant heat levels, flame, ember and smoke attack to the buildings. The size of the protection zones will take into consideration matters such as the type of vegetation, slope of the land, fuel load source and criticality of the asset to the operation. The APZ areas will be maintained and inspected prior to the start of the fire season (1st October to 31st March unless advised otherwise). In the event additional bush fire hazard reductions works are proposed, they will be undertaken only after obtaining the requisite Bushfire Hazard Reduction Certificate from the NSW Rural Fire Service. Regular training of mine firefighting crews is also undertaken.

The APZ areas will be inspected prior to the start of the fire season (1st October to 31st March). In the event additional bush fire hazard reductions works are proposed, they will be undertaken only after obtaining the requisite Bushfire

Hazard Reduction Certificate from the NSW Rural Fire Service. Regular training of mine firefighting crews is also undertaken.

10 Public Access Management

10.1 Background

While public access management is not specified in SSD-5465 as a matter to be addressed within the BMP, it has been identified as an issue within the larger surrounding Delta Electricity land (Connell Wagner 2008). Though primarily a concern from a safety management perspective, uncontrolled access to bush land areas, particularly by motor-bikes, has the potential to introduce and/or spread weeds and be a cause of erosion, both of which have the potential to affect biodiversity in remnant areas, rehabilitation or biodiversity enhancement activities.

Uncontrolled public access does not appear to be an issue within the pit top area even though some small access tracks occur throughout the areas of remnant vegetation and function as fire trails and access routes to the power line easements. These do not however appear to be commonly used and rubbish dumping does not appear to be a significant problem in this area. Motorbike tracks have been observed on the fire trails of the Ventilation Facility area and, given its location relative to local rural residential properties, it is possible that it is accessed by locals on occasion.

10.2 Management and Control

A security firm is engaged to undertake scheduled site security checks and remote alarm monitoring and reporting with these security checks are generally undertaken at times of higher unauthorised access risk such as nights and weekends.

As uncontrolled public access or potential associated problems does not appear to be a major issue at either the pit top area or the ventilation facility, it is not considered that any further management actions are required to control public access. Public access will be monitored and managed during operation of the mine through the standard incident reporting process which would include reporting of unauthorised access. Similarly, the monitoring programs such as for weeds and erosion, are considered appropriate for the management of any potential uncontrolled access issues.

Any reported incidents concerning public safety or access will be detailed in the Annual Review.

11 Biodiversity Monitoring

11.1 Overview

Table 6 provides an overview of the biodiversity monitoring programs which are identified in this BMP. Further details are provided for each of the monitoring program methodologies within the following sections. As required by the project approval conditions, this includes ecological monitoring of the:

- weed occurrence and control effectiveness;
- feral animals;
- fire risk (including asset protection zones);
- uncontrolled public access; and
- Ecological aspects including:
    - receiving waters;
    - the EEC downstream of the discharge point;
    - remnant vegetation around ventilation facilities at Summerland Point; and
    - habitat within the Biodiversity Enhancement Area as detailed in **Figure 5**.

Table 6: Biodiversity Monitoring Details

Monitoring Regime	Site	Monitoring Frequency	Methodology
Weeds	Pit Top area Ventilation Shaft	Annually	Target existing locations and significant new occurrences of weed species (**Figure 6** and **Figure 7**) in each management zone. Record: - the number of individual weeds, the estimated size of infestation (i.e. m² for large infestations); - the estimated distance to native vegetation; and - recommended control measures.
Feral animals	Pit Top area and Ventilation Shaft	Annually	Monitor activity of feral species by searching for tracks, diggings, scats, burrows and sightings of individuals. Monitoring to be undertaken in conjunction with weed monitoring.
Bushfire risk /uncontrolled public access	Pit Top area Ventilation shaft	Annually prior to the fire season	APZ and fire trails (access to ventilation shaft area, access to houses to the north of the pit top area and tracks south of the pit top area to the transmission lines) to be visually inspected annually prior to the fire season (1st October – 31st March). Security firm to continue site security patrols and remote monitoring of security systems/alarms. Public access issues to be reported via standard incident form or in conjunction with weed/feral animal monitoring programs.
Receiving waters	Pit Top area	n/a	Monitoring requirements related to receiving waters are documented in the Water Management Plan. Results will

Monitoring Regime	Site	Monitoring Frequency	Methodology
			be considered in conjunction with the outcomes of biodiversity monitoring.
EEC areas downstream of the D10 discharge	Pit Top area	Annually	Continuation of surveys in the identified swamp oak forest areas. Two BioBanking plots have been established within the Swamp Oak forest which will be monitored annually. Refer to **Section 3.1** for further information.
Native vegetation	Ventilation Shaft	Annually	Monitoring of the health and condition of vegetation surrounding the ventilation shaft area. Two large Rough-barked Apple (*Angophora floribunda*) occurring directly adjacent to the Ventilation Shaft will be monitored for condition and health.

11.2 Monitoring of the Biodiversity Enhancement Area

The Biobanking methodology provides a means of determining the baseline condition, structure and composition of vegetation communities. Repeating this method over time allows changes in these variables to be identified.

A baseline event was completed in 2013 where vegetation data was collected from two plots and transects across the swamp oak forest at the site, in accordance with the Biobanking methodology (**Table 7**). The baseline monitoring identified that the generic benchmark values for the swamp oak forest (HU635) were much higher than the condition identified onsite, and would not provide a useful value to compare changes over time. Accordingly, local benchmarks (**Table 8**) were assigned for Swamp Oak Forest using the baseline surveys results. These local benchmarks will provide an accurate point of comparison with site attribute scores collected in the future to determine any changes in condition resulting from management and the proposed discharge works.

Using the local benchmarks, the weighted site attribute score for these plots has varied between 65.0 – 80.3% during monitoring conducted 2016 and 2018. A value of 60% has been assigned which will trigger management in addition to the proposed enhancement strategy, if the weighted site attribute score drops below this value. A high degree of flexibility has been applied in assigning this trigger value. As this trigger is based on local benchmark data of a system already in low condition, any significant changes are likely to result in a noticeable decrease in scores. Trigger values will be reviewed and updated to reflect these changes if they occur as part of the review of the BMP.

Coupled with the water quality data, the monitoring will be able to detect changes in the composition and health of the community. **Table 7** describes the attributes to be measured during the ecological monitoring of the EEC area.

Trigger values will be determined using the final weighted site score out of 100, based on the benchmark conditions.

Table 7: Condition Criteria for Monitoring as per the Biobanking Methodology

Site attribute		Site attribute score				Weighting for site score attribute
		1	2	3	4	
A	Native plant species richness	0	0-<50% of benchmark	50-<100% of benchmark	≥ benchmark	25%
B	Native over-storey cover	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	10%
C	Native mid-storey cover	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	10%
D	Native ground-cover (grasses)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.5%
E	Native groundcover (shrubs)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.5%
F	Native groundcover (other)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.5%
G	Exotic plant cover (all strata)	>66%	>33-66%	>5-33%	0-5%	5%
H	Number of trees with hollows	0 (unless benchmark includes 0)	0-<50% of benchmark	50-<100% of benchmark	≥ benchmark	20%
I	Proportion of over-storey species occurring as regeneration	0	>0-<50%	50-<100%	100%	12.5%
J	Total length of fallen logs	0-10% of benchmark	>10-<50% of benchmark	50-<100% of benchmark	≥ benchmark	10%
Total weighted score						100%

Table 8 provides the local benchmarks that have been developed as a baseline for the Swamp Oak Forest. This information will form the basis against which changes will be assessed using the above criteria (**Table 7**).

Table 8: Benchmarks to measure changes within the Swamp Oak Forest Community

Criteria	Benchmarks	
	Biobanking Benchmark (HU635)	Local Benchmark
Native plant species	15	≥ 6
Native overstorey cover	15 to 65	5 to 18
Native midstorey cover	0 to 50	36 to 48
Native ground cover (grasses)	0 to 90	3 to 21
Native ground cover (shrubs)	1 to 15	0 to 0

Criteria	Benchmarks	
	Biobanking Benchmark (HU635)	Local Benchmark
Native ground cover (other)	2 to 90	1 to 13
Number of trees with hollows	0.8	≥ 0
Total length of fallen logs (m)	10	≥ 20

11.3 Weed Control

Monitoring is vital to assessing the effectiveness of the treatment methods carried out. Assessing the site response to any treatments is also essential in providing any follow-up actions. This will be conducted by collecting information about the site and the treatment methods used in the following ways:

- using photographic monitoring points;
- mapping of weed species, their location and densities;
- noting if the weeds have been previously treated; and
- recording significant native species and their density within the treatment area.

Information on the best practice for weed monitoring and detail on the monitoring techniques to be applied will be utilised from guidelines for monitoring weed control and recovery of native vegetation.

The results and recommendations from any monitoring will be detailed in a report or Weed Action Plan and supplied to the Environmental Compliance Coordinator.

Baseline information and data should be collected and assessed when measuring the effectiveness of presence and/or densities of weed species over time. The weed contractors must maintain daily activity reports detailing the following information:

- number of contractors and total number of person/people hours worked;
- weed control methods used;
- herbicide application (if any) and the type of chemical and quantity/volume used;
- weather conditions, morning, midday and afternoon, including Delta T measurements;
- location of work performed;
- the approximate area (m^2) or % of weeds treated within each management area;
- consider establishing photo points at significant infestation areas;
- other information or observations that may be relevant;
- provide this information in a report to DC, summarising weed management activities undertaken; and

record threatened or endangered flora or fauna identified within the study area.

12 Compliance Management

12.1 Introduction

The biodiversity monitoring results will be reviewed on an annual basis to confirm compliance with the conditions specified in SSD-5465.

The results will also be presented in the Annual Review and include a summary of monitoring results during the past year; a comparison against the impact assessment criteria; a summary of previous years' monitoring results; a comparison of the impacts with those predicted in the EIS and present an analysis of the potential cause(s) of significant discrepancies, if any. The Annual Review will also identify any relevant trends and any non-conformance over the year as well as describing any actions currently implemented or planned to ensure compliance with the impact assessment criteria. The Annual Review will be forwarded to the relevant authorities including the DPE and the EPA. The Annual Review will also be forwarded to members of the Community Consultative Committee and local Councils (Central Coast and Lake Macquarie) and will also be placed on the company's website along with a summary of environmental monitoring results.

12.2 Compliance Monitoring

Trigger values have been identified for each of the biodiversity monitoring regimes implemented within this BMP based on the compliance criteria specified in Section 1. These are outlined in **Table 9** with recommended actions if trigger values are exceeded.

Table 9: Biodiversity Monitoring Triggers and Actions

Management Issue	Compliance Criteria	Triggers	Action
Weeds	Control and suppress the spread of weeds into remnant vegetation around the ventilation facility and pit top areas.	Spread of weed infestations into remnant vegetation as determined by monitoring.	Include findings in the Annual Review and undertake targeted weed control as per **Table 5** in identified areas.
Feral animals	Control feral animals.	Feral animal monitoring will identify if the number of individuals and activity levels increase. As current levels are low, the trigger value is an increase in activity levels of 2 points from the previous monitoring period for any given species.	Include findings in Annual Review and employ a suitably qualified person to undertake feral animal control for the identified species in accordance with local control programs.
Bushfire risk	Asset Protection Zones (APZs) are well maintained.	Growth of vegetation in asset protection areas surrounding the pit top and ventilation shaft areas.	Include findings in the Annual Review and undertake firetrail and APZ maintenance.
Uncontrolled public access	Control public access	Public accesses prohibited areas.	Restrict public access as required.
Receiving waters	Ecological monitoring of the receiving waters of the mine water discharge.	Use results of the Water Management Plan monitoring to compare to the trigger values in **Table 10**.	Monitoring requirements related to receiving waters are documented in the Water Management Plan. Results will be considered with the outcomes of biodiversity monitoring and will be included in the Annual Review. If ecological triggers are exceeded (based on annual averages), amelioration measures to improve water quality will be determined in accordance with the Water Management Plan.
EEC areas downstream of the discharge from D10 (Pit top area)	Any harm to EEC vegetation due to mine water discharge would be offset in accordance with the Office of Environment and Heritage (OEH) policy.	A decrease in the total weighted score to less than 60% for any Biobanking plots (decrease in condition and health of the EECs) within the swamp oak forest and below trigger values identified by baseline monitoring for the Swamp Sclerophyll Forest.	If the trigger is exceeded, amelioration and compensatory measures will be adopted. See Section 12.4 for details.
Native vegetation (Ventilation shaft)	Condition of remnant native vegetation around the ventilation shaft to be monitored.	Observable decrease in health of the two Rough-barked Apple in close proximity to the ventilation shaft. Observable dieback in vegetation surrounding the ventilation shaft from monitoring photos.	Amelioration measures to be discussed with the Project Ecologist to minimise impacts. This could include additions to fencing, restrictions for access and rehabilitation of disturbed vegetation.

12.3 Water Quality Triggers

The water quality triggers detailed in **Table 10** have been devised to maintain the ecological health of the receiving waters and EEC area downstream of dam D10. Trigger values will be determined by averaging the annual water quality parameters over the sampling events to ensure that stochastic environmental events are not influencing the results.

Table 10: Water Quality Triggers for Compliance Monitoring

Water quality parameter (units)	Estuary health (DECC, 2010)			Trigger (averaged annual results)
	Healthy	Fair	Poor	
pH	7 - 9	-	<7 or >9	Poor health
Suspended Solids (mg/L)	<10	10 - 20	>20 (may be influenced by tides)	Poor health
EC (µS/cm)	No trigger value. Area affected by tides			No trigger value – Area affected by tides. Monitoring in association with vegetation condition
Total Phosphorus (mg/L)	<0.02	0.02 - 0.3	>0.3	Poor health

Notes:

- *Suspended solids measurements are used instead of turbidity (as per DECC, 2010) but utilises the same health criteria. Turbidity data will also be collected in the event that the suspended solids trigger is reached.*
- *Total phosphorus used instead of Phosphates (PO_4), with the same estuary health guidelines applied from DECC, 2010.*

Water quality triggers will be investigated when EEC condition appears to be declining, that is when it has a total weighted score of less than 60%. If the threshold is exceeded, annual average water quality values will be investigated to determine if trigger values are being exceeded, to establish whether or not water quality is negatively influencing EEC condition. Results will be included within the annual monitoring report with appropriate recommendations in line with the water quality management plan reporting.

Water quantity (volumetric) triggers have not been proposed as flows may vary significantly on any day as a result of mine dewatering changes and the daily discharge volume is restricted to a maximum of 12,161 kL under EPL 1770. The need for a volumetric trigger will be reassessed in the future if EPL 1770 is varied to include a higher daily discharge volume.

12.4 Swamp Oak Forest Actions

The significance of any degradation in condition of the Swamp Oak Forest community will be determined based on the final weighting of the data from two Biobanking plots undertaken annually. Plot data will be compared to the local benchmark (baseline) data (**Table 10**) to calculate a final weighting.

A trigger value has been developed for the project of 60% for the total weighted score. If the weighted score for a plot falls below this threshold as a result of impacts from the Colliery, ameliorative measures and compensation will be required. Using the baseline data as a 'before impact condition', the Biobanking calculator (under the Biobanking Assessment Methodology) will be used to determine the compensatory measures required for the decrease in vegetation condition identified. The calculator will generate ecosystem credits required to be retired.

Potential offset sites will then be identified, with a preference for CVC land within the locality, using existing vegetation mapping and ground-truthing by the Project Ecologist. Offset requirements will be determined in consultation with the BCD and in the manner approved at the time.

13 Reporting

13.1 Annual Review

The results of any monitoring will be summarised in the relevant Annual Review. The Annual Review will also include a description of any actions being implemented or planned with respect to biodiversity.

Annual Review will be forwarded to members of the Community Consultative Committee, local Councils (Central Coast and Lake Macquarie), DPIE and other relevant authorities and be placed on the company's website.

13.2 Incident or Non-compliance Reporting

If monitoring reveals that actions by CVC have resulted in an environmental issue or that there has been non-compliance in relation to rehabilitation, then DC will conduct an investigation into the cause of the non-compliance.

The report will:

- describe the date, time and nature of the observation;
- identify the cause (or likely cause) of the damage/incident;
- describe what action has been taken to date; and
- describe the proposed measures to address the incident and prevent further such occurrences.

14 Stakeholder Management and Response

14.1 Complaints Handling

DC has a 24-hour telephone hotline (1800 687 260) through which members of the public can lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters.

All complaints are recorded and responded to and if, for some reason, no action is taken then the reason why is recorded. The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or, if no action was taken, the reason why; and
- follow up contact with the complainant.

14.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review

14.3 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environment and Community Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager together with the Environment and Community Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in Schedule 5 of SSD-5465.

15 Audit and Review

The BMP will be kept up to date through DC's standard audit and review process, however it is noted that significant planning for the detailed mine closure plan is not expected until around 2025. Current site audit and review arrangements are set out below.

15.1 Review

This document will be reviewed, and if necessary revised, within three months of the following;

- The submission of an Annual Review;
- The submission of an incident report;
- The submission of an independent environmental audit; and
- Following any modification to the project approval.

Internal and external audits of this document will be carried out as described below. If possible, internal and external audits will be objective and be conducted by a person or organisation independent of the document being audited.

Audits will be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the Colliery Incident Database to ensure the actions are assigned to the relevant people and completed.

15.2 Auditing

The objectives of an audit are to maintain compliance with the Development Consent, Environmental Protection License and Environmental Management System (including the BMP). Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.
External audits will be conducted utilising external specialists and will consider this document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished.

An Independent Environmental Audit (IEA) was completed and approved (by DPE) in September 2022. In accordance with SSD-5465 Schedule 6, Condition 9, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

16 Records and Document Control

16.1 Records

Generally, the Environmental Compliance Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

16.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environment and Community Coordinator.

A copy of this document is available on the DC website. Details on document revisions are provided in **Table 11**.

Table 11: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	06/03/2013	Original BMP	LakeCoal	P. Stewart C. Ellis B. Johnston
2	07/01/2014	Review	LakeCoal	C. Ellis
3	05/12/2014	Review	LakeCoal	C. Ellis
4	01/03/2019	Review	LakeCoal	C. Armit W. Covey
5	1/12/2019	Updated to Delta Coal format	Delta Coal	K. Weekes E. Dodd C. Armit
6	3/12/2020	CVC Modification update	Delta Coal	C.Armit
7	11/10/2022	Review following CVC 2022 Independent Environmental Audit.	Delta Coal	L. McWha

17 Roles and Responsibilities

Roles and responsibilities specific to completing the requirements of the BMP are identified in **Table 12**.

Table 12: Roles and Responsibilities for Biodiversity Management

Role	Responsibilities
General Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the BMP, including rehabilitation activities.
Environmental Compliance & Approvals Coordinator	• Document owner managing the implementation of the plan. • Coordinate the biodiversity monitoring. • Engage contractors to undertake weed management and feral animal management activities and review plan updates. • Coordinate the required native vegetation enhancement strategy. • Provide results of other environmental monitoring for the project to the Project Ecologist to assist in determining any change and cause of changes to monitored vegetation. • Inspect and report on bushfire risk and management and uncontrolled public access management. • Inspect APZs prior to the start of the fire season. • Arrange for access to site for all personnel involved in implementing this BMP. • Compile data for the Annual Review. • Follow up complaints or disputes. • Respond to any potential or actual non-compliances and report these as required to regulatory bodies and other stakeholders. • Undertake reviews of this document. • Undertake or coordinate the required audits of this document. • Complete notification process for any noncompliance or incident.
Project Ecologist	• Undertake ecological monitoring specified within this BMP. • Determine compliance with approval conditions based on monitoring results and in accordance with the criteria. • Incorporate results of other environmental monitoring into the biodiversity monitoring program. • Provide feedback to the Environment and Community Coordinator for updates to the plan based on monitoring results.
All employees and contractors	• Comply with the requirements of this BMP.

18 References

Documents used in the preparation of this management plan are detailed in Error! Reference source not found..

Table 13: References

Reference	Title
Standards	AS/NZS ISO 14001:2004 Environmental management systems – Requirements with guidance for use AS/NZS ISO 14004:2004 Environmental management systems – General guidelines on principles, systems and support techniques AS2601-2001: The demolition of structures
Legislation and Regulations	*Biodiversity Conservation Act 2016* *Biosecurity Act 2015* Biosecurity Regulation 2017 Environment Protection Licence (EPL) 1770 *Environmental Planning and Assessment Act 1979 (EP&A Act)* *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* *Fisheries Management Act 1994* *Game and Feral Animal Control Act 2002* *Game and Feral Animal Control Regulation 2012* *Local Land Services Act 2013* *Mining Act 1992* *National Parks and Wildlife Act 1974* *Pesticides Act 1999* Development consent SSD-5465 (as modified) *Protection of the Environment Operations Act 1997 (POEO Act)* *Rural Fires Act 1997*
Delta Coal documents	EMS 001 Environmental Management Strategy. Chain Valley Colliery Benthic Communities Management Plan, May 2020 Chain Valley Colliery Biodiversity Management Plan, December 2019 Chain Valley Colliery Heritage Management Plan, June 2020 Chain Valley Colliery Seagrass Management Plan, June 2020 Chain Valley Colliery Water Management Plan, July 2020 Delta Coal 2020, MC and CVC Mine Operations Plan 2020 - 2021 Delta Coal Permit to Clear or Disturb land
External	AECOM, 2011, Environmental Assessment Chain Valley Colliery Domains 1 &2 Continuation Project, prepared for LakeCoal.

Reference	Title
	Australian Government Weeds of National Significance, www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html, viewed 5 August 2019. Bureau of Meteorology (BOM) 2019, Map of Climate Zones of Australia. Cardno Ecology Lab, 2011, Mannering Colliery Extension of Mining – Aquatic Ecology Assessment, prepared for Centennial Coal. Commonwealth of Australia, September 2016, Mine Closure: Leading Practice Sustainable Development Program for the Mining Industry. Department of Environment, Climate Change and Water (DECCW) 2009, Threatened species survey and assessment guidelines: field survey methods for fauna (Amphibians), NSW Government. Department of Environment, Climate Change and Water (DECCW) 2010, Waterwatch estuary field manual and guide. Ecotone Ecological Consultants 1997, Flora and Fauna Survey and Assessment Vales Point Power Station Perimeter lands Biodiversity. Waratah, NSW. Ecotone Ecological Consultants 2010, Flora and Fauna Investigations Vales Point Power Station Perimeter lands Biodiversity Update. Waratah, NSW. EMGA Mitchell McLennan, 2015 – Statement of Environmental Effects, Chain Valley Colliery – Modification 2, Prepared for LakeCoal Pty Ltd EMGA Mitchell McLennan, 2013 – Environmental Impact Statement, Chain Valley Colliery Mining Extension 1 Project, Prepared for LakeCoal Pty Ltd. Greater Sydney Regional Strategic Weed Management Plan 2017 - 2022 Developed in partnership with the Greater Sydney Regional Weed Committee - Revised September 2019. Kelly, G.L., 2006, Recycled Organics in Mine Site Rehabilitation - A review of scientific literature, prepared for the Department of Environment and Conservation NSW. Kleinfelder 2016, Weed Action Plan - Mannering Colliery and Chain Valley Colliery. NSW Government Department of Land, Water and Biodiversity Conservation (DLWBC) 2006, Asparagus Weeds Best Practice Management Manual, Department of Water, Land and Biodiversity Conservation, South Australia. NSW Government, Australian Government and QLD Government 2009, Lantana Best Practice Manual and Decision Support Tool, Department of Employment, Economic Development and Innovation, Queensland. NSW Minerals Council Improving Mine Rehabilitation Discussion Paper, February 2018. NSW Office of Environment & Heritage (OEH) 2014, BioBanking Assessment Methodology 2014. Office of Environment and Heritage for the NSW Government, Sydney. NSW Primary Industries Weed Management Unit 2009, Blackberry control manual: Management and control options for Blackberry (Rubus spp.) in Australia, Department of primary Industries, Victoria. NSW Rural Fire Service (RFS) 2006, Planning for bush fire protection: a guide for councils, planners, fire authorities and developers. NSW Government.

Reference	Title
	Office of Environment and Heritage (OEH) 2014, *Wallum Froglet – profile,* www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10183, viewed 29 November 2019. Sydney Weeds Committee 2012, Groundcovers: Nasturtium (Tropaeolum majus), www.sydneyweeds.org.au/nasturtium, viewed 29 November 2019. Total Earth Care 2019, Weed Action Plan - Mannering Colliery and Chain Valley Colliery. Watterson, E.K., Burston, J.M., Stevens, H. and Messiter, D.J., 2011, The hydraulic and morphological response of a large coastal lake to rising sea levels. Worley Parsons. pp 1-14. Winkler MA, Cherry H and Downey PO (eds) 2008, *Bitou bush management manual. Current management and control options for bitou bush Chrysanthemoides monilifera* ssp. *rotundata) in Australia,* Department of Environment and Climate Change (NSW), Sydney.

19 Definitions

BMP Biodiversity Management Plan

CCC Central Coast Council

DC Delta Coal

DP&E Department of Planning & Environment

DPIE Department of Planning, Industry and Environment

DPI Department of Primary Industries

EA Environmental Assessment

EMS Environmental Management System

EPA NSW Environment Protection Authority

EPL Environmental Protection License

EP&A Act *Environmental Planning and Assessment Act 1979*

LMCC Lake Macquarie City Council

MC Mannering Colliery

MOP Mine Operations Plan

MP 10_161 Project Approval for CVC Domains 1 & 2 Continuation Project, referred to in Schedule 3, Condition 25 of SSD-5465

MSDS Material Safety Data Sheet

NSW New South Wales

OEH NSW Office of Environment and Heritage

POEO Act *Protection of the Environment Operations Act 1997*

RFS NSW Rural Fire Service

ROM Run of mine

Secretary Secretary of the Department, or nominee

VPPS Vales Point Power Station

WoNS Weed of National Significance

Appendix 1: Consultation

DPE Biodiversity Management Plan Approval

Department of Planning and Environment

NSW GOVERNMENT

Our ref: SSD-5465-PA-10

Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd (t/a Delta Coal)
PO Box 7115
Mannering Park, NSW, 2259

24/04/2023

Subject: Approval of Biodiversity Management Plan

Dear Mr McWha

I refer to the Biodiversity Management Plan submitted in accordance with condition 20, Schedule 3 of the consent for the Chain Valley Extension Project (SSD-5465).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions of consent.

Accordingly, as nominee of the Planning Secretary, I approve the Biodiversity Management Plan (rev 6, dated April 2023).

You are reminded that if there are any inconsistencies between the Plan and the conditions of consent, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact James McDonough on (02) 9585 6313.

Yours sincerely

JEvans

Jessie Evans
Director Energy and Resource Assessments

As nominee of the Planning Secretary

4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150 www.dpie.nsw.gov.au 1
Locked Bag 5022, Parramatta NSW 2124

DPE - BCD

NSW GOVERNMENT

Department of Planning and Environment

Your ref: SSD-5465 MOD3
Our ref: DOC22/1042194-3

Mr Lachlan McWha
Environmental Compliance & Approvals Coordinator
Great Southern Energy Pty Limited (t/as Delta Coal)
By email: lmcwha@deltacoal.com.au

Dear Mr McWha

Chain Valley Colliery Extension project (SSD-5465) – Chain Valley Colliery Biodiversity Management Plan

On 25 November 2022 Planning and Assessment Group of the Department of Planning and Environment invited Biodiversity and Conservation Division (BCD) for advice in relation to the Draft *Environmental Management System: Chain Valley Colliery: Biodiversity Management Plan* (BMP) (dated 23 November 2022). The BMP was prepared by Delta Coal as a requirement of Schedule 3, Condition 20 'Biodiversity Management Plan' of Development Consent SSD-5465, and it has been revised following an Independent Environmental Audit conducted in 2022.

BCD has reviewed the BMP and recommends

- That Section 3.2.1 'Native Vegetation' includes photos of Plot 1 and Plot 2 and that the BMP includes a copy of the raw Plot data. If this data has already been presented, say in an Annual Review, then cite that reference instead.
- Show the location of the Plot 1 and Plot 2 on a map - such as Figure 2 'Pit Top Area Broad Vegetation Types' or Figure 3 'ventilation Fan Site Broad Vegetation Types', or in a new map.
- Clarify whether the 'Native Vegetation Enhancement Area' shown in Figure 4 is the same as the 'Biodiversity Enhancement Area' mentioned elsewhere in the BMP. If so, the title to Figure 4 may need to be changed, if not, then please describe how these two areas differ in Section 3.2.1.

BCD's review has not been comprehensive, so the recommended changes (listed above) do not suggest that other parts of the BMP cannot be improved.

If you have any further questions about this advice, please contact Robert Gibson, Senior Regional Biodiversity Conservation Officer, on 4927 3154 or at huntercentralcoast@environment.nsw.gov.au

Yours sincerely

Sarah Warner
Acting Senior Team Leader Planning
Hunter Central Coast Branch
Biodiversity and Conservation Division

9 December 2022

Level 3, 6 Stewart Avenue, Newcastle West | Locked Bag 1002 Dangar NSW 2309 | dpie.nsw.gov.au

NSW EPA

DOC22/1045102-1

Planning and Assessment Division
Department of Planning and Environment
Returned by Major Projects Portal

Attention: Lachlan McWha

Dear Mr McWha

No Comment – Chain Valley Colliery – Biodiversity Management Plan

We refer to your request on 25 November 2022 regarding input from the NSW Environment Protection Authority (**EPA**) on the Post Approval Consultation for the Chain Valley Colliery Biodiversity Management Plan (SSD-5465-PA-101).

The EPA has not reviewed and has no comments on the Biodiversity Management Plan. The EPA's role, as a regulatory authority, is to set environment objectives rather than being involved in the development of strategies to achieve those objectives.

The development of such plans by proponents and licensees is encouraged by the EPA, to ensure they have determined how they will meet their statutory obligations and environmental objectives.

If you have any questions about this matter, please contact Gabrielle Clark on (02) 8229 2822.

Yours sincerely

JENNY LANGE
Unit Head
Regulatory Operations
5 December 2022

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Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

Relevant sections of Development Consent SSD-5465 detail the requirements of the BMP and are reproduced in Table A1 below along with identification of where the requirements are addressed in this document.

Table A1: Requirements from Chain Valley Colliery Development Consent (SSD-5465)

Condition No.	Requirements	Relevant section of this document
	Schedule 2 Administrative Conditions	
18	***Updating and Staging Strategies, Plans or Programs*** *The Applicant must regularly review the strategies, plans and programs required under this consent and ensure that these documents are updated to incorporate measures to improve the environmental performance of the development and reflect current best practice in the mining industry. To facilitate these updates, the Applicant may at any time submit revised strategies, plans or programs for the approval of the Secretary. With the agreement of the Secretary, the Applicant may also submit any strategy, plan or program required by this consent on a staged basis.* *With the agreement of the Secretary, the Applicant must prepare a revision or stage of any strategy, plan or program required under this consent without undertaking consultation with all parties nominated under the applicable condition in this approval.* *Notes:* *While any strategy, plan or program may be submitted on a staged basis, the Applicant must ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*	**Section 10.1**
	Schedule 3 Specific Environmental Conditions	
	BIODIVERSITY ***Rehabilitation Objectives***	
19	*The Applicant shall implement a Biodiversity Enhancement Strategy as described in the EIS and summarised in* **Table 6**, *in consultation with OEH, and to the satisfaction of the Secretary.* *Table 6: Summary of the Biodiversity Enhancement Strategy* **Area** / **Offset Type** / **Minimum Size/Amount** Biodiversity Enhancement Area / Enhancement and restoration measures, including weed and rubbish removal, return of natural hydrological regime and regeneration with native endemic species. / 3 ha (in total) of Swamp Sclerophyll Floodplain Forest and Swamp Oak Floodplain Forest endangered ecological communities within the surface facilities sites *Note: To identify the Biodiversity Enhancement Area referred to in Table 6 see the applicable figures in Appendix 7.*	**Section 6**

Condition No.	Requirements	Relevant section of this document
	The Applicant shall implement its preferred option of the three options set out in new dot point 1 of the Terrestrial Ecology section of its Statement of Commitments by 1 December 2016, following consultation with OEH and to the satisfaction of the Secretary.	**See below**
	Biodiversity Management Plan	
20	*The Applicant shall prepare a Biodiversity Management Plan for the surface facilities sites, for all areas that are not, or will not, be subject to condition 7 of schedule 4, to the satisfaction of the Secretary. This plan must:*	
	(a) be prepared by a suitably qualified person approved by the Secretary; in consultation with OEH, and submitted to the Secretary within 6 months of the date of this consent;	**Section 1.5**
	(b) establish baseline data for the existing habitat in the Biodiversity Enhancement Area and elsewhere on the site;	**Section 6**
	(c) describe the short, medium, and long term measures that would be implemented to:	
	manage the impacts of clearing vegetation;	**Section 5**
	manage the remnant vegetation and habitat in the Biodiversity Enhancement Area and elsewhere on the site; and	**Section 6, 10**
	implement the Biodiversity Enhancement Strategy, including detailed performance and completion criteria;	**Section 6**
	(d) include a program to monitor and report on the effectiveness of these measures, and progress against the detailed performance and completion criteria;	**Section 11**
	(e) identify the potential risks to the successful implementation of the Biodiversity Enhancement Strategy, and the contingency measures that would be implemented to mitigate these risks; and	**Section 6**
	(f) include details of who would be responsible for monitoring, reviewing, and implementing the plan.	**Section 17**
	The Applicant shall implement the approved management plan as approved from time to time by the Secretary.	**Noted**
20 A	*Within 3 months of the approval of MOD 2, the Applicant shall revise the Biodiversity Management Plan to incorporate the measures required to implement its commitments described in new dot point 2 of the Terrestrial Ecology section of its Statement of Commitments, and submit it to the Secretary for approval.*	**This document**
	BUSHFIRE MANAGEMENT	
24	*The Applicant shall:*	
	(a) ensure that the development is suitably equipped to respond to any fires on site; and	**Section 9**
	(b) assist the Rural Fire Service and emergency services as much as possible if there is a fire in the vicinity of the Surface facilities sites.	**Section 9**

Condition No.	Requirements	Relevant section of this document
	STATEMENT OF COMMITMENTS	
	Terrestrial Ecology	
	In addition to the management and mitigation measures undertaken at the Colliery for terrestrial ecology as described in the BMP, the following commitments specific to the Proposal will be undertaken. Some commitments are already undertaken under the BMP. LakeCoal will:	
	• *investigate one of the following options in consultation with OEH to offset the biodiversity impacts arising from the proposed modification:* *provide $10,000 of funding, which is equivalent to the biodiversity being lost (i.e. 5 credits x $2,000 per credit) to existing environmental programs at the site which benefits the Swamp Sclerophyll EEC; or* *consult with OEH to identify a suitable conservation program and provide $10,000 of funding; or* *purchase and retire 5 credits on the Biobanking register.*	**Financial contribution by LakeCoal in 2016**
	• *update* the BMP to include the following: *the completion of predisturbance surveys in the survey area for Blackeyed Susan, Leafless Tongue Orchid and Variable Midge Orchid during their flowering periods (July to December, November to February and September to October, respectively);* *pre-disturbance surveys by an ecologist to determine the important components of vegetation communities and fauna habitats that should be preferentially retained in the APZs;* *installation of delineation fencing around threatened flora populations (if found) to ensure their protection during development and maintenance of the APZs;* *condition monitoring for threatened flora populations (if found);* *retention of hollow-bearing trees in the APZs, where possible, with details to be included in a hollow tree register;* *installation of nest boxes (or salvaged hollows) within the APZs under the supervision of a suitably qualified ecologist or wildlife carer to replace hollows where hollow-bearing trees cannot be retained;* *measures for APZ maintenance that include weed control;* *clearing of hollow-bearing trees (if required) under the supervision of a suitably qualified ecologist;* *any injured fauna would be taken to the nearest veterinary hospital for treatment before release; and* *relocation of suitable hollow-bearing felled trees adjacent to the APZs to create additional fauna habitat;*	**Section 5, 7 and 9**
	• *undertake the design of the dam embankment and spillway works in consultation with an ecologist to minimise potential impacts on the Swamp Oak Floodplain Forest EEC;*	**Dam works completed 2017**
	• *ensure pre-clearing surveys are undertaken by an ecologist to minimise the potential impact to fauna and significant vegetation prior to clearing works being undertaken within the embankment and spillway area;*	**As above and Section 5**
	• *clearly delineate the clearing footprint and cordon off surrounding vegetation as a 'no go' zone during works to the dam embankment and spillway;*	**As above and Section 5**

Condition No.	Requirements	Relevant section of this document
	• *minimise disturbance areas where possible by ensuring all stockpiling of materials, parking of machinery etc, is undertaken in previously cleared areas;*	**As above and Section 5**
	• *ensure that, wherever possible, dead standing timber and fallen timber will be avoided by any clearing works, or if required to be removed, be relocated into suitable habitat areas nearby;*	**As above and Section 5**
	• *ensure all equipment used for the earthworks associated with the dam embankment and spillway will be cleaned of excess soil potentially containing pathogens and weed seeds prior to entering the Site;*	**As above and Section 5**
	• *install sediment fencing surrounding the proposed earthwork areas, in accordance with a site-specific erosion and sediment control plan for the works;*	**As above and Section 5**
	• *ensure that in the event that sedimentation dam water is released from Dam 10 prior to the works being undertaken, it will be undertaken in a controlled manner over a number of days to ensure that the release does not result in significant erosion and sedimentation to the Swamp Oak Floodplain Forest;*	**As above and Section 5**
	• *continue the management and monitoring of flora and fauna in accordance with the BMP for the life of the mine, including:* *the condition and composition of the Swamp Oak Floodplain Forest area;* *the condition of vegetation adjacent to the ventilation shaft and fans;* *the location and distribution of weed infestations; and* *the abundance and distribution of feral animal use.*	**Section 7, 8, 11**
	• *noxious weeds will be removed and continually controlled from the pit top area, allowing for natural regeneration of vegetation;*	**Section 7**
	• *weed invasion will be monitored as part of the Colliery's BMP; and*	**Section 11**
	• *the condition of the EEC areas will be monitored through the Colliery's BMP.*	**Section 11**

Appendix 7 Benthic Communities Management Plan

Delta coal

Environmental Management System

Chain Valley Colliery

Benthic Communities Management Plan

Reviewers	L McWha
	P van Rooyen
Authorised by:	Delta Coal
Date:	28 July 2023

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1 Introduction

1.1 Purpose

The purpose of this Benthic Communities Management Plan (BCMP) is to minimize the impact on Benthic Communities through:

- outlining the required data to be collected on monitored benthic communities;
- identifying benthic community monitoring locations;
- identifying reporting requirements;
- detailing preventative management measures;
- identifying the requirements for incident or exceedances reporting;
- identifying the responsible persons for all required actions; and
- Identifying the review requirements for the BCMP .

A formal Environmental Management System (EMS) has been developed as a systematic and structured approach to managing environmental issues at the operation. This has been developed in general accordance with the requirements of the international standard ISO 14001. This BCMP is an element of the Chain Valley Colliery (CVC) Environmental Management System (EMS).

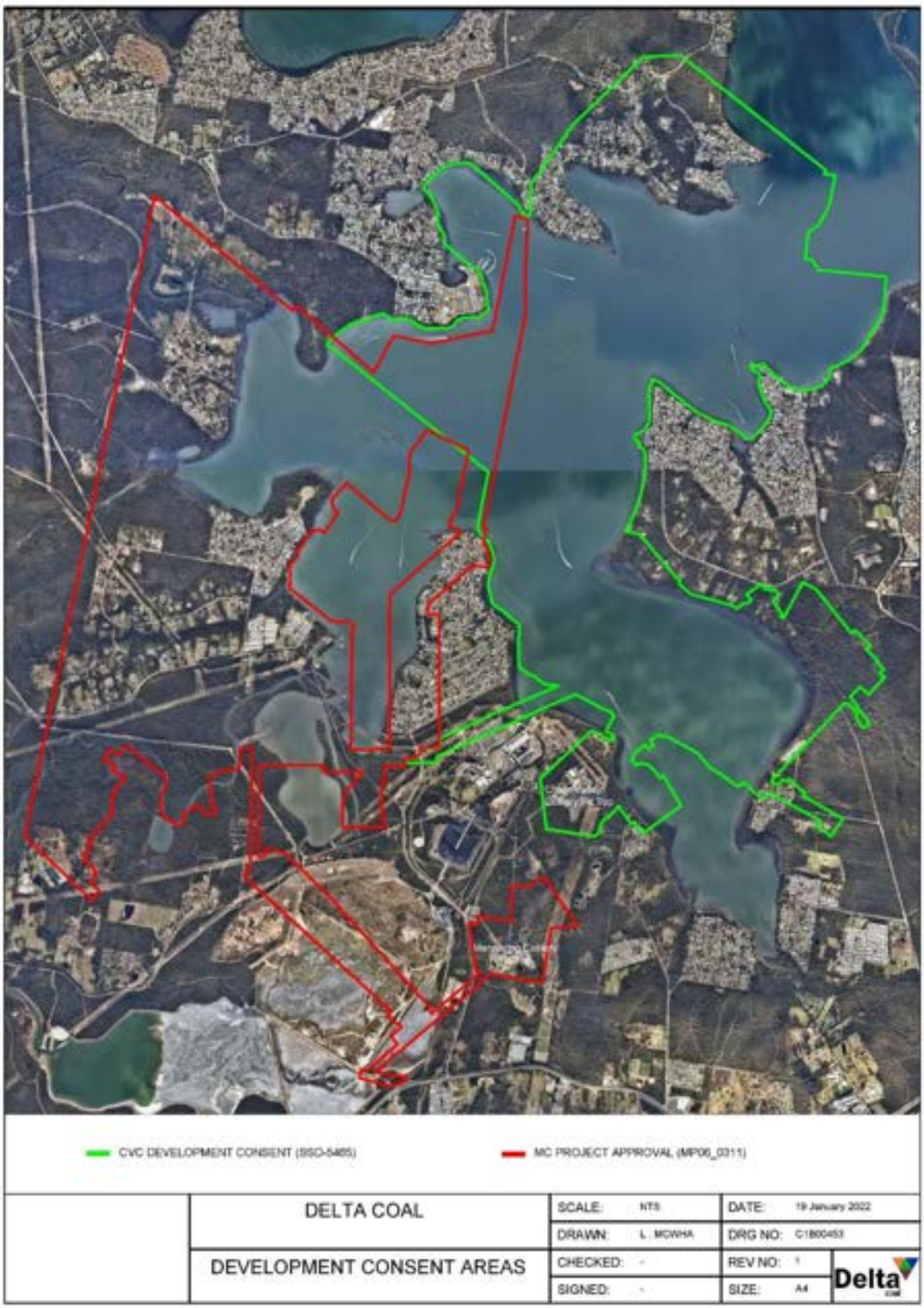
1.2 Background

Chain Valley Colliery (CVC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see **Figure 1**). The pit-top is located approximately 1 km south-east of the township of Mannering park at the southern extent of Lake Macquarie, as shown on **Figure 1**.

Mining is currently undertaken at CVC, with the coal being transported underground to Mannering Colliery (MC) where the coal is crushed and screened and sent directly to Vales Point Power Station (VPPS).

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam, commenced with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963. As of 1 April 2019, Great Southern Energy Pty Ltd, trading as Delta Coal (DC), own and operate the two underground coal mines, CVC and MC.

Figure 1 - Regional Context



1.3 Consultation

A copy of the BCMP review which includes an update for Miniwall S5 and Northern Mining Pillar extraction and SSD 5465 Modification 3 was provided to the stakeholders listed in the below table on 4 December 2020.

A summary of the comments received during this round of review, and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**. This plan was approved by DPIE on the 6 April 2021 as part of the Miniwall S5 and Northern Pillar Area extraction plan.

Delta Coal has reviewed and made minor amendments to this plan following the completion of an Independent Environmental Audit, and issued the plan to stakeholders for comment and approval on the 16th November 2022.

The Management Plan has been revised (version 9) in July 2023, to include recommendations of the biennial statistical review of the benthic communities monitoring results, indicating that the benthos of Lake Macquarie have not shown significant seasonal variation warranting monitoring twice annually.

Table 1: Consultation Summary

Stakeholder	Comments	Response/Action
NSW DPIE	Benthic Communities Management Plan(V9) approved 19 September 2023.	Noted.
NSW DPIE-BCD	1. Given the six-monthly monitoring program spanning 2012-2022 did not indicate any significant changes to benthic communities over time, the request to reduce monitoring is appropriate; 2. The selection of Autumn for the annual sampling is appropriate as it will avoid seasonal extremes; 3. The frequency of monitoring should be reviewed if future results indicate impacts to benthic assemblages attributed to CVC Operations.	1. Noted. 2. Noted. 3. Noted.
Lake Macquarie City Council (LMCC)	1. LMCC concurs with DPI-Fisheries comments and are also satisfied with the option of moving to annual monitoring. 2. Consideration of a BIOENV procedure to reveal the most important variables affecting the structure of benthic communities is required.	1. Noted. 2. Comments noted and recommendations will be included in the 2024 statistical analysis.
DPI Fisheries	4. DPI-Fisheries supports the proposal to reduce monitoring frequency from twice yearly to annual only. 5. DPI-Fisheries review of the BCMP and statistical analysis identified that data analysis in Table 4 of the BCMP does not entirely match up with text in Section 5.2, Table 4 notes BIOENV analysis will be undertaken 6. Remainder of DPE-Fisheries comments relates to improvements in the statistical analysis of benthic communities	1. Noted. 2. Comment included in Section 5.2 that BIOENV was not undertaken in 2022 modelling and will be captured in all future analyses. 3. Comments noted and recommendations will be included in 2024 Statistical analysis.

2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities. A number of legislative requirements, government policies and guidelines are applicable. Key items relevant to this management plan are:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Mining Act 1992*;
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*;
- Department of Primary Industries (2013), *Policy and guidelines for fish habitat conservation and management*; and
- ANZECC 2000, Australian *and New Zealand Guidelines for Fresh and Marine Water Quality*.

Delta Coal's operation is within the LMCC and Central Coast Council local government areas (LGAs).

2.2 Development Consent SSD-5465 Requirements

This BCMP has also been completed to satisfy the requirement of Condition 7(h), Schedule 4 of Development Consent SSD-5465 (Modification 4), which states:

"The Applicant shall prepare an Extraction Plan for all second workings on site, to the satisfaction of the Secretary. Each Extraction Plan must:

(h) include a Benthic Communities Management Plan, which has been prepared in consultation with BCD, LMCC and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on benthic communities, and which includes:

- surveys of the lake bed to enable contours to be produced and changes in depth following subsidence to be accurately measured;
- benthic species surveys within the area subject to second workings, as well as control sites outside the area subject to second workings (at similar depths) to establish baseline data on species number and composition within the communities;
- a program of ongoing seasonal monitoring of benthic species in both control and impact sites;
- development of a model to predict likely impact of increased depth and associated subsidence impacts and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities' composition, incorporating the monitoring and survey data collected; and
- updating the model every 2 years using the most recent monitoring and survey data.

The relevant requirements from **Table 6** within Condition 2, Schedule 4 of SSD-5465 (Modification 3), including the relevant notes, are recreated in **Table 2**.

Table 2: Subsidence Impact Performance Measures

Biodiversity	
Benthic Communities	Minor environmental consequences, including minor changes to species composition and/or distribution

Notes:

- *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.*
- *The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.*

Benthic related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

3 Benthic Communities Management

3.1 Baseline Data

Both species diversity and abundance are recorded as part of the benthic communities monitoring, which commenced in 2012.

The mud basin off Summerland Point, in Chain Valley Bay and Bardens Bay, was found to be inhabited by 21 species of organisms greater than 1mm in size. The soft sediment benthic communities within the monitoring area are dominated by polychaete worms and bivalve molluscs.

Bottom sediment in the study area was composed of a small fraction of black sand and shell fragments of various sizes. Most of the sediment was fine black or grey mud.

The sampling results of the benthos undertaken at six-monthly intervals between February 2012 and September 2022 revealed the following:

- the similar suite of organisms dominated each of the 22 sample stations. These were polychaete worms and bivalves;
- stations were distinguished by the relative abundance of the dominant species;
- water depth was not the key parameter in determining the species composition at a station; and
- physical variables such as salinity (conductivity), dissolved oxygen concentration and turbidity of the bottom water, measured only on the day the benthos was sampled, had little influence on the species composition of the benthos over the period sampled.

The results collated to date appear to support the notion that increasing the water depth by the predicted levels of subsidence has, to date, had no discernible effect on the composition and abundance of organisms making up the benthos of the mud basin.

3.2 Bathymetric Surveys

Bathymetric data from the NSW Office of Environment and Heritage (OEH) was obtained in draft format during 2012. DC was granted a license to use this OEH data for the purposes of monitoring changes in the bed of Lake Macquarie, and acknowledges the OEH's data which has enabled the subsidence comparison to be undertaken based on this 2010 data and data subsequently obtained in 2012 by Delta Coal. OEH notes that the data was obtained via use of differential GPS and a 200 kHz echosounder, which is noted to provide a general data accuracy of 0.1 m.

Delta Coal has commissioned a specialist provider to undertake a bathymetric survey over the areas of current and proposed secondary extraction workings. The primary purpose of bathymetric surveys are:

- to obtain accurate baseline data prior to any secondary extraction of an area; and
- to obtain relatively accurate time based subsidence assessments over areas where secondary extraction took place.

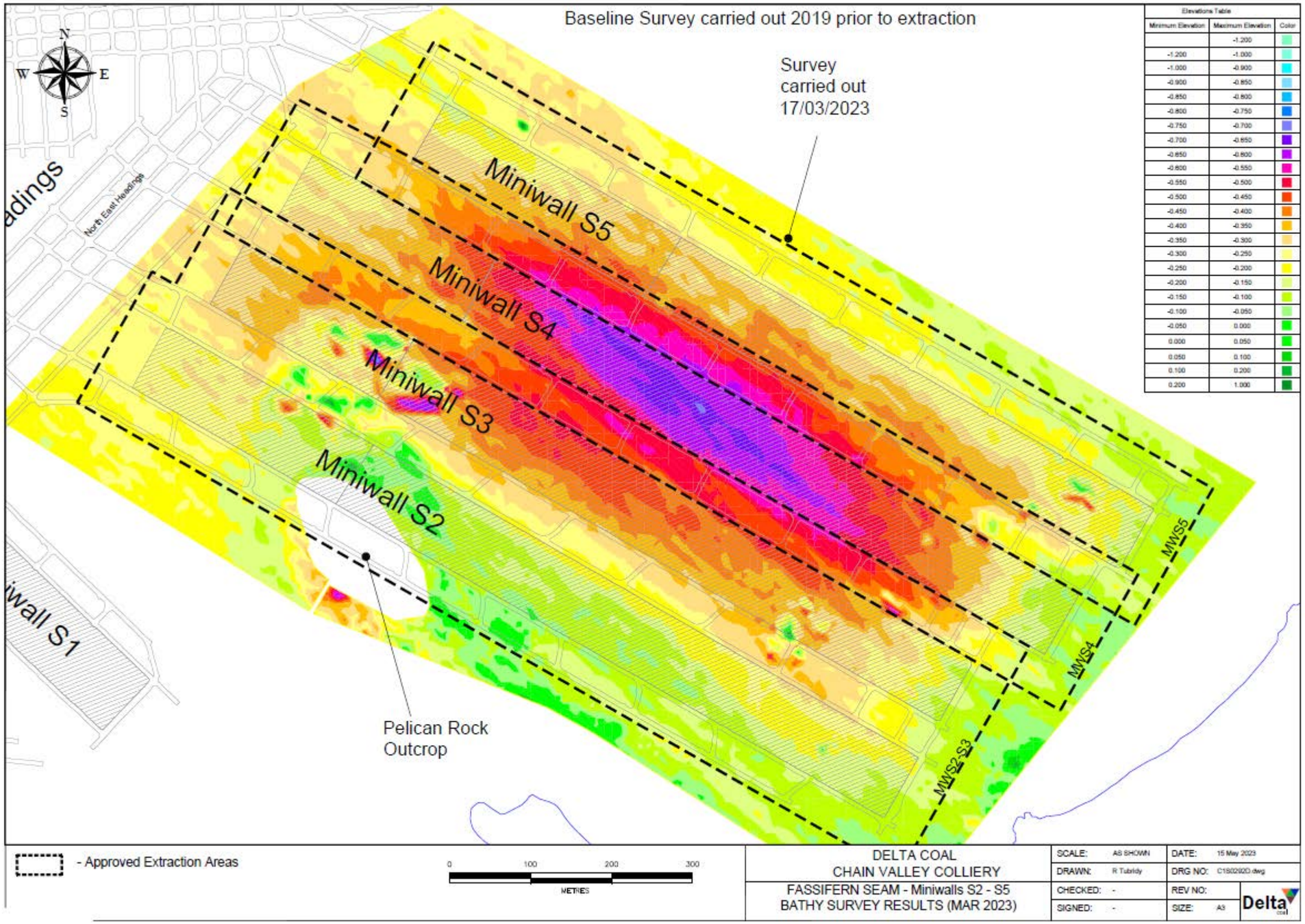
Prior to 2018, bathymetric surveys were conducted annually. Following an exceedance of the subsidence predictions over CVC's MW7-12 mining area in 2017, Delta Coal has committed to undertaking bathymetric surveys at six monthly intervals over areas of secondary extraction to understand the behaviour of subsidence over these mining areas. The latest bathymetric survey was undertaken in March 2023 (**Figure 2**).

The bathymetric surveys have shown that subsidence from the miniwall mining can be monitored with a useful level of accuracy and the surveys will be continued to cover future and completed secondary extraction areas.

3.3 Subsidence Predictions and Modelling

Subsidence predictions and modelling is undertaken by specialist geotechnical engineers for each extraction plan. The subsidence predictions and modelling assist the site technical services personnel in the mine design and planning process. The mine design and planning process is fundamental to controlling mine subsidence to consented limits.

Figure 2 - Bathymetric Scan March 2023 of Miniwalls S2-S5



3.4 Benthic Communities Trigger Action Response Plan

Delta Coal has developed a TARP for the management of benthic communities, TARP 00156. The TARP has been reproduced below.

	NORMAL	LEVEL 1 TRIGGER	LEVEL 2 TRIGGER
BENTHIC COMMUNITIES MONITORING	• No environmental impact recorded to benthic communities or changes in species composition and/or distribution.	• Minor environmental impact recorded, including minor changes to species composition and/or distribution.	• Significant environmental impact recorded, including significant changes to species composition and/or distribution.
Action / Response	• No response required. • Continue monitoring as detailed in the Benthic Communities Management Plan.	• Complete investigation to determine cause of impact to benthic communities • Continue monitoring as detailed in the Benthic Communities Management Plan.	• Notify relevant stakeholders of recorded impact to benthic communities as a result of mining induced subsidence. • Review of future mine workings to see if mitigation of impact to benthos; • Review of Benthic Communities Management Plan and determine if revisions are required to the plan.

4 Benthic Communities Monitoring Program

Based on contour mapping of Lake Macquarie and Delta Coal hydrographic surveys, it was identified that the mining operations are largely proposed to occur beneath areas of the Lake at water depths between 4-6 m which represent the general lake depths where subsidence is proposed and under which mining activities have been, will be or are proposed to occur. Accordingly, the monitoring program was designed to sample benthic invertebrate communities from these depths and to provide ongoing monitoring of the potential effects of subsidence. The methodology and monitoring details are presented in the following sections.

4.1 Sampling Locations

In order to analyse the community assemblages and determine potential impacts of subsidence over time, sampling are undertaken across two depth intervals from numerous site locations within three site types. The site types consist of:

- Impacted (site prefix “IM”): Sites which are currently, or were historically impacted upon by subsidence;
- Reference (site prefix “R”): Sites which are not currently impacted by subsidence but fall within the proposed future mining footprint. Following undermining, Reference sites are designated as Impacted sites; and
- Control (site prefix “C”): Sites which will not be impacted upon by subsidence.

The sampling locations are identified in **Table 3** and **Figure 3**.

Figure 3 - Benthic Sampling Locations



Table 3: Benthic Community Sampling Locations

Site Name	Sample Depth (m)	Easting	Northing
C1	-4.5	364519	6330815
C2	-4.5	366214	6332927
C3	-5.5	366014	6333144
C4	-6.0	364260	6332794
C5	-6.0	367701	6334310
C6	-5.5	363988	6332492
C7	-5.5	366276	6334947
R1	-4.5	364177	6331535
R9	-4.5	365258	6331210
R10	-5.5	365172	6334706
IM1	-4.5	364738	6330734
IM2	-4.5	364842	6332237
IM3	-5.5	364693	6332101
IM4	-6.0	364673	6332705
IM5 (previously R3)	-6.0	364771	6332763
IM6 (previously R4)	-5.5	364660	6332992
IM7 (previously R5)	-5.5	364229	6333889
IM8 (previously R6)	-6.0	364533	6334146
IM9 (Previously R8)	-5.5	364523	6332010
IM10 (Previously R2)	-4.5	365919	6330294
IM11 (previously R7)	-6.0	366232	6333856
IM12 (previously R11)	-6.0	367072	6333639

4.2 Sampling Methods

Each of the sites will be surveyed for biotic (benthic invertebrates) and environmental (water quality, benthic sediment) variables. The surveys will be undertaken during autumn.

4.2.1 Water Quality

General physico-chemical water quality variables will be measured at the sites during sampling. The water quality parameters will be measured at 0.5m below the surface and 0.5 m above the lakebed. The variables measured will include temperature (oC), pH, turbidity (NTU), conductivity (µS/cm), dissolved oxygen (mg/L and % saturation) and oxygen reduction potential (ORP) or photosynthetically active radiation (PAR).

4.2.2 Benthic Sediment

Sediment samples will be collected to a depth of 20 cm at each of the sites using 250 mL jars. The jars will be labelled and transported to the laboratory for analysis via settlement method.

4.2.3 Benthic Invertebrates

At each site, five replicate samples of benthic sediment will be collected by a diver using 200x200x100 mm sieve boxes with 1 mm mesh.

The samples will be sieved to remove sediment particles less than 1 mm in diameter. The residual material will then be transferred to a labelled 250 mL plastic jar and preserved with formaldehyde. Large fragments of shell will be removed from the sample at this time to ensure that the sample volume did not exceed 250 mL and the samples are retained for later inspection at the laboratory.

4.3 Laboratory Analysis

4.3.1 Benthic Sediment

The 250 mL sample of the entire sediment from each site will be transferred into a 500 mL clear glass measuring cylinder and the volume made up to 500 mL with seawater. The cylinder is then to be stoppered and shaken vigorously to suspend the sediment in the seawater. The sample will then be allowed to settle and the volumes of each fraction (shell and coarse sand, fine sand, mud and fine silt) calculated and recorded. Results are then determined relative to the initial volume of sediment collected in the 250 mL jar.

4.3.2 Benthic Invertebrate Identification

The contents of each jar are run through a 1mm mesh sieve and washed free of formalin and any remaining mud.

The washed material is then placed into two enamel dishes and portions of each sample placed in a 100 mm diameter petri dish for examination under a stereoscopic binocular microscope to detect and recover small organisms. Organisms and parts of organisms are removed, counted, identified and the results entered a spreadsheet. The benthic invertebrates are identified to genera and species where possible. This process is repeated until the debris of the entire sample had been examined. The results for each site are then entered an excel spreadsheet for summary and analysis. All shell remaining in the sample is kept for later examination.

4.4 Data Analysis

The biotic and environmental data will be analysed using a variety of univariate and multivariate analysis (**Table 4**). The statistical methods used to analyse the data were determined based on earlier monitoring data to provide the most statistically robust assessment of comparison between impacted and reference and control sites and environmental data. It must be noted that control and reference sites are the same until undermined.

Table 4: Data Analysis

Variable Type	Analysis	Description
Environmental: Water quality	ANZECC/ARMCANZ Guidelines (ANZECC Guidelines)	Trigger values for slightly – moderately disturbed ecosystems: Estuaries.
Biotic and Environmental	Univariate	Descriptive graphical statistics. Analysis of Variance and Similarity (2 way nested)
Biotic and Environmental	Multivariate	A square-foot transformation was performed on the data and Bray-Curtis Similarity matrices created. Cluster analysis was then performed for each site and dendrogram plots produced.
	Multidimensional Scaling Ordination	The analysis represents the sites as points in space so the relative distances between samples show similarities in community structure. Samples that are placed closer together are more similar than samples further apart.
	BIOENV	The analysis matches environmental variables against biotic data which have been measured at the same sites. This analysis enables analysis of the extent to which the physio-chemical data is related to the observed biological patterns. Correlations were performed for each site between the biotic and environmental factors using the BIOENV function in PRIMER5.

4.5 Monitoring Frequency

The baseline sampling program methods outlined in **Section 3** will form the basis for an annual monitoring program that will be undertaken during autumn each year to survey biotic (benthic invertebrates) and environmental variables (water quality and sediment). The program has been designed to enable analysis and reporting of the data to monitor the impacts of subsidence and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities' composition and distribution.

In addition to the above, annual lakebed bathymetric surveys will be undertaken prior to each survey. The annual bathymetric surveys will enable any change to the lake floor to be identified and addressed during the data analysis process.

4.6 Program Refinements

The survey methods will be reviewed every two years of sampling to refine the sampling program if required. Prior to each sampling event the sites will be reviewed against the mine plans to ensure that any reference sites that have become impacted upon by mining are reclassified as impact sites, and replacement reference sites are identified and sampled. This will result in additional reference sites being added to the program during the monitoring period. Provided that sites record no impact to benthic communities due to mining induced subsidence and subsidence levels do not exceed limits specified within Development Consent SSD-5465, Delta Coal will cease monitoring of impact sites following 3 years of monitoring undermined sites. Should monitoring indicate impact to monitoring sites due to mining

induced subsidence, or, subsidence exceeding limits, Delta Coal will determine monitoring requirements in consultation with stakeholders (DPE and BCD).

Statistical review of the benthic communities monitoring between 2012 and 2022 observed that subtidal benthic habitats, like those monitored in the Delta Coal benthic communities monitoring, that are not dominated by benthic primary producers (such as seagrass and/or microalgae), typically do not exhibit strong seasonal variation since the benthic species do not photosynthesise and are therefore largely unaffected by changing light levels. Additionally, benthic environments are often quite stable with respect to sediment conditions that do not change on a regular cyclical nature with the seasons. For these reasons and given the current absence of statistically relevant differences between benthic assemblages at the monitoring sites when compared to the reference and control sites, it was recommended that the benthic monitoring could be reduced to once per year. The recommended timing of annual monitoring was in March (autumn) to capture any variation in benthic assemblages that might occur following summer temperature extremes. The 2022 biennial statistical review report can be viewed on the Delta Coal website (https://www.deltacoal.com.au/environment/chain-valley-colliery/chain-valley-colliery-environmental-reporting).

5 Modelling to Monitor Potential Impacts

5.1 Model Background

Maximum subsidence for the proposed future mining activities is predicted to be 1230 mm, or 780 mm where no overlying workings exist. The analysis undertaken on the baseline data provides an initial assessment of biotic and environmental variables associated with the study area and forms the basis of the formation of the predictive modelling (JSA 2012). The results will be reported in biannual monitoring reports and the Annual Review.

The aim of the predictive modelling is to compare the condition of the baseline benthic community assemblages prior to mining to the benthic community assemblages after mining has occurred, to ensure that only minor environmental consequences occur due to mining activities. The effects of subsidence are required to result in only minor changes to species composition and/or distribution. As the environmental variables which affect benthic communities are complex, in order to determine whether community dynamics at reference sites are related to subsidence, seasonal biotic survey data will be analysed against environmental data and between impacted types. The analysis and modelling will be undertaken to determine whether:

- Overall community dynamics are related to seasonal and environmental variables and/or subsidence impacts;
- Abundance and diversity changes to community composition at reference sites that have been undermined are related to seasonal and environmental variables or subsidence impacts; and
- Changes identified in reference sites that have been undermined are considered minor.

5.2 Analysis

For the model to identify whether the environmental consequences of subsidence are considered minor (and therefore whether mitigation measures will be required) a series of statistical analysis will be undertaken and reported seasonally. Based on the expected timing of subsidence impacts, the analysis will model scenarios to determine:

- Changes in undermined reference sites with the baseline conditions at the same sites; and
- Similarity of impacted sites to control and reference sites at similar depths.

The modelling will be based on Multi-dimensional Scaling (MDS) Ordination, two-way ANOVAs (analysis of variation) and ANOSIM (analysis of similarity) techniques to identify any links in benthic community structure between sites at the same depth profiles. The modelling will be based on the existing benthic community structure, actual subsidence levels (determined from annual bathymetric surveys), predicted levels of increased subsidence and collection of seasonal data.

Figure 3 identifies the reference sites applicable to the project. The communities at the reference sites will be compared against control and reference sites at a similar depth profile. The determination of the level of impact of subsidence, once other environmental variables have been discounted by the model will be based on ANOVA/ANOSIM techniques.

Where ANOVA/ANOSIM results indicate that undermined reference site communities are changing at a rate of ANOVA/ANOSIM test of significance <5% then the impacts will be moderate or major mitigation measures to manage impacts will be required. The use of 5% (the p significance level of 0.05) is a standard statistical method of determining level of significance, another is p= 0.01. Because the data set used in the initial analysis represents a single sampling event the use of the conservative 5% significance rule has been applied to determine minor impacts (other methods such as ranking and scaling were applied to the data but did not provide adequate measurable results). The 5% significance will be applied to monitoring data and revisited regarding suitability based on data outcomes.

The options for mitigation measures to manage subsidence on the lake floor are largely limited to changes to mine design. If impacts are determined to be moderate or major, mine planning will be required to modify mine plans.

The benthic community results of surveys and annual monitoring undertaken have identified that while communities at some sites were defined by dominant species, the abundance and diversity of the communities did not identify clear links to location or impact type. Rather the analysis identified that natural environmental fluctuations in water quality, benthic substrate composition and natural depth intervals were influencing the communities (JSA 2013).

The results of sampling between February 2012 and September 2017 appear to support the notion that increasing the water depth by the predicted subsidence will have no discernible effect on the composition and abundance of organisms

making up the benthos of the mud basin (Laxton & Laxton, 2017). This is supported by the statistical modelling of results which is undertaken every 3 years.

In January 2018 Delta Coal engaged JSA environmental to undertake the 3 yearly statistical modelling of the sites Benthos data set. Detailed ANOSIM analysis of the benthic community data between un-impacted and impacted sites between 2012 and 2017 identified a significance p value of 24.1%. This value indicates that there had been no significant differences between the un-impacted and impacted sites over the last 5 years.

EMM Consulting undertook statistical modelling of the Benthic communities monitoring data between in April 2020 and in November 2022 with both analyses presenting the following conclusions, the results of statistical analysis of CVC's benthic monitoring data indicate that no exceedance of the BCMP subsidence impact performance measure of "minor environmental consequences, including minor changes to species composition and/or distribution" has occurred. Consequently, CVC is not required to implement any additional investigations of benthic communities within the project study area at this time and should continue the routine monitoring of benthic assemblages and biennial statistical analysis. The reports recommended that there was sufficient data to determine that the benthos of Lake Macquarie had not been significantly impacted by seasonal variation and as such, monitoring should be reduced from twice yearly to annually, in Autumn, only. It was noted that BIOENV modelling was not undertaken in the 2022 statistical analysis, it will be ensured that BIOENV analysis is captured in all future statistical modelling analyses.

the assessment of results from future analysis indicate that impacts are outside the defined trigger level Delta Coal will investigate the cause of incident and implement corrective actions where required as outlined in **Section 8**.

6 Reporting

6.1 Regular Reporting

In accordance with Schedule 6, Condition 13, the Delta Coal will provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of the development consent.

The benthic community monitoring results will be reviewed as survey reports are received to confirm compliance with the conditions specified in the Subsidence Impact Performance Measures specified in **Table 6** of Development Consent SSD-5465.

6.2 Annual Review

In accordance with Schedule 6, Condition 8, Delta Coal will review the environmental performance of the development to the satisfaction of the Secretary, by the end of March each year, or other timing as may be agreed by the Secretary.

The Annual Review will also include a summary of monitoring results during the past year, discussion with reference to the impact assessment criteria, and any relevant details related to comparisons between actual results and predictions in the Environmental Impact Statement. The Annual Review will be forwarded to the relevant authorities including DPE, and EPA. The Annual Review will also be forwarded to members of the Community Consultative Committee and local Councils (Central Coast and Lake Macquarie). It will also be placed on the company's website along with a summary of environmental monitoring results.

6.3 Incident or Non-Compliance Reporting

As detailed in Schedule 6, Condition 6 of SSD-5465, DPIE and other relevant agencies will be notified immediately after Delta Coal becomes aware of an incident via the appropriate reporting process. A written report will be provided to the DPE within 7 days of the date of the incident or being made aware of the incident.

If monitoring reveals that, because of mining activities, the criterion has been exceeded, then DC will investigate the cause of the non-compliance. Within 7 days of becoming aware of a non-compliance, DC will notify the Department of the non-compliance via the appropriate reporting process. DC will complete an investigation and provide a written report will be provided to the DPE.

DC will implement the recommendations of the investigation to address any potential future incidents. Any incidents or complaints will be recorded and fully investigated to find root causes and corrective actions implemented where necessary.

7 Stakeholder Management, Response and Training

7.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 687 260) through which members of the public can lodge complaints or concerns. This is operated as per the Delta Coal Environmental Management Strategy (ENV00001, Section 4.4).

7.1.1 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who considers the development to be exceeding the relevant environmental conditions:

If the Planning Secretary is satisfied that an independent review is warranted, then within 2 months of the Planning Secretary's decision the Applicant must:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Planning Secretary and landowner a copy of the independent review.

7.1.2 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environmental Compliance Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager (or his delegate) together with the Environmental Compliance Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant.

7.2 Training, Awareness and Competence

Training is an essential component of the implementation phase of this BCMP. The Environmental Compliance and Approvals Coordinator will ensure that training and awareness processes are implemented to manage, identify and minimise potential impacts of CVC and to ensure personnel are aware of their roles and responsibilities in terms of benthic management.

The Environmental Compliance and Approvals Coordinator is the contact point for any person that does not understand this document or their specific requirements and will provide guidance and training to any person that requires additional training regarding this BCMP.

8 Audit and Review

8.1 Review and Improvement

This document will be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Review;
- the submission of an incident report related to this management plan;
- the submission of an independent environmental audit; and
- following any modification to the development consent.

As outlined in **Section 6.2**, the Annual Review will include a review of the monitoring program and mine plans to ensure that any reference sites that have been impacted by mining reclassified as impacted impact sites, and replacement reference sites identified and sampled. Survey methods will be reviewed every two years to refine the sampling program if required. Improvements identified during reviews or audits will be incorporated into the BCMP.

8.2 Auditing

Internal and external audits of this document will be carried out as described below. Internal and external audits will be objective and if possible be conducted by a person or organisation independent of the document being audited.

Audits will be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

Delta Coal will review any improvement opportunities and determine if it will implement any actions to address the improvement opportunity, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

An Independent Environmental Audit (IEA) was undertaken during June 2022. In accordance with SSD-5465 Schedule 6, Condition 9, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

9 Records and Document Control

9.1 Records

The Environmental Compliance Coordinator (or delegate) will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

9.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environmental Compliance & Approvals Coordinator.

A copy of this document is available on the DC website. Document revision details are provided in **Table 5**.

Table 5: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	May 2012	Version 1 Final	LakeCoal	Unknown
2	07/04/2014	Version 2 Final	LakeCoal	Chris Ellis
3	10/02/2017	Version 3 Final	LakeCoal	Wade Covey
4	14/05/2018	LakeCoal updated document to reflect the development consent requirements and to include monitoring locations for proposed mining areas that are referred to in Extraction Plan	LakeCoal	Wade Covey Adrian Moodie
5	17/06/2019	Updated for Miniwalls S2/S3	Delta Coal	Chris Armit
6	10/03/2020 12/05/2020	Updated document to reflect current S4 workings and consultation with stakeholders Updated document to reflect consultation with DPIE and 2020 statistics report	EMM Consulting / Delta Coal	Katie Weekes Chris Armit

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
7	04/12/20 18/01/21 19/03/2021 6/04/2021	Updated document for S5 and NMA pillar extraction areas and SSD5465 Modification 3 Updated for consultation Plan approval from DPIE	Delta Coal	Chris Armit
8	13/10/2022	Update following completion of 2022 Independent Environmental Audit	Delta Coal	Lachlan McWha
9	28/07/2023	Updated to include recommendations of statistical analysis of monitoring results (reduce monitoring from twice-yearly to annual frequencies.)	Delta Coal	Lachlan McWha

10 Roles and Responsibilities

All employees and contractors at CVC are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this plan are identified in **Table 6**.

Table 6: Benthic Communities Management Plan Roles and Responsibilities

Role	Responsibilities
Manager of Mining Engineering (Mine Manager)	• Ensure that adequate financial and personnel resources are made available for the implementation of the BCMP • Maintain overall responsibility for environmental compliance with Mining Lease, EPL, development consent and other mining approvals as they pertain to the management of benthic communities • Provide adequate personnel to ensure that appropriate mining engineering and geotechnical engineering designs are undertaken to protect subsidence barriers and maintain compliance within subsidence limits • Make the required people available to be trained in their responsibilities in relation to this management plan and to minimise impacts to benthic communities
Environmental Compliance & Approvals Coordinator or delegate	• Co-ordinate benthic community monitoring • Review benthic community monitoring results • Develop management actions in consultation with regulatory agencies as/if required from the monitoring results • Compile the Annual Review (including a summary of the benthic community monitoring) • Respond to any potential or actual non-compliance and report these as required to regulatory bodies and other stakeholders • Undertake reviews of this document • Undertake or coordinate the required audits of this document • Notify relevant agencies if there are any exceedances in impact thresholds • Ensure complaint handling and response is undertaken, including determination of sources and potential remedial action to avoid recurrence
Technical Services Manager	• Maintain overall responsibility for environmental compliance with Mining Lease, EPL, development consent and other mining approvals as they pertain to the management of benthic communities • Ensure that appropriate mining engineering and geotechnical engineering designs are undertaken to protect subsidence barriers and maintain compliance within subsidence limits • Assist and enable the Environmental Compliance Coordinator.
Health, Safety and Training Manager	• Ensure that adequate training is provided to staff to understand their responsibilities in relation to this management plan • Ensure that adequate training is provided to staff to minimise impacts to benthic communities

Role	Responsibilities
Mine Surveyor	• Ensure mine layout and workings are set out as approved, taking into consideration protection barriers and subsidence predictions
All employees and contractors	• Comply with the requirements of this BCMP • Immediately notify Environmental Compliance Coordinator of possible incident

11 References

Documents referenced in the preparation of the BCMP are detailed in **Table 7**.

Table 7: References

Reference	Title
Australian Standards	AS/NZS ISO 14001:2004, *Environmental management systems – Requirements with guidance for use* AS/NZS ISO 14004:2004, *Environmental management systems – General guidelines on principles, systems and support techniques* ANZECC 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
Government Department	Department of Primary Industries (2013), *Policy and guidelines for fish habitat conservation and management* SSD-5465 Development Consent SSD-5465 (Modification 2), 16 December 2015 NSW EPA Environment Protection Licence: EPL 1770, 2 April 2019
Delta Coal documents	EMS Environmental Management Strategy.
External documents	JSA Environmental 2013, *Chain Valley Colliery Mining Extension 1 Project Marine Ecology Assessment,* Lake Coal JSA Environmental 2015*, Chain Valley Colliery Modification 2 Marine Ecology Assessment,* Lake Coal JSA Environmental 2018*, Chain Valley Colliery Benthos Statistical Analysis,* Lake Coal EMM Consulting 2020, Chain Valley Colliery Benthic Community Monitoring - Statistical Analysis Laxton 2020, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton and Laxton 2019, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton and Laxton 2018, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton and Laxton 2017, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton and Laxton 2016*, Lake Macquarie Benthos Survey Results No.10 September 2016.* J.H. & E.S. Laxton - Environmental Consultants P/L. Report for Lake Coal Pty Ltd Chain Valley Colliery Laxton and Laxton 2015, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton and Laxton 2014, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW Laxton & Laxton, 2013, *Lake Macquarie Benthos Survey Results of Sampling No. 4.* September 2013.

Reference	Title
	Laxton and Laxton 2012, *Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie*, NSW O'Connor S et al 2007, Stone Construction on Rankin Island, Kimberley, Western Australia, Australian Archaeology, Number 64, PP: 15-22

12 Definitions

CVC Delta Coal - Chain Valley Colliery

DA Development approval

DC Delta Coal

DP&E Department of Planning & Environment (former)

DPIE Department of Planning, Industry and Environment

DPI Fisheries Department of Primary Industries – Fisheries NSW

DTIRIS Department of Trade, Investment, Regional Infrastructure and Services

EMS Environment Management System

EPA NSW Environment Protection Authority

EPL Environmental Protection License

EP&A Act *Environmental Planning and Assessment Act 1979*

LMCC Lake Macquarie City Council

POEO Act *Protection of the Environment Operations Act 1997*

OEH Office of Environment and Heritage

ROM Run-of-mine

Secretary Secretary of the Department of Planning and Environment, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

Appendix 1: Consultation

LMCC Consultation:

Hi Lachlan,

Council concurs with Fisheries' comments. We are also satisfied with the option of moving to annual monitoring. Our Natural Areas section provided the following comments:

> *Multivariate analysis of the benthic community data included non-metric multidimensional scaling (nMDS), analysis of similarities (ANOSIM) and similarity percentage analysis (SIMPER), correlated with environmental variables (water depth and grain size) using principal components analysis (PCA).*
>
> *The PCA analysis was restricted to the use of two environmental variables (water depth and sediment grain). The concluding remarks included that the site groupings evident in benthic community structure suggest that factors other than, or in addition to, sediment composition are driving the benthic structure.*
>
> *Additional environmental variables were collected during sampling included water temperature, conductivity, salinity, pH, DO, and turbidity which may lead to a more meaningful analysis of the impact of the development on benthic communities. These additional environmental variables should have been included in the PCA analysis. Log transformation is recommended for environmental variables.*
>
> *After a correlation matrix, significant environmental variables could be combined into a BIOENV procedure against macroinvertebrate data. BIOENV analysis can reveal the most important variables affecting the structure of benthic communities.*
>
> *Consideration of a BIOENV procedure to reveal the most important variables affecting the structure of benthic communities is required.*

Regards,
Geoffrey Keech
Senior Development Planner

LAKE MACQUARIE CITY
E gkeech@lakemac.nsw.gov.au
lakemac.com.au

From: Geoffrey Keech <gkeech@lakemac.nsw.gov.au>
Sent: Thursday, 8 December 2022 4:56 PM
To: Lachlan McWha <LMcWha@deltacoal.com.au>
Subject: RE: Chain Valley Colliery Benthic Communities Management Plan - Stakeholder Consultation

Hi Lachlan,

Council has reviewed the Benthic communities management plan and has no comments.

Regards,
Geoffrey Keech
Senior Development Planner

LAKE MACQUARIE CITY
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DPI Fisheries Consultation

Thank you for referring Delta's Benthic Communities Management Plan (BCMP) V9 to DPI Fisheries for comment.

DPI Fisheries supports the proposal to reduce monitoring frequency from twice yearly to annual only.

We have reviewed the report and note that some statistical analyses of the benthic data don't reflect what is written in the BCMP, and that there are potential opportunities for improvement so that analyses are fit for purpose in future iterations of the monitoring program.
The issues we have identified with the BCMP and recent analysis of data by EMM can be summarised as follows:

- Data analysis Table 4 of the BCMP does not entirely match up with text in Section 5.2 of the BCMP. In Table 4, it is indicated that BIOENV would be done. This analysis matches environmental variables against biotic data enables analysis of the extent to which the physio-chemical data is related to the observed biological patterns. However, text about this analysis does not appear in Section 5.2. Further this analysis doesn't appear to have been done in the EMM report. It appears that EMM used a PCA with vectors as a substitute for BIOENV but the reasons for this change is not clarified or justified in the BCMP or the EMM report.
- The BCMP indicates that two-way ANOVAs (analysis of variance) and ANOSIM (analysis of similarity) techniques are to be used, yet the EMM report only uses ANOSIM. ANOVAs would offer more opportunity than ANOSIM to look at the time series in the data (see below). EMM justifies ANOSIM as an analogue for ANOVA but DPI Fisheries does not agree with this.
- The EMM '2 Methods' section indicates that a 2-way crossed design ANOSIM, sites within treatments, was used, yet the results indicate a 2-way nested design was used. We have assumed that the latter test was used.
- In the ANOSIM it appears that samples for years between 2016-2022 have been pooled for each treatment (control, reference, impact). It is not clear why this has been done when a time series of information is available. By averaging the treatments over the 6 year period, the sensitivity of testing for changes over time is lost.
- In the ANOSIM it appears that temporal changes in some sites have been interpreted by visualisation of the data in plots (ie section 3.7 of the EMM report) yet EMM have made some interpretation of these plots/data as "significant" or otherwise. Without statistical significance as determined through statistical testing, such terminology should not be used given it is misleading.
- It may be more appropriate to have undertaken the ANOSIM analyses, as well as any future analyses for the ongoing program, using 3-way multivariate ANOVA with three factors – Treatment, Year and Site. EMM uses the software Primer and this type of analysis can be done in Primer with a PERMANOVA add-on.
- The PCA (EMM fig 3.1) would be better done with a PCO (principle co-ordinates analysis, also in Primer).

Please get in touch if you have any further questions.

Kind regards,

Cherie
Cherie Colyer-Morris (she/her) | Fisheries Manager – Coastal Systems Unit
NSW Department of Primary Industries | Fisheries
Port Stephens Fisheries Institute | Taylors Beach Road, Taylors Beach, NSW 2316

NSW GOVERNMENT Department of Primary Industries

Our Ref: C23/83 21/02/2023

Your Ref: PAE-54772715

Department of Planning, Industry and Environment
c/o: Major Projects Portal

To Whom It May Concern,

Request for comments on Chain Valley Colliery, Benthic Communities Management Plan v8 (SSD-5465-PA-110)

Thank you for your referral seeking comments on the Chain Valley Colliery, Benthic Communities Management Plan v8 from DPI Fisheries, a division of NSW Department of Primary Industries.

DPI Fisheries is responsible for ensuring that fish stocks are conserved and that there is no net loss of key fish habitats upon which they depend. To achieve this, DPI Fisheries ensures that developments comply with the requirements of the *Fisheries Management Act 1994* (FM Act) (namely the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act, respectively), and the associated *Policy and Guidelines for Fish Habitat Conservation and Management (2013)*. In addition, DPI Fisheries is responsible for ensuring the sustainable management of commercial, recreational and Aboriginal cultural fishing, aquaculture, marine parks and aquatic reserves within NSW.

DPI Fisheries has reviewed the Benthic Communities Management Plan v8 and has no comments to provide.

If you have any queries, please contact Cherie Colyer-Morris, Fisheries Manager, Coastal Systems (Central) at cherie.colyer-morris@dpi.nsw.gov.au.

Yours sincerely,

C. Colyer-Morris

Cherie Colyer-Morris
Fisheries Manager, Coastal System

DPE Consultation

Department of Planning and Environment

NSW GOVERNMENT

Our ref: SSD-5465-PA-121

Mr Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd (t/as Delta Coal)
PO BOX 7115 Mannering Park NSW 2259

19/09/2023

Subject: Chain Valley Colliery (SSD 5465) Benthic Communities Management Plan Revision v9

Dear Mr McWha

I refer to the Chain Valley Colliery Benthic Communities Management (v9) submitted in accordance with Condition 7(h), Schedule 4 of Development Consent SSD-5465 (Modification 4) for the Chain Valley Colliery Extension Project. I note the plan:

- has been prepared in consultation with parties required to be consulted with;
- has been reviewed by Delta Coal and no issues have been raised with the Department;
- has been reviewed by the NSW Biodiversity Conservation Division, Lake Macquarie City Council and Department of Fisheries; and
- contains the information required by the conditions of approval.

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions in Condition 7(h), Schedule 4 of Development Consent SSD-5465 (Modification 4).

Accordingly, as nominee of the Planning Secretary, I approve the Chain Valley Colliery Benthic Communities Management (v9) (July 2023).

You are reminded that if there are any inconsistencies between the plan and the conditions of approval, the conditions prevail. Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Melissa Dunlop on 02 8229 2941 or melissa.dunlop@dpie.nsw.gov.au.

Yours sincerely

JEvans

Jessie Evans

Director, Resource Assessments
Resource Assessments

As nominee of the Planning Secretary

DPIE-BCD

NSW GOVERNMENT

Department of Planning and Environment

Your ref: SSD-5465
Our ref: DOC23/778475

Mr Lachlan McWha
Environmental Compliance & Approvals Coordinator
Delta Coal
Chain Valley Colliery
Off Construction Rd (Off Rutley's Rd)
Mannering Park NSW 2259

By email: LMcWha@deltacoal.com.au

Dear Mr McWha

Chain Valley Extension Project (SSD-5465) – Review of Benthic Communities Management Plan

I refer to the e-mail dated 31 July 2023, in which Biodiversity and Conservation Division (BCD) was invited to comment on the *Chain Valley Colliery: Benthic Communities Management Plan* (BCMP) with a request to consider reducing the monitoring frequency from twice-yearly (Spring and Autumn) to annual only (Autumn only).

BCD has reviewed the report and provides the following comments:

- Given that the six-monthly monitoring program spanning 2012 – 2022 did not indicate any significant changes to the benthic communities in the existing Zone A and B subsidence areas over time, the request to reduce the monitoring frequency is appropriate.
- The selection of *Autumn* for the annual sampling is appropriate as it will avoid seasonal extremes that may impact these communities (e.g., temperature).
- The frequency of monitoring should be reviewed however if future results indicate impacts to benthic assemblages attributed to Chain Valley Colliery operations. Delta Coal has developed a Trigger Action Response Plan for the management of benthic communities (TARP 00156), which states that if significant environmental impact is recorded, a review of the BCMP will be undertaken to determine if revisions are required. The advice is that this TARP is sufficient to manage the proposed changes in the survey frequency.

If you have any further questions about this issue, please contact Steven Crick, Senior Team Leader – Planning, on 02 4927 3248 or at huntercentralcoast@environment.nsw.gov.au.

Yours sincerely



Neil Kelleher
Senior Team Leader Water Floodplain Coast
Hunter Central Coast Branch
Biodiversity and Conservation Division

1 September 2023

Steven Crick

From: Steven Crick
Sent: Tuesday, 28 February 2023 6:06 PM
To: LMcWha@deltacoal.com.au
Cc: OEH ROD Hunter Central Coast Mailbox
Subject: RE: For Action - Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - Benthic Communities Management Plan_V8 (SSD-5465-PA-110) (Central Coast,Lake Macquarie City)

Hi Lachlan

BCD has reviewed the Benthic Communities Management Plan and has no comments.

Regards

Steven Crick
Senior Team Leader – Planning
Hunter Central Coast Branch
Biodiversity & Conservation Division
Department of Planning & Environment

6 Stewart Avenue, Newcastle, 2300
Locked Bag 1002, Dangar, 2309

Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

This BCMP has been prepared in accordance to Schedule 4, Condition 7(h) of SSD-5465, which states the requirements of the BCMP and what it must address. **Table A2** outlines the requirements of the BCMP and where this document addresses these requirements.

Table A2: Requirements from Chain Valley Colliery Development consent SSD-5465

<table>
<tr><th>Condition No.</th><th>Requirement</th><th>Relevant section of this document</th></tr>
<tr><td></td><td>Schedule 2 Administrative Conditions</td><td></td></tr>
<tr><td>23</td><td>•
Staging, combining and updating strategies, Plan or Programs

With the approval of the Planning Secretary, the Applicant may: (a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program); (b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined); (c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and (d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining mining consent or approval, in common ownership or management.</td><td>Section 8</td></tr>
<tr><td></td><td>Schedule 3 Specific Environmental Conditions</td><td></td></tr>
<tr><td>2</td><td>Performance Measures- Natural Environment

The Applicant shall ensure that the development does not cause any exceedance of the performance measures in Table 6 to the satisfaction of the Planning Secretary.

Table 6: Subsidence Impact Performance Measures
<table>
<tr><td colspan="2">Biodiversity</td></tr>
<tr><td>Threatened species or endangered populations</td><td>Negligible environmental consequences</td></tr>
<tr><td>Seagrass beds</td><td>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.</td></tr>
</table></td><td>This document</td></tr>
</table>

	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.*

Notes:

- *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.*

The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent

3	***Offsets*** *If the Applicant exceeds the performance measures in* **Table 6** *and the Planning Secretary determines that: (a) it is not reasonable or feasible to remediate the impact or environmental consequence; or (b) the remediation measures implemented by the Applicant have failed to satisfactorily remediate the impact or environmental consequence; then the Applicant must provide a suitable offset to compensate for the impact or environmental consequence to the satisfaction of the Planning Secretary. Note: Any offset required under this condition must be proportionate with the significance of the impact or environmental consequence.*	**Section 4**
7	***Extraction Plan*** ***(h)*** *include a Benthic Communities Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of*	**This document**

	the potential impacts and/or environmental consequences of the proposed second workings on benthic communities, and which includes: *• surveys of the lakebed to enable contours to be produced and changes in depth following subsidence to be accurately measured;* *• benthic species surveys within the area subject to second workings, as well as control sites outside the area subject to second workings (at similar depths) to establish baseline data on species number and composition within the communities;* *• a program of ongoing seasonal monitoring of benthic species in both control and impact sites;* *• development of a model to predict likely impact of increased depth and associated subsidence impacts and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities' composition, incorporating the monitoring and survey data collected; and* *• updating the model every 2 years using the most recent monitoring and survey data.* *The Applicant must implement the approved management plan as approved from time to time by the Planning Secretary.* *Notes:* *• To identify the underground mining areas approved under this consent referred to in this condition, see Appendix 3.* • *• This condition does not limit secondary extraction under a Subsidence Management Plan approved as at the date of this consent.* • • *The Applicant must implement the Extraction Plan as approved by the Planning Secretary.*	
8	*The Applicant must ensure that the management plans required under conditions 7(g)-(j) above include: (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this consent; and (b) a detailed description of the measures that would be implemented to remediate predicted impacts*	**Section 4 and 6**

Appendix 8 Seagrass Management Plan

Environmental Management System

Chain Valley Colliery

Seagrass Management Plan

Reviewed	Lachlan McWha – Delta Coal
Authorised by:	Lachlan McWha – Delta Coal Environmental Compliance & Approvals Coordinator
Date:	12 October 2022

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1 Introduction

Chain Valley Colliery (CVC) and Mannering Colliery (MC) are underground coal mines on the southern side of Lake Macquarie, approximately 60 kilometres (km) south of Newcastle and 80 km north of Sydney (**Figure 1**). An underground linkage within the Fassifern Seam is approved between CVC and MC, which enables coal extracted at CVC to be transferred to, and handled at, MC.

Great Southern Energy Pty Ltd, trading as Delta Coal (DC) became the owner and operator of CVC and the operator of MC on 1 April 2019. Prior to the purchase by Great Southern Energy Pty Ltd, CVC was owned and operated by LakeCoal Pty Ltd (LakeCoal). LakeCoal also operated MC under an agreement with the owners of the mine; Centennial Mannering Pty Limited, a wholly owned subsidiary of Centennial Coal Company Limited.

CVC operates under Development Consent SSD-5465, as modified (most recently on the 5th August 2021, Modification 4), 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), which relates to State Significant Development (SSD). The consent permits the extraction of coal by bord and pillar (First Workings) and Miniwall (Second Workings) mining methods within the Fassifern Seam at a maximum rate of 2.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal, with all Second Workings confined to areas under the Lake Macquarie water body.

1.1 Project description

CVC is located near Mannering Park and is accessed via the public Ruttleys Road and Construction Road, a private road which services CVC and VPPS. The current development consent boundary includes an area of approximately 1,425 hectares (ha) which straddles the boundary of Lake Macquarie and Central Coast local government areas (LGAs). CVC's pit top area is located within the Central Coast LGA, adjacent to VPPS, in an existing industrial area on the southern end of Lake Macquarie and west of Chain Valley Bay.

Underground mining at CVC commenced in 1962, and since that time has extracted coal from three seams; namely, the Wallarah Seam, the Great Northern Seam and the Fassifern Seam, using a combination of bord and pillar and miniwall mining methods. Current mining activities are generally within the Fassifern Seam. An underground linkage within the Fassifern Seam between CVC and MC enables coal extracted at CVC to be transferred and handled at MC.

Miniwall mining methods were previously utilised at CVC, however extraction has since ceased via miniwall mining as of September 2021 with bord and pillar mining methods utilised thereafter.

Figure 1: Local Context



1.2 Purpose

The purpose of this Seagrass Management Plan is to:

- Provide a system to manage the potential impacts and/or environmental consequences of proposed secondary extraction methods on seagrass beds;
- outline details of the seagrass monitoring data collected;
- outline subsidence prediction methodology;
- identify seagrass monitoring locations;
- identify reporting requirements;
- detail seagrass management measures;
- identify the requirements for incident or exceedances reporting and reviews of the document; and
- identify persons responsible for implementation of requirements.

This Seagrass Management Plan is an element of the Delta Coal (DC) Environmental Management System (EMS).

1.3 Consultation

The original version of this Seagrass Management Plan was provided to OEH, LMCC and DPI Fisheries for comment. Both LMCC and DPI Fisheries reviewed the Seagrass Management Plan, with comments from DPI Fisheries provided on the 28th June 2013. At that time DPI Fisheries had no objection to the plan being implemented as written. Comments from Lake Macquarie City Council were received on the 19th July 2013, which were addressed and incorporated into the document, this final version was then sent back to Council who confirmed on the 19th August 2013 that the changes had addressed their comments. The changes made previously to address Council's comments remain in the current version.

Revision 2 of the draft Seagrass Management Plan was provided to OEH, DPI Fisheries and LMCC on the 12th March 2014, with comments on the draft plan requested back by the 1st April 2014. The only response received was from OEH, dated the 21st March 2014. The OEH noted that while they encourage the development of such plans, they do not approve or endorse these documents and accordingly no comments were provided.

Revision 3 of the Seagrass Management Plan was sent to OEH, DPI Fisheries and LMCC on 4 November 2016 for review and comment. All three agencies provided comments on the revised Plan. LMCC and DPI Fisheries confirmed that the document was acceptable in its revised form while OEH noted that while they encourage the development of such plans, they do not approve or endorse these documents and accordingly no comments were provided on the content of the Plan.

Revision 4 of the Seagrass Management Plan was provided to OEH, DPI Fisheries and LMCC on 26 February 2018 with the Extraction Plan application for Chain Valley Colliery's Northern Mining Area (NMA).

Revision 5 of the Seagrass Management Plan was sent to OEH, DPI Fisheries and LMCC in May 2019. On the 5 June 2019 DPI Fisheries responded that the Seagrass Management Plan was adequate. On 5 June 2019 OEH noted that they do not approve or endorse these documents and accordingly no comments were provided on the content of the Plan.

Revision 8 of the Seagrass Management Plan was sent to DPI-Fisheries, OEH, DPIE and LMCC on 27 November 2020.

A summary of the comments received, and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**. This plan was approved by DPIE on the 6 April 2021 as part of the Miniwall S5 and Northern Pillar Area extraction plan.

Table 1: Consultation Summary (Revision 9)

Stakeholder	Comments	Response/Action
DPI- Fisheries	• DPI Fisheries has no objections or comment as there appears to be no proposed impacts on fish or fish habitat.	• Nil required.
NSW DPIE-BCD	1. Methods for measuring seagrass functioning need to be described in detail. 2. Additional detail is required to explain the changes in seagrass cover above the chain valley colliery. The BMP [Biodiversity Management Plan] states that there has been an increase in seagrass cover but additional data and evidence is required to validate these statements. 3. BCD recommends that additional details are added or retained to clarify aspects of the BMP. 4. BCD recommends clarification of Management Practices in Section 4.1.	1. Section 5 revised, however, beyond seagrass meadow size and species distribution, the methods for recording density of growth, bio-fouling, the presence of algae and the number of large bi-valve (*Pinna menkei*) is also recorded, these aspects, along-side size and distribution of seagrass beds provides the method for measuring seagrass functions. 2. Section 5.4 added to the Management Plan to validate statements regarding increases in seagrass cover percentages. 3. Section 3.2 revised, Section 3.3 revised. 4. Section 4.1 removed as it was not required under Section 4.
Department of Regional NSW - Mining Exploration & Geoscience (MEG)	• No issues / comments	• Nil required.
DPIE-Resource Assessments	• TBD	• TBD
LMCC	• No comments	• Nil required.
Combined CVC and MC Community Consultative Committee	• No comments	• Nil required

2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities. A number of legislative requirements, government policies and guidelines are applicable. Key items relevant to this management plan are:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Mining Act 1992*;
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*; and
- Department of Primary Industries (2013), *Policy and guidelines for fish habitat conservation and management*.

Delta lands are within the LMCC and Central Coast Council local government areas (LGAs).

2.2 Development Consent SSD-5465 (as modified)

This management plan has also been completed to satisfy the requirements of Development Consent SSD–5465 (Modification 4), Schedule 4, Condition 7(i) and Schedule 4, Table 8, which states:

"7. The Applicant must prepare an Extraction Plan for all second workings on site, to the satisfaction of the Planning Secretary. Each Extraction Plan must:

(i) include a Seagrass Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on seagrass beds, and which includes:

- a program of ongoing monitoring of seagrasses in both control and impact sites; and
- a program to predict and manage subsidence impacts and environmental consequences to seagrass beds to ensure the performance measures in Table 8 are met."

In addition to the above, Condition 2 within Schedule 4 of SSD-5465 (Modification 4) also requires that:

"The Applicant must ensure that the development does not cause any exceedance of the performance measures in **Table 7** to the satisfaction of the Planning Secretary."

The relevant seagrass requirements from Table 8 within Schedule 4 of the Development Consent, including the relevant notes, are recreated in **Table 2**.

Table 2: Subsidence Impact Performance Measures - Natural and Heritage Features

Biodiversity	
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.

Notes:

- *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.*
- *The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.*

Seagrass related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

3 Background

3.1 Lake Macquarie

Lake Macquarie is the largest saline lake in New South Wales. It lies on the central coast between Sydney and Newcastle within the local government areas of Wyong and Lake Macquarie. Lake Macquarie has a catchment of 700 km^2 and a water surface area of 125 km^2 (Bell & Edwards, 1980). The lake has a permanent entrance to coastal waters at Swansea and has an average depth of around 6 m (Laxton, 2005).

The catchment of Lake Macquarie is largely rural with large areas of bush land and grazing land. The shoreline of Lake Macquarie is heavily urbanised, especially the eastern, western and northern shorelines. The region has a relatively long history of coal mining and power generation, with mining occurring since the late 1800s and the first power station at Lake Macquarie commencing operations in 1958.

3.2 Seagrass Communities

Lake Macquarie contains approximately 10% of the total area of seagrass beds in NSW (DPI 2007). The following four species of seagrass are reported to occur in Lake Macquarie:

- eelgrass (*Zostera capricorni*);
- paddle weed (*Halophila ovalis*);
- *Ruppia sp.*; and
- strapweed (*Posidonia Australia*), which is listed as an endangered species under the *Fisheries Management Act, 1994*.

Seagrass distribution within estuaries is naturally influenced by light penetration, depth, salinity, nutrient status, bed stability, wave energy, estuary type, and the evolutionary stage of the estuary. Light is a major limiting factor for the growth of seagrasses and the effects of shading either by artificial structures or increased turbidity associated with sediment re-suspension are common light reducing factors in estuaries (BioAnalysis, 2008).

In 2007, LakeCoal engaged Laxton Environmental Consultants to identify environmental factors including seagrasses, benthic fauna and bathymetry. The study area was the area east of Mannering Park where it was found that the seagrass beds were composed of *Zostera capricorni* (eelgrass) only. The study also identified that seagrass beds within the area extended from the foreshore to a maximum depth of approximately 2m below water level, it was concluded that any mining beneath the beds could lead to subsidence which would cause a decline of seagrasses along the outer edge of the seagrass beds. It was also noted that the distribution and density of seagrass beds in Chain Valley Bay could change due to events unrelated to underground coal mining.

Since 2008, the following seagrass species have been identified along transects within the annual CVC seagrass monitoring program:

- 'eelgrass' (*Zostera capricorni*) short leaved and long leaved forms;
- 'paddle weed' (*Halophila ovalis*);

Annual surveys of seagrass communities at Summerland Point, Chain Valley and Crangan Bay have been undertaken by J.H. & E.S. Laxton - Environmental Consultants Pty Ltd (Laxton Environmental Consultants) on behalf of Delta Coal (and previously LakeCoal) since 2008. Since 2011 seagrass cover has increased progressively as further discussed in Section 5.4 (Seagrass Monitoring Results). Subsequent annual seagrass surveys discovered large and unexplained changes in seagrass cover which were unrelated to underground coal mining, as no mining had subsided seagrass beds since commencement of monitoring. The precise reasons for these longer-term changes in seagrass distribution are not always obvious but may be related to changes in water transparency, salinity, nutrient concentrations and the proliferation of epiphytic algae. Migration of sediment may also change the distribution of seagrasses over time. It is also thought that the cessation of commercial fishing in Lake Macquarie has positively contributed to the regrowth of seagrass beds.

Seagrass is a vital component of Lake Macquarie's marine ecosystem. It captures the sun's energy and converts it into organic matter that may be utilised by the whole food chain. Destruction of seagrass beds could lead to a reduction in available organic matter for marine flora and faunal species. Seagrass also improves water quality as it decreases sediment within the water column and takes in many nutrients and heavy metals entering the waterway. Hence, a reduction in seagrass population may also result in decreased water quality.

Figure 2: General Layout of the Chain Valley Colliery Mining Domain



3.3 Seagrass Mapping

Surveys have shown that the short leaved and long leaved forms of *Zostera capricorni* present adjacent to the proposed mining operations commence along the lake edge and terminate when water depths approached 2 m.

Further mapping undertaken as part of the Chain Valley Mining Extension 1 Project in 2011/2012, enabled the maximum depths and locations of seagrass to be considered in the mine design. This resulted in the generation of a broader seagrass protection barrier, extending to the proposed mining areas, which was then used to refine the mine design and ensure subsidence impacts to seagrass communities could be avoided. This study found that the communities were dominated by *Zostera capricorni* and that in general, the areas were characterised by patchy meadows of *Zostera*. The seagrass beds were found to exist to a maximum depth of 1.9 m.

Further visual assessments and remapping of seagrass beds within the areas of Sugar Bay, Frying Pan Bay and Point Wolstoncroft was undertaken by LakeCoal, Laxton Environmental Consultants, and Daly Smith Surveyors in February 2018.

Details from these studies have been combined to produce the mapping of seagrass over the entirety of the historic, current and future mining areas, and enabled the seagrass protection barrier to be further defined. The current seagrass mapping is shown on **Figure 3**. Subsidence modelling and predictions are undertaken by specialist geotechnical engineers for each extraction plan. The subsidence predictions and modelling assist the site technical services personnel in the mine design and planning process. The mine design and planning process is fundamental to controlling mine subsidence to consented limits.

The seagrass communities within the entirety of the proposed mining areas have been mapped and the majority of the seagrass beds appear to extend to depths around 2 – 2.5 m. As a result, if mining takes place beneath the seagrass beds, and subsidence takes place, it could be expected that the lower areas of the seagrass beds will potentially retreat with increased depth as a result of reduced light available for photosynthesis.

In light of Condition 7 (i) Schedule 4 of Development Consent SSD-5465 and to ensure the performance measures are met, an essential component of this Seagrass Management Plan is the seagrass protection barrier to ensure that any impacts associated with mining operations are negligible. This barrier is further described in **Section 4.2**.

4 Seagrass Management

4.1 Seagrass Protection Limits

Only first workings are to be undertaken within the seagrass protection barrier and beneath seagrass beds. In these areas, subsidence will be limited to less than 20 mm which is considered to be within normal ground movement and measurement tolerances.

As part of the protection of the lake foreshore, the Colliery holding mining leases require a protection barrier around the foreshore. This is known as the High-Water Mark (HWM) subsidence barrier and is shown on **Figure** 4. The barrier is approximately 130 m wide, but varies based on the depth of cover, and no secondary extraction occurs within this zone.

In addition, to achieve negligible impact on seagrass beds due to subsidence effects, a seagrass protection barrier has been established. This barrier is based on the seagrass mapping and the application of an "angle of draw" of 26.5^{o} from the seagrass area to the coal seam being mined, as depicted in **Figure** 3.Although similar in some locations, the HWM subsidence barrier and the seagrass protection barrier are separate barriers, with the mine layout limited (among other factors) by either barrier at any specific location. The application of the HWM subsidence barrier and seagrass protection barrier is depicted on **Figure** 3.

4.2 Seagrass Management TARP

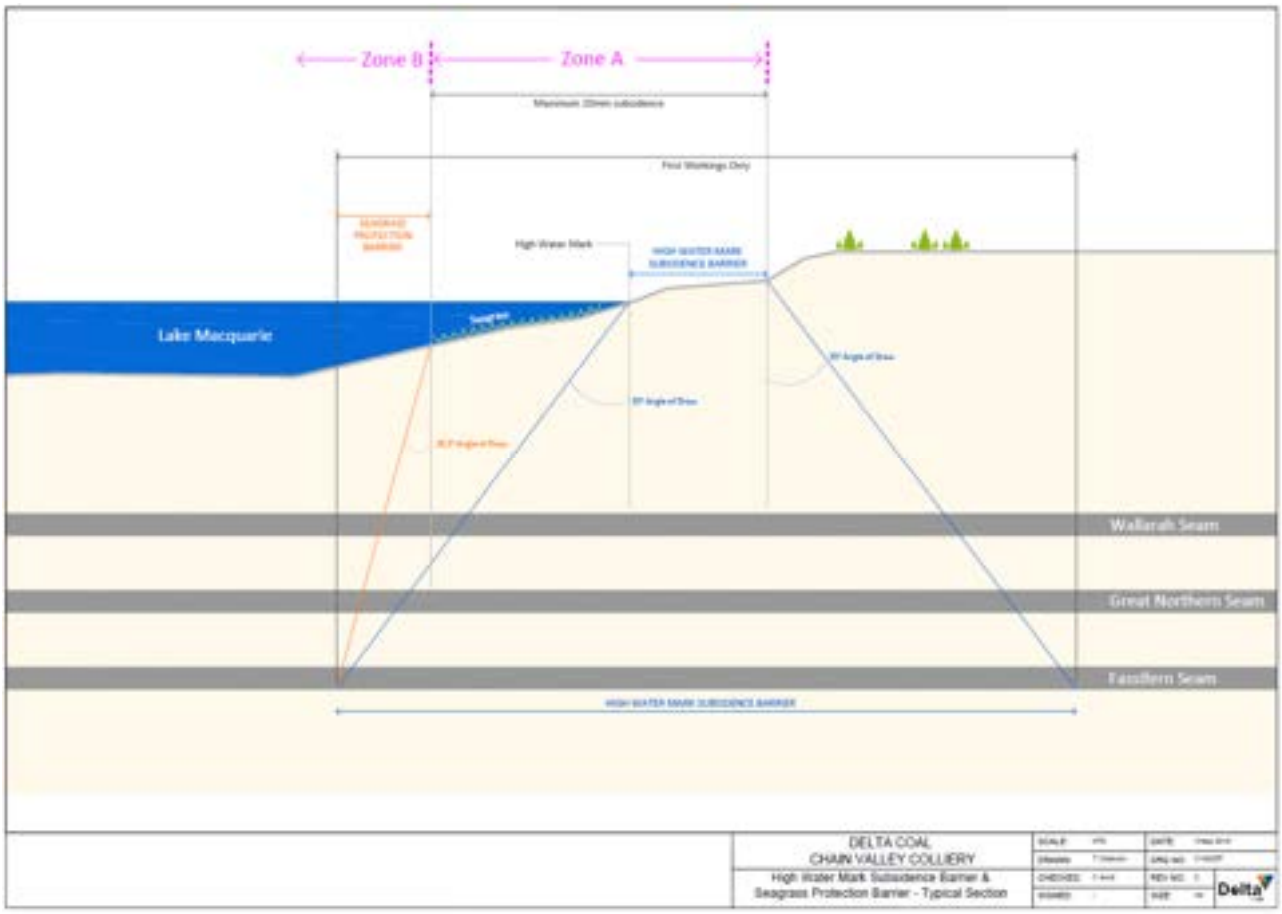
Delta Coal has developed a Trigger Action Response Plan (TARP) for the management of seagrass above mine workings in Lake Macquarie. The TARP is maintained in the Delta Coal document control system as TARP 00157 and is reproduced below.

	NORMAL	LEVEL 1 TRIGGER	LEVEL 2 TRIGGER
LAKE MACQUARIE SEAGRASS MONITORING	No observed change to seagrass above mine workings including: • Negligible change in the size and distribution of seagrasses • Negligible change in the functioning of seagrass beds • Negligible change to the composition or distribution of seagrass species within seagrass beds	Observed change to seagrass above mine workings including: • Change in the size and distribution of seagrasses • Change in the functioning of seagrass beds • change to the composition or distribution of seagrass species within seagrass beds	Observed change to seagrass above mine workings as a result of mining induced subsidence.
Action / Response	• No response required. • Continue monitoring as detailed in the Seagrass Management Plan.	• Complete investigation to determine the cause of the impact to seagrass. • Continue monitoring as detailed in the Seagrass Management Plan.	• Notify relevant stakeholders of recorded impact to seagrass as a result of mining induced subsidence. • Undertake remedial measures as outlined in the Seagrass Management Plan. • Review of future mine workings to prevent subsidence of seagrass beds, including extents of the seagrass protection barriers. • Review of Seagrass Management Plan and determine if revisions are required to the plan.

Figure 3: Mapped Seagrass and Protection Barrier



Figure 4: Protection Barrier Schematic cross section



Despite the above barriers, which are in place to protect the seagrass and foreshore areas, monitoring thresholds have been established based on observable change to seagrass beds. The following triggers has been set:

1. 20% decline in condition from the base year survey (i.e. earliest survey prior to mining occurring nearby).

The DC Environmental Compliance & Approvals Coordinator will notify DPI Fisheries, Lake Macquarie City Council and the Department of Planning and Environment if the above impact thresholds is exceeded. If deemed necessary by any of the parties, a meeting will be convened to discuss the results and determine any required future action.

4.3 Seagrass Impact Mitigation

If through the monitoring program, impacts are found to have occurred to seagrass beds (as identified in **Table 4**) and loss of seagrass habitat has been determined to have occurred as a direct result of mining-induced subsidence, DC would commit to undertaking remediation strategies to replace an equal area of any loss of seagrass habitat that has occurred.

DC's approach to managing seagrass is aimed at protection. However, if an investigation were to identify that an exceedance or incident has occurred that was a direct result of the mining activities and associated subsidence, then DC would develop a remediation plan which would be submitted to DPI Fisheries, identifying the proposed remediation strategy. The strategy would identify proposed remediation measures which could include:

- Transplanting existing communities with additional fast growing locally occurring seagrass plants;
- Transplanting aquaria grown seedlings,
- Seeding, stapling, plugging and anchoring
- Regrading, topographical restoration; and/or
- Fertilising, to stimulate lateral ingrowth of seagrass communities.

The exact method of remediation would be determined based on the existing integrity of the seagrass beds, existing species and specific impacts that have occurred. The remediation strategy would be developed in consultation with DPI Fisheries and be "site specific" to ensure the most appropriate remediation methodology is implemented.

Should remediation on-site not be viable, mitigation could be undertaken at other sites within Lake Macquarie in consultation with DPI Fisheries and LMCC. Work would be completed to offset the impact arising as a result of mining activities.

5 Seagrass Monitoring

Monitoring of seagrass is undertaken to assess the health and composition of seagrass communities within areas in the vicinity of Chain Valley Colliery underground coal operations within Lake Macquarie.

The seagrass monitoring program reports on any changes in seagrass communities over time. To achieve this, the following will be undertaken:

- an annual survey of the study area with 50 seagrass transects using differential GPS survey methods. These differential GPS survey methods will establish the precise location of seagrass transects for repeatability of the surveys;
- A measurement of water quality and recording of environmental conditions experienced/observed during the study;
- photographic survey of seagrass distribution, density and condition along each transect to be recorded using a video camera enclosed within a waterproof housing and mounted on a floating platform;
- review of photographic surveys by a suitably qualified marine biologist reviewing the seagrass distribution, density and condition along each transect, as well as in comparison to previous survey results; and
- Preparation of an annual seagrass reporting providing detail on the seagrass monitoring program for the annum.

Provided no impact is observed to seagrass as a result of mining induced subsidence for 3 years following under-mining, seagrass monitoring above areas of mine workings will cease. Reports of annual surveys will be sent to the Department of Primary Industries – Fisheries, Lake Macquarie City Council and the Department of Planning and Environment;

The detailed methods to conduct the photographic surveys of seagrass distribution, density and conditions are described below. The same or similar methods should be used in future seagrass surveys to ensure consistency of results.

5.1 Seagrass Surveying

The annual seagrass survey is completed in the winter season, usually in June and is completed by a suitably qualified marine biologist. Physicochemical properties of the water within Lake Macquarie are measured using a calibrated water quality meter which measures:

- Water Temperature;
- Conductivity;
- Salinity;
- Turbidity;
- pH; and
- Dissolved Oxygen.

The survey includes observations on growth characteristics of seagrass beds, fouling of seagrass leaves by algal species with a level of fouling determined for each transect (none, low or heavy fouling). Annual surveys are to compare results

to previous years surveys to determine any change in the coverage or composition of seagrass beds, and plausible causes of potential changes.

Seagrass transects are located via GPS equipment to ensure repeatability and comparable results for annual surveys. Two GPS measurements are collected for each transect, an inner portion and an outer portion, seagrass transects follow a straight line between the inner and outer portions of each transect.

Historically, depth surveying of seagrass beds was undertaken, however, results did not prove repeatable to acceptable tolerances (i.e. less than ±20mm) due to shifting sediments. Seabed height is now considered within foreshore monitoring, where by any exceedance of the 20 mm subsidence limit for foreshore monitoring would also be considered as an exceedance of the 20 mm subsidence limit within seagrass beds. Consideration is also made within bathymetric surveying, while this survey method isn't completed in shallow waters where seagrass beds exist, it is undertaken over secondary extraction areas and will provide indication of potential subsidence extending beyond predicted impact areas.

5.2 Seagrass Photography

A video camera fitted with a wide conversion lens and enclosed in an underwater housing is used to capture the video footage.

The camera in the underwater housing is mounted vertically in the centre of a 1 m long surfboard. This rig is towed alongside a workboat. Experimentation revealed that the best photographic results are obtained when the boat and photographic rig were pulled very slowly along the transect line on windless days.

The water depth along most of the transect lines ranges from around 0.5 to 2 m (depending on the lake level). At the end of the transect line the water depth could be around 2 m. Transect lines are photographed from the outer end to the inner end. The beginning of each transect is marked by photographing a plate with the transect number printed in large type.

At the end of each day's photography, the hard drive of the video camera is downloaded, the film is paused at around 1m intervals along the transect line. Each still frame is examined and the following information is recorded on a data sheet:

1. The file name and number of the video segment being examined;
2. The transect number and date the video was taken;
3. The percentage areas occupied by the following organisms in each still or quadrat was determined:
   - (a) % area occupied by long leaved seagrass (*Zostera capricorni*);
   - (b) % area occupied by short leaved seagrass (*Zostera capricorni*);
   - (c) % area occupied by the small seagrass (*Halophila ovalis*);
   - (d) degree of fouling of the seagrass leaves by algae 1=no fouling, 2=light fouling, 3=heavy fouling;
   - (e) % area occupied by the large brown alga (*Sargassum* sp., *Hormosira banksii* or *Cystoseira trinodis*);
   - (f) % area occupied by filamentous and thallous algae (green or brown algae);
   - (g) Number of the large bivalve *Pinna bicolor;*
   - (h) % area of uncolonised (by macroscopic epibenthos) ground (bare ground).

At the end of the analysis of the photographs, the results are entered into a work sheet and mean values for each category of organism are calculated.

5.3 Monitoring Locations

Monitoring locations have been chosen based on the proposed mining activities that will be covered by the Seagrass Management Plan, over time, as this management plan is updated to reflect future mining locations, it is anticipated that additional monitoring transects will be incorporated and others removed from the monitoring regime as time progresses. More specifically, the monitoring locations proposed to be monitored are those that are adjacent to past, current and proposed mining activities that are within the review period of this management plan, as well as monitoring of several control stations.

The monitoring locations are substantially derived from the original experimental and control transects were selected by Laxton Environmental Consultants and JSA Environmental Pty Ltd who completed the Marine Ecology assessment that supported the Environmental Impact Assessment for the SSD-5465 Development Consent. An additional 15 transects were added to the seagrass monitoring program as part of the latest revision to this plan to obtain baseline information within the areas of Frying Pan Bay, Sugar Bay and the Northern side of Point Wolstoncroft. Two additional Control Points (C5 and C6) were also added to the monitoring program in 2018. The current monitoring locations are described in **Table 3**.

Table 3 - Seagrass Monitoring Transect Areas

ID	Location Description
Transects E1 to E16	Chain Valley Bay and adjacent Summerland Point
Transects T1 to T8	Adjacent Summerland Point
Transects A1 to A6	In Bardens Bay
Transect L1	Above first workings connecting CVC and MC underground
Transects S1 to S6	Adjacent Sugar Bay
Transects F1 to F7	Adjacent Frying Pan Bay and along Point Wolstoncroft
Transects C1 to C6	Control stations in Crangan Bay and Frying Pan Bay

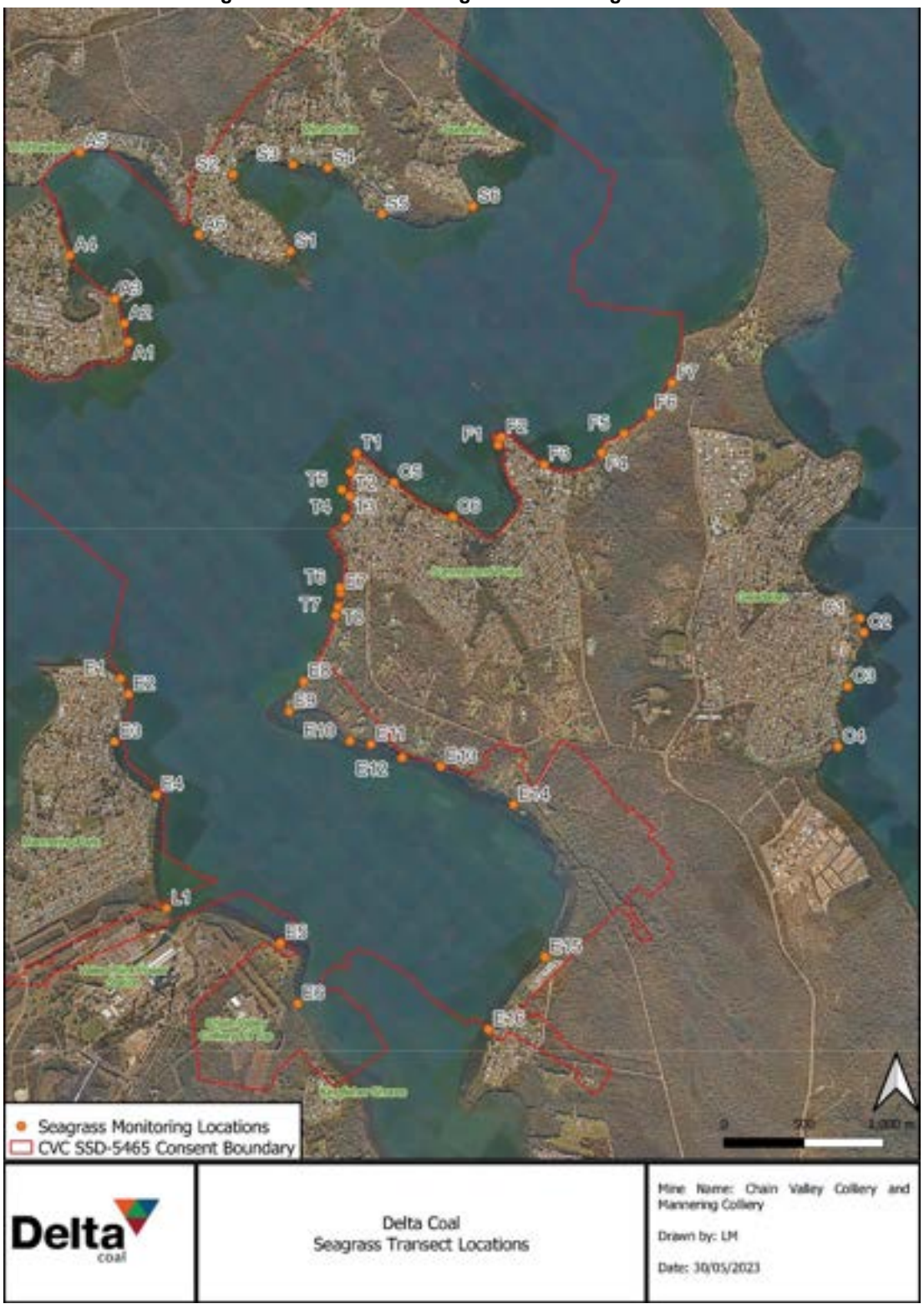
Table 4 shows the GPS locations of the inner ends of the seagrass monitoring transects. Where available, reduced levels of the lakebed measured historically are presented. Transects in Crangan Bay were for control purposes only, i.e. no mining or subsidence impact potential, and accordingly no differential GPS depths/locations are required. Relocation of the control stations is done with hand-held GPS.

Table 4: Seagrass Monitoring Transect Coordinates

Site	Easting	Northing	Reduced Level (m) – inner transect	Reduced Level (m) – outer transect
E1	363986	6331797	-0.68	-1.00
E2	364035	6331701	-0.64	-1.78
E3	363953	6331405	-0.32	-2.34
E4	364220	6331078	-0.46	-1.69
E5	365006	6330164	-0.46	-1.68
E6	365118	6329788	-0.48	-1.21

Site	Easting	Northing	Reduced Level (m) – inner transect	Reduced Level (m) – outer transect
E7	365351	6332350	-0.24	-1.68
E8	365128	6331796	-0.27	-0.99
E9	365040	6331608	-0.19	-1.07
E10	365423	6331427	-0.41	-1.74
E11	365554	6331410	-0.40	-1.09
E12	365750	6331329	-0.59	-1.50
E13	365991	6331278	-0.59	-1.44
E14	366447	6331047	-0.52	-1.34
E15	366657	6330098	-0.39	-1.22
E16	366310	6329644	-0.55	-1.08
T1	365440	6333217	-0.40	-1.15
T2	365403	6333101	-0.70	-1.31
T3	365400	6332952	-0.29	-1.01
T4	365377	6332817	-0.46	-1.12
T5	365350	6332590	-0.42	-1.38
T6	365348	6332380	-0.47	-1.61
T7	365321	6332207	-0.17	-1.64
T8	365337	6332262	-0.20	-1.14
C1	368596	6332235	N/A	N/A
C2	368619	6332147	N/A	N/A
C3	368524	6331811	N/A	N/A
C4	368467	6331435	N/A	N/A
C5	365676	6333038	N/A	N/A
C6	366045	6332831	N/A	N/A
A1	363991	6333894	-0.51	-1.19
A2	363974	6334009	-0.39	-0.81
A3	363912	6334156	-0.33	-1.44
A4	363621	6334445	-0.16	-0.72
A5	363678	6335072	-0.30	-0.96
A6	364423	6334560	-0.14	-0.68
L1	364306	6330322	-1.12	-1.63
S1	365009	6334470	-0.64	-1.78
S2	364642	6334943	-0.28	-1.59
S3	365017	6335008	-0.11	-1.87
S4	365235	6334992	-0.11	-1.73
S5	365575	6334709	-0.69	-1.39
S6	366144	6334765	-0.1	-0.92
F1	366321	6333281	-0.25	-1.31
F2	366342	6333330	-0.24	-1.98
F3	366611	6333163	-0.11	-1.88
F4	366968	6333242	-0.11	-2.45
F5	367106	6333361	-0.33	-2.46
F6	367271	6333493	-0.3	-2.81
F7	367402	6333682	-0.48	-1.4

Figure 5 - Locations of Seagrass Monitoring Transects



5.4 Seagrass Monitoring Results

In July 2008, the first seagrass survey for CVC was conducted to the west of Summerland Point (see **Figure 2**), from Frying Pan Point to Sandy Beach Reserve, Summerland Point, Lake Macquarie. The 2008 seagrass survey provided the baseline data for seagrass distribution, density and condition to which annual surveys are compared. It was determined that seagrass densities in Chain Valley Bay and Crangan Bay ranged from 17.74 to 99.32% of the substratum in the -0.19 to -2.34 A.H.D zone around the shore. Additional transects were added over-time as underground workings progressed.

The 2022 survey report *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW (Results for 2008 to 2022)* (Laxton Environmental Consultants, June 2022) reported seagrass cover along the transects ranged from 79% to 100% of the substratum in 2020.

In general, an improvement in seagrass coverage has been observed throughout the period in which monitoring has been undertaken, specifically from 2011 seagrass cover has increased progressively. Annual seagrass monitoring reports are made available via the Delta Coal website (www.deltacoal.com.au).

Initially the annual increases were treated with some suspicion until it was realised that almost all of the beaches in the study area were used by commercial fishermen as net landing grounds. Nets up to 3km in length were drawn across the lake and hauled up on beaches to extract the various fish species. This fishing effort caused damage to seagrass beds over the 150 years of commercial fishing in Lake Macquarie. Lake Macquarie was established as a recreational fishing zone in 2002 which led to the banning of commercial fishing, subsequently the seagrass beds began recovery, with part of the recovery process considered to have taken place over the period of CVC's seagrass monitoring program.

Results for monitoring of Seagrass over the monitoring period conducted by CVC are presented as **Figure 6** to **Figure 11**.

It is noted that in 2019 a decrease in seagrass coverage was observed during the survey in numerous locations, specifically around Summerland Point and also within the control monitoring transects in Crangan Bay. This decrease was associated with being in a time of very low rainfall, long lived high atmospheric pressure over Lake Macquarie causing a depressed water level of approximately 0.3m for long periods of time. The lowered lake level resulted in increased water temperature over the seagrass beds and increased damaging wave attack during period of strong westerly winds. Less water over the seagrass beds also increased the likelihood of damage by boats, waders and swimmers.

Figure 6 - Changes in percent cover of seagrass in Chain Valley Bay (2008-2022)

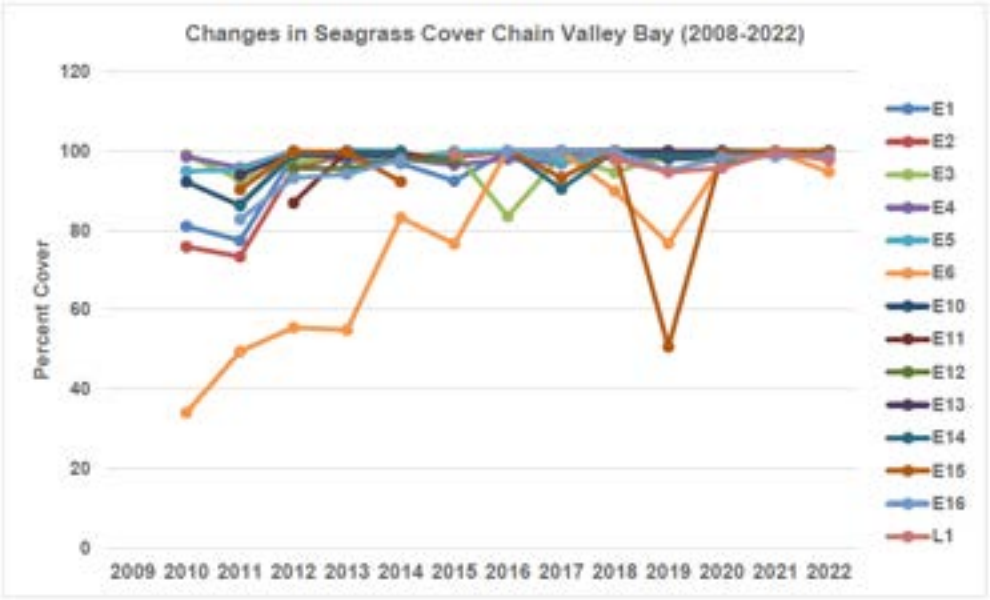


Figure 7 - Changes in percent cover of seagrass along Summerland Point (2009-2022)

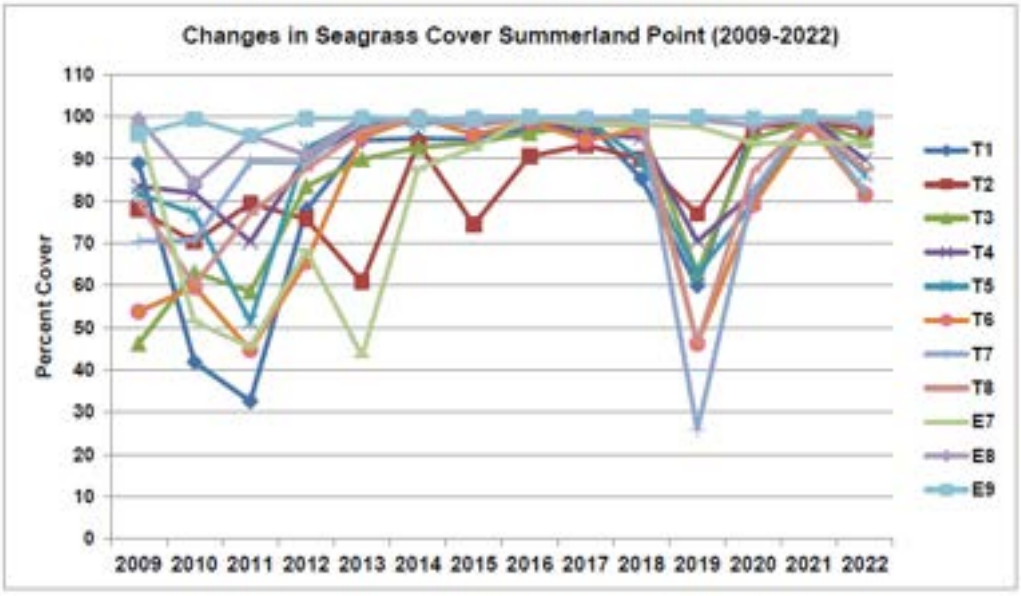


Figure 8 - Changes in percent cover of seagrass along Frying Pan Bay, Summerland Point (2018-2022)

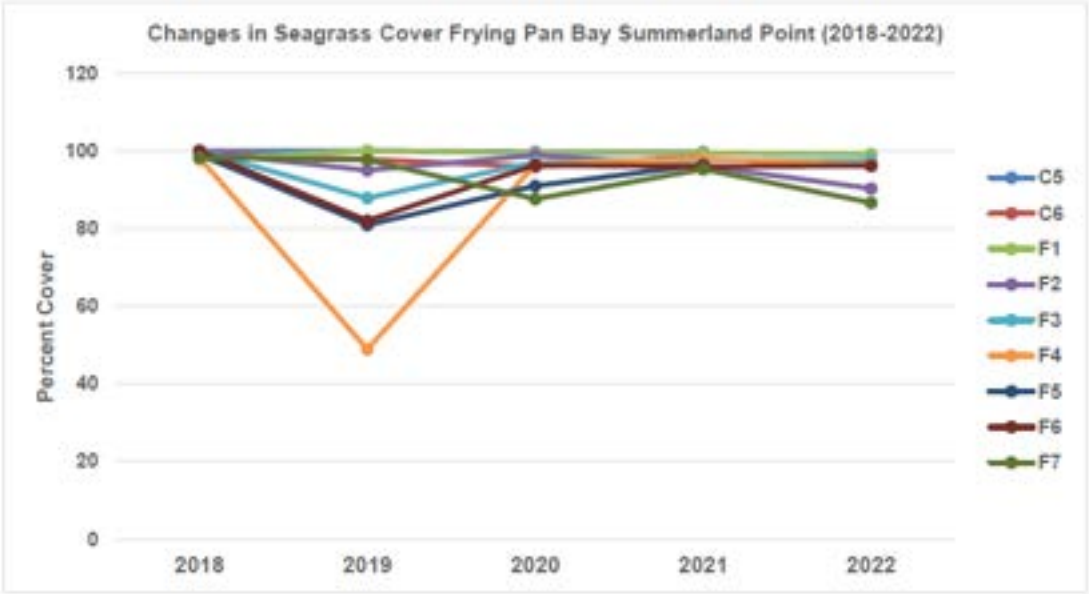


Figure 9 - Changes in percent cover of seagrass in Bardens Bay (2014-2022)

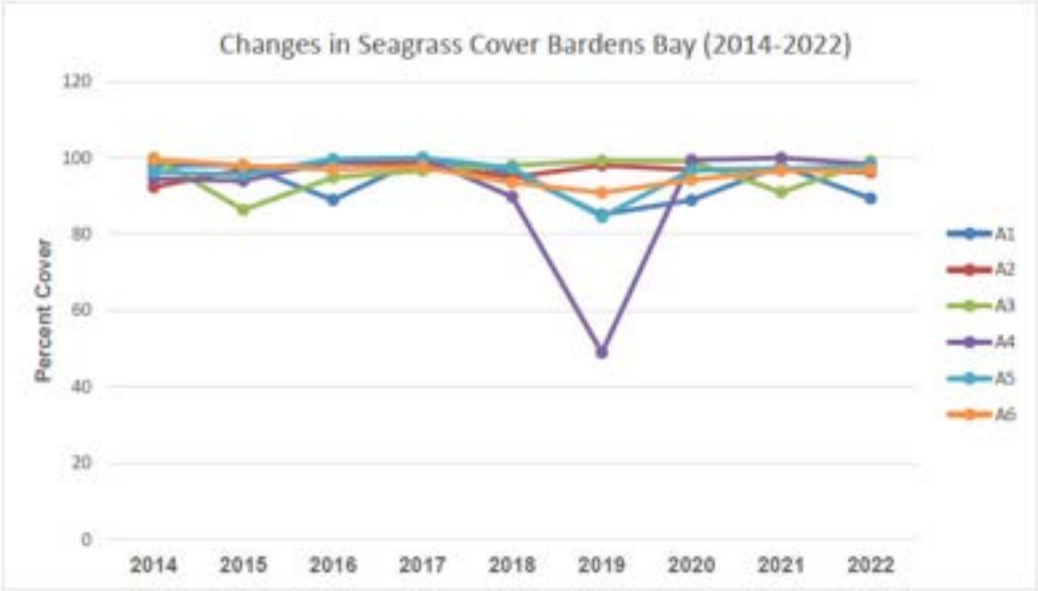


Figure 10 - Changes in percent cover of seagrass in Crangan Bay (2015-2022) (Control Monitoring Location)

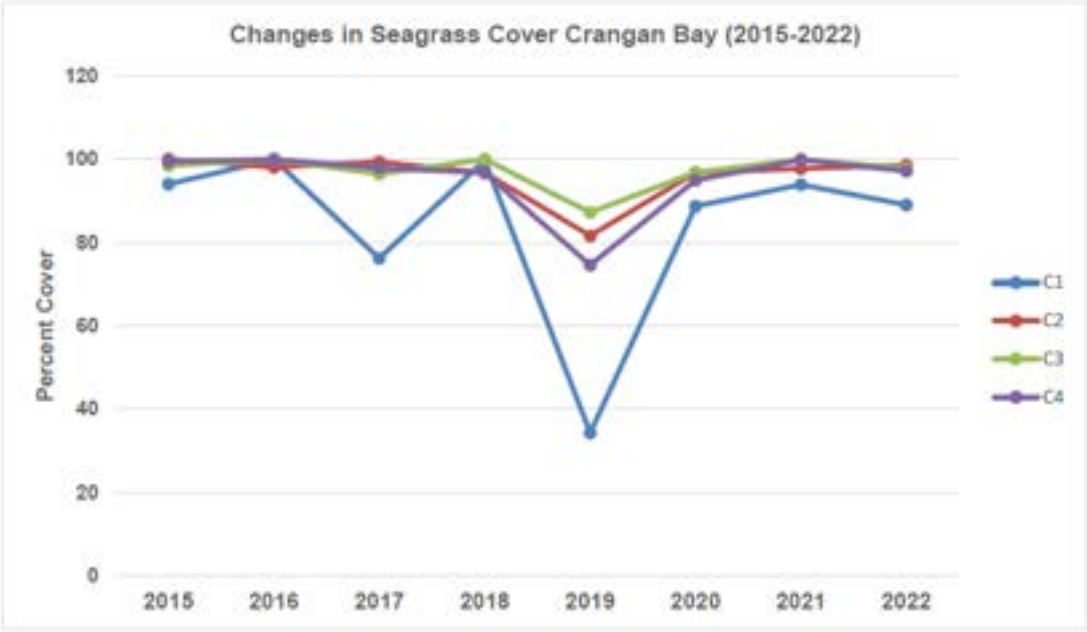
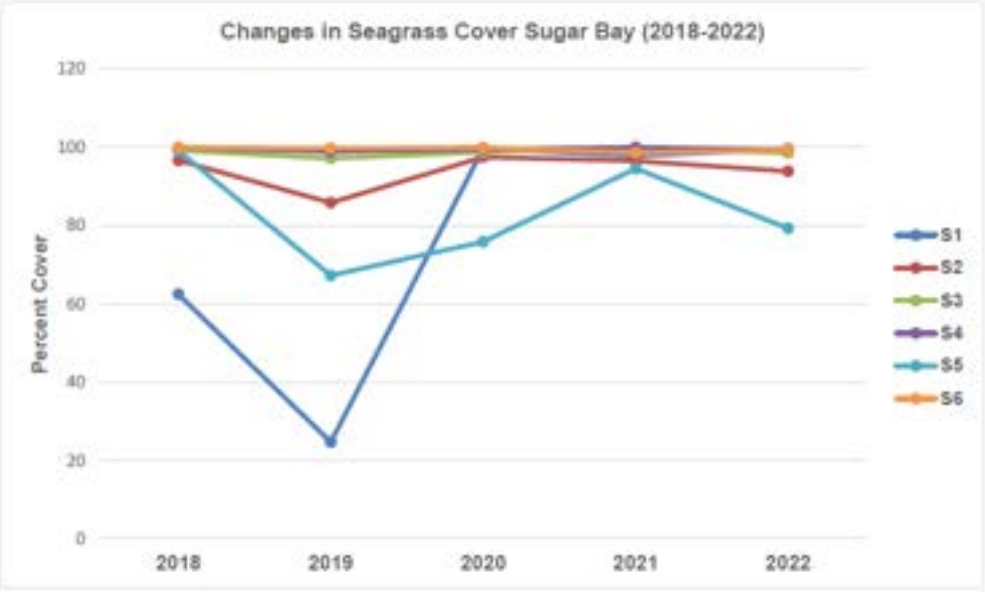


Figure 11 - Changes in percent cover of seagrass in Sugar Bay (2018-2022)



6 Reporting

6.1 Regular reporting

In accordance with Schedule 6, Condition 13(a), DC shall provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of the development consent.

The seagrass monitoring results will be reviewed on an annual basis as survey reports are received to confirm compliance with the conditions specified in the *Subsidence Impact Performance Measures - Natural and Heritage Features* found in **Table 2** and the criteria outlined in **Section 4.1**.

6.2 Annual review

In accordance with Schedule 6, Condition 8, the proponent must review the environmental performance of the development to the satisfaction of the Planning Secretary, by the end of March each year, or other timing as may be agreed by the Secretary. A summary of seagrass monitoring is provided within the Annual Review.

The Annual Review will be forwarded to the relevant authorities including DPIE, EPA, members of the Community Consultative Committee and local Councils (Central Coast Council and Lake Macquarie) and will also be placed on the Delta Coal website along with a summary of environmental monitoring results.

6.3 Incident or Non-Compliance Reporting

If seagrass monitoring reveals that, as a result of mining activities, the criterion outlined in **Section 4.1** have been exceeded, then DC will investigate the cause of the non-compliance. As detailed in Schedule 6, Condition 7 of SSD-5465, DPIE and other relevant agencies will be immediately notified by email (DPIE - compliance@planning.nsw.gov.au) of an incident. Within seven days of becoming aware of a non-compliance, DC must notify the Department of the non-compliance...

A written report will be provided to the DPIE within 7 days of the date of the incident or being made aware of the incident (such as receiving monitoring data).

The report will:

- describe the date, time, location and nature of the observation;
- identify the development (development application number and name), applicable non-compliance schedule and condition;
- describe non-compliance and reasons for non-compliance;
- identify the cause (or likely cause) of the damage;
- describe what action has been taken to date; and
- describe the proposed measures to address the impacts and prevent further such occurrences.

DC will implement the recommendations of the investigation in order to address any potential future incidents. Additional details of the incident reporting process are provided in the Environmental Management Strategy (EMS).

Any incidents or complaints will be recorded and fully investigated to find root causes and corrective actions implemented where necessary.

7 Stakeholder Management, Response and Training

7.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 687 260) through which members of the public can lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters. All complaints are recorded and responded to. The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or if no action was taken, the reason why; and
- follow up contact with the complainant.

7.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review

7.3 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environmental Compliance Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager together with the Environmental Compliance Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in Schedule 5 of SSD-5465.

7.4 Training, Awareness and Competence

Training is an essential component of the implementation phase of this Seagrass Management Plan. Any person or position that has a role or responsibility under this document will be provided with a copy of the document.

8 Audit and Review

8.1 Review and improvement

In accordance with Schedule 6, Condition 5 of SSD-5465, this management plan shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the project approval.

8.2 Audits

Internal and external audits of this document will be carried out as described below. Internal and external audits will be objective and if possible be conducted by a person or organisation independent of the document being audited.

Audits will be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

Delta Coal will review any improvement opportunities and determine if it will implement any actions to address the improvement opportunity, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

An Independent Environmental Audit (IEA) was undertaken during June 2022. In accordance with SSD-5465 Schedule 6, Condition 9, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

9 Records and Document Control

9.1 Records

The Environmental Compliance & Approvals Coordinator (or delegate) will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

9.2 Document Control

This document and all others associated with the Environmental Management System (EMS) shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environmental Compliance Coordinator. Details on document revisions are provided in **Table 5**.

Table 5: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	16/08/2013	Final	LakeCoal	Chris Ellis
2	09/04/2014	Final	LakeCoal	Chris Ellis
3	4/11/2016	Final	LakeCoal	Wade Covey
5	17/06/2019	Update to Delta Coal format and include proposed S2/S3 secondary workings	Delta Coal	Wade Covey Chris Armit Dave McLean
6	10/03/2020	Update to include proposed S4 secondary workings / 2020 Seagrass report	EMM Consulting	Katie Weekes Chris Armit
7	12/5/2020	Update to include DPIE comments	DeltaCoal	Chris Armit
8	27/11/2020 18/01/2021 19/03/2021 6/04/2021	Mine workings update and Modification 3 and MWS5 and Northern Pillar Area Extraction Plan Update for consultation	Delta Coal	Chris Armit

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
		Plan approval from DPIE		
9	12/10/2022	Reviewed following IEA submission and administrative updates.		Lachlan McWha

10 Roles and Responsibilities

Roles and responsibilities specific to completing the requirements of the Seagrass Management Plan are identified in **Table 6**.

Table 6: Seagrass Management Roles and Responsibilities

Role	Responsibilities
Mine Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the Seagrass Management Plan. • Ensure mine layout and workings are as approved, taking into consideration the seagrass barriers
Environmental Compliance & Approvals Coordinator or delegate	• Co-ordinate seagrass monitoring, through the use of differential GPS surveying and photographic monitoring of seagrass beds. • Develop management actions in consultation with regulatory agencies as/if required from the monitoring results. • Review seagrass monitoring results on an annual basis. • Send Annual Seagrass Monitoring reports to DPI Fisheries, DPIE-BCD and DPIE-Compliance • Compile the Annual Review (including a summary of the annual seagrass survey). • Respond to any potential or actual non-compliance and report these as required to regulatory bodies and other stakeholders. • Undertake reviews of this document as per **Section 9** • Undertake or coordinate the required audits of this document, in accordance with **Section 9**. • Notify the DPI Fisheries, Department of Industry – Resources and Energy and Department of Planning and Environment if there are any exceedances in impact thresholds outlined in **Section 4.1** • Ensure complaint handling and response is undertaken, including determination of sources and potential remedial action to avoid recurrence.
Mine Surveyor	• Ensure mine layout and workings are as approved, taking into consideration the seagrass barriers

11 References & Associated Documents

Documents referenced in the preparation of the Seagrass Management Plan are detailed in **Table 7.**

Table 7: References and Associated Documents

Reference type	Document
Australian Standards	AS/NZS ISO 14001:2004 *Environmental management systems – Requirements with guidance for use* AS/NZS ISO 14004:2004 *Environmental management systems – General guidelines on principles, systems and support techniques*
Legislation and regulations	NSW DPI (2007) *PrimeFacts 629 - Seagrasses*. NSW EPA, EPL 1770 *Environment Protection License 1770* SSD–5465 Development Consent SSD-5465 (Modification 3) dated June 2020 for the Mining Extension 1 Project POEO Act 1997 Protection of the Environment Operations Act, 1997
Delta Coal documents	EMS Environmental Management Strategy.
External documents	Bell, F.C. and Edwards, A.R. (1980) *An Environmental Inventory of Estuaries and Coastal Lagoons in New South Wales*. Total Environment Centre. BioAnalysis (2008) *Assessment of seagrasses associated with proposal to expand the Lake Macquarie yacht club in Belmont Bay*. EMM (June 2015) *Chain Valley Colliery Modification 2 Statement of Environmental Effects*, prepared by EMGA Mitchell McLennan (EMM) dated 29 June 2015. Laxton, J.H. (2005) *Water Quality of Lake Macquarie*. J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished Report. Laxton, E. and Laxton, J.H. (August 2007) *Aquatic Biology of Chain Valley Bay Lake Macquarie, NSW*. J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery Laxton, J.H. and Laxton, E. (July 2008) *Seagrass Survey of Chain Valley Bay Lake Macquarie, NSW*. J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E. (2009). *Peabody Energy – Chain Valley Colliery. Aquatic Biology of Domain No. 2 off Summerland Point, Lake Macquarie, NSW.* Emma and John H. Laxton. July 2009 Laxton, J.H. and Laxton, E. (2011). *Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW* (Results from 2008, 2010 and 2011) J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E. (2012). *Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW* (Results from 2008,

	2010, 2011 and 2012) J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E. (2013). *Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW*. (Results for 2008, 2010, 2011, 2012 and 2013). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2014) *Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2014). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2015) *Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2015). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2016) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2016). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2017) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2017). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2018) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2018). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, J.H. and Laxton, E.S. (2019) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2019). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, E.S. (2020) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2020). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery. Laxton, E.S. (2021) *Seagrass Survey of Chain Valley Bay, Summerland Point, Bardens Bay and Crangan Bay, Lake Macquarie, NSW* (Results for 2008 to 2020). J.H. & E.S. Laxton – Environmental Consultants P/L. Unpublished report prepared for Chain Valley Colliery.

12 Definitions

BCD Biodiversity and Conservation Division within the Department (formerly OEH – Office of Environment and Heritage)

CVC Delta Coal - Chain Valley Colliery

DC Delta Coal

DP&E Department of Planning & Environment (former)

DPIE Department of Planning, Industry and Environment

DPI Fisheries Department of Primary Industries NSW Department of Primary Industries – Fisheries

EMS Environmental Management System

EPA NSW Environment Protection Authority

EPL Environment Protection License

EP&A Act *Environmental Planning and Assessment Act 1979*

HWM High Water Mark

LMCC Lake Macquarie City Council

POEO Act *Protection of the Environment Operations Act 1997*

Planning Secretary Planning Secretary under the EP&A Act, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

Appendix 1: Consultation

BCD Consultation

NSW GOVERNMENT

Department of Planning and Environment

Your ref: SSD-5465 MOD3
Our ref: DOC22/1042188-4

Mr Lachlan McWha
Environmental Compliance & Approvals Coordinator
Great Southern Energy Pty Limited (t/as Delta Coal)
By email: lmcwha@deltacoal.com.au

Dear Mr McWha

Chain Valley Colliery Extension project (SSD-5465) – Chain Valley Colliery Seagrass Management Plan

On 25 November 2022 Planning and Assessment Group of the Department of Planning and Environment invited Biodiversity and Conservation Division (BCD) for advice in relation to the Draft *Environmental Management System: Chain Valley Colliery: Seagrass Management Plan* (SMP) (dated 12 October 2022). The SMP was prepared by Delta Coal as a requirement as part of the Extraction Plan as per Schedule 4, Condition 7(i) and Schedule 4, Table 8 of Development Consent SSD-5465. The SMP has been revised following an Independent Environmental Audit conducted in 2022, which now triggers the review by BCD.

BCD has reviewed the SMP and recommends the changes to the document of which the key issues are:

- methods for measuring seagrass functioning is required
- additional details are required to explain changes in seagrass cover mentioned in the SMP
- parts of the SMP require clarification and some typographic errors require correcting.

If you have any further questions about this issue, please contact Robert Gibson, Senior Regional Biodiversity Conservation Officer, on 4927 3154 or at huntercentralcoast@environment.nsw.gov.au

Yours sincerely

Sarah Warner
Acting Senior Team Leader Planning
Hunter Central Coast Branch
Biodiversity and Conservation Division

9 December 2022

Enclosure: Attachments A and B

Level 3, 6 Stewart Avenue, Newcastle West| Locked Bag 1002 Dangar NSW 2309 | dpie.nsw.gov.au | 1

Lake Macquarie City Council Consultation

LAKE MACQUARIE CITY

22 December 2022

Chain Valley Colliery
C/- Delta Coal Environmental compliance and Approvals Coordinator

Dear Lachlan,

Subject: Seagrass management plan post consent review – SSD-5465-PA-102

Thankyou for the opportunity to review the seagrass monitoring plan for Chain Valley Colliery. Council have considered the document and have no comments.

Should you require further information, please contact me on +61 2 4921 0025.

Yours faithfully,

Geoffrey Keech
Senior Development Planner
DA&C - Development

Mining Exploration & Geoscience

MINING, EXPLORATION & GEOSCIENCE
Department of Regional NSW

NSW GOVERNMENT

RDOC22/ 253085
30 November 2022

Lachlan McWha
Coordinator Compliance and Approvals
Delta Coal
lmcwha@deltacoal.com.au

ADVICE RESPONSE: Chain Valley Extension Project - Seagrass Management Plan

Dear Lachlan

I refer to your correspondence dated 25 November 2022 inviting the Department of Regional NSW – Mining, Exploration & Geoscience (MEG) to provide comments on the Chain Valley Extension Project - Seagrass Management Plan.

MEG has reviewed the information supplied and raises no issues/has no further comment.

For further advice on this matter, please contact the Industry Advisory & Mining Concierge unit - Industry Development branch on 02 4063 6860 or mining.concierge@regional.nsw.gov.au.

Sincerely

Adam W. Banister
Senior Advisor Industry Advisory & Mining Concierge
Industry Development
Department of Regional NSW – Mining, Exploration & Geoscience

for

Tony Linnane
Executive Director Strategy, Performance & Industry Development
Department of Regional NSW – Mining, Exploration & Geoscience

DPE Consultation

Department of Planning, Housing & Infrastructure

NSW GOVERNMENT

Our ref: SSD-5465-PA-102

Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd
PO BOX 7115
Mannering Park NSW 2259

23/10/2024

Subject: Chain Valley Colliery Seagrass Management Plan

Dear Mr McWha

I refer to the Seagrass Management Plan submitted in accordance with condition 7 (i), Schedule 4 of the consent for the Chain Valley Colliery (SSD-5465).

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions of consent (SSD-5465).

Accordingly, as nominee of the Planning Secretary, I approve the Seagrass Management Plan (version 9, dated 12 October 2022).

You are reminded that if there are any inconsistencies between the Plan and the conditions of approval, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Kristina Robinson on 02 9860 1543 or at Kristina.Robinson@dpie.nsw.gov.au.

Yours sincerely

James McDonough
Team Leader
Resource Assessments

As nominee of the Planning Secretary

Appendix 2: Development consent summary

Chain Valley Colliery SSD-5465 Summary

Relevant sections of SSD-5465 detail the requirements of the SMP and are reproduced in **Table A2** below along with identification of where the requirements are addressed in this document.

Table A2: Requirements from Chain Valley Colliery Development Consent (SSD-5465)

<table>
<tr><th>Condition No.</th><th>Requirements</th><th>Relevant section of this document</th></tr>
<tr><td colspan="3">Schedule 4 Environmental Conditions – Underground Mining</td></tr>
<tr><td>2</td><td>Performance Measures- Natural Environment
The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 6 to the satisfaction of the Planning Secretary.
Table 6: Subsidence Impact Performance Measures
<table>
<tr><td colspan="2">Biodiversity</td></tr>
<tr><td>Seagrass beds</td><td>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.</td></tr>
</table>
Notes:
The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).
Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.
The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent</td><td>Section 1</td></tr>
<tr><td>3</td><td>Offsets
If the Applicant exceeds the performance measures in Table 6 and the Planning Secretary determines that: (a) it is not reasonable or feasible to remediate the impact or environmental consequence; or (b) the remediation measures implemented by the Applicant have failed to satisfactorily remediate the impact or environmental consequence; then the Applicant must provide a suitable offset to compensate for the impact or environmental</td><td>Section 4</td></tr>
</table>

	consequence to the satisfaction of the Planning Secretary. Note: Any offset required under this condition must be proportionate with the significance of the impact or environmental consequence.	
7	***Extraction Plan*** *(i) include a Seagrass Management Plan, which has been prepared in consultation with BCD, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on seagrass beds, and which includes:* *• a program of ongoing monitoring of seagrasses in both control and impact sites; and* *• a program to predict and manage subsidence impacts and environmental consequences to seagrass beds to ensure the performance measures in Table 6 are met;* *Notes:* *• To identify the underground mining areas approved under this consent referred to in this condition, see Appendix 3.* *• This condition does not limit secondary extraction under a Subsidence Management Plan approved as at the date of this consent.*	**This document**
8	*The Applicant shall ensure that the management plans required under conditions 7(g)-(j) above include: (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this consent; and (b) a detailed description of the measures that would be implemented to remediate predicted impacts*	**Section 4 and 6**

Appendix 9 Heritage Management Plan

Environmental Management System
Delta Coal
Heritage Management Plan

Reviewers	
	Lachlan McWha (Delta Coal)
	Morgan Wilcox (EMM Consulting)
Authorised by:	
	Lachlan McWha (Environmental Compliance & Approvals Coordinator, Delta Coal)
Date:	12/10/2022

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Acknowledgement

Delta Coal would like to acknowledge and pay respect to the traditional custodians of the area and their unique cultural heritage, spiritual beliefs and continuing relationship with the land and water.

We pay our respect to the Elders, past, present and emerging, and recognise their strength, resilience and rich contribution to society.

Delta Coal recognises the role of the registered Aboriginal parties in the management of the Aboriginal cultural heritage sites, landscape features and values of the area around Delta Coal operated land and support their custodial and legislative rights and obligations to manage and participate in Caring for Country.

1 Introduction

1.1 Purpose

This Heritage Management Plan (HMP) outlines the requirements to be undertaken to ensure compliance with statutory requirements and applies to the surface operations at Chain Valley Colliery (CVC) and Mannering Colliery (MC), including pit top facilities and lands where additional infrastructure may be constructed.

This management plan addresses the requirements for Development Consent SSD-5465 (MOD3), Schedule 3, Conditions 21 and 21A (CVC) and Project Approval PA 06_0311 (MOD5), Schedule 3, Conditions 18 and 18A (MC). The conditions require the preparation of a HMP.

The purpose of this management plan is to:

- provide an overall framework for consultation related to heritage items;
- detail the regulatory requirements and commitments made in relation to management of Aboriginal and historic heritage at CVC and MC;
- identify measures to minimise impacts to heritage items;
- detail monitoring requirements for known heritage sites (if required);
- facilitate the effective management of heritage issues;
- outline the requirements and actions to be taken upon the discovery of heritage items;
- define specific responsibilities of all stakeholders and function as a management tool for all relevant operational personnel; and
- identify the requirements for review of the document and a procedure for continual improvement.

The overall aim of this management plan is to promote a high level of environmental performance through the minimisation of heritage impacts.

1.2 Background

CVC and MC are underground coal mines located adjacent to each other on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see **Figure 1**). The CVC pit-top is located approximately 1 km south-east of the township of Mannering Park at the southern extent of Lake Macquarie. The MC pit-top is located 3 km south of the township of Mannering Park.

1.2.1 Chain Valley Colliery

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site of CVC, with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam commenced, with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963.

LakeCoal was formed in 2001 to acquire BHP Billiton's 80% share in the Wallarah Coal Joint Venture (WCJV), the remaining 20% share was owned by Sojitz. In October 2006, Peabody Energy, a US listed company acquired LakeCoal Pty Limited.

In November 2009 LDO Coal Pty Limited purchased LakeCoal Pty Limited. LDO Coal is a consortium consisting of LD Operations, AMCI and private investors. In March 2011 the 20% share in the WCJV which Sojitz held was acquired by LDO Coal shareholders through the entity Fassi Coal Pty Ltd. The WCJV had operated the Wallarah, Moonee and Chain Valley underground coal mines and the Catherine Hill Bay Coal Preparation Plant, all located at the southern end of Lake Macquarie. At the time of LakeCoal's acquisition by LDO Coal, both the Wallarah and Moonee mines were closed.

1.2.2 Mannering Colliery

Development of MC (known as Wyee Mine) began in 1960 in conjunction with the construction of VPPS and was operated by Powercoal Pty. Ltd. Production commenced in 1961 with extensive mining (first workings and secondary extraction) having taken place in both the Great Northern and Fassifern seams. Coal operations temporarily ceased on 30 June 2002 when the operation was placed on care and maintenance.

Centennial Coal acquired control of Powercoal on 7 August 2002 and the Colliery remained on care and maintenance until reopening as Mannering Colliery. Production recommenced in December 2005, mining the Fassifern Seam to gain access to greater than 5 million tonnes of recoverable reserves beneath Lake Macquarie and surrounding lands.

MC was once again placed on care and maintenance in November 2012 and in 2013 the owners of MC and CVC entered into an agreement which enabled LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013. The underground link road between CVC and MC was completed in October 2017.

LakeCoal was placed into Voluntary Administration on 3 October 2018. The receivers continued operation of the mines in the period 3 October 2018 to 1 April 2019. As of 1 April 2019, Great Southern Energy Pty Ltd (trading as Delta Coal) own and operate the two underground coal mines, CVC and MC.

1.3 Operations

CVC is an underground coal mine which extracts coal through both first workings and miniwall extraction methods (second workings) as per the development approval SSD-5465 (as modified), with the latest modification (MOD 4) granted on 5 August 2021. Mining is currently undertaken at CVC, with the ROM coal being transported underground to MC where the coal is crushed and screened and sent to VPPS.

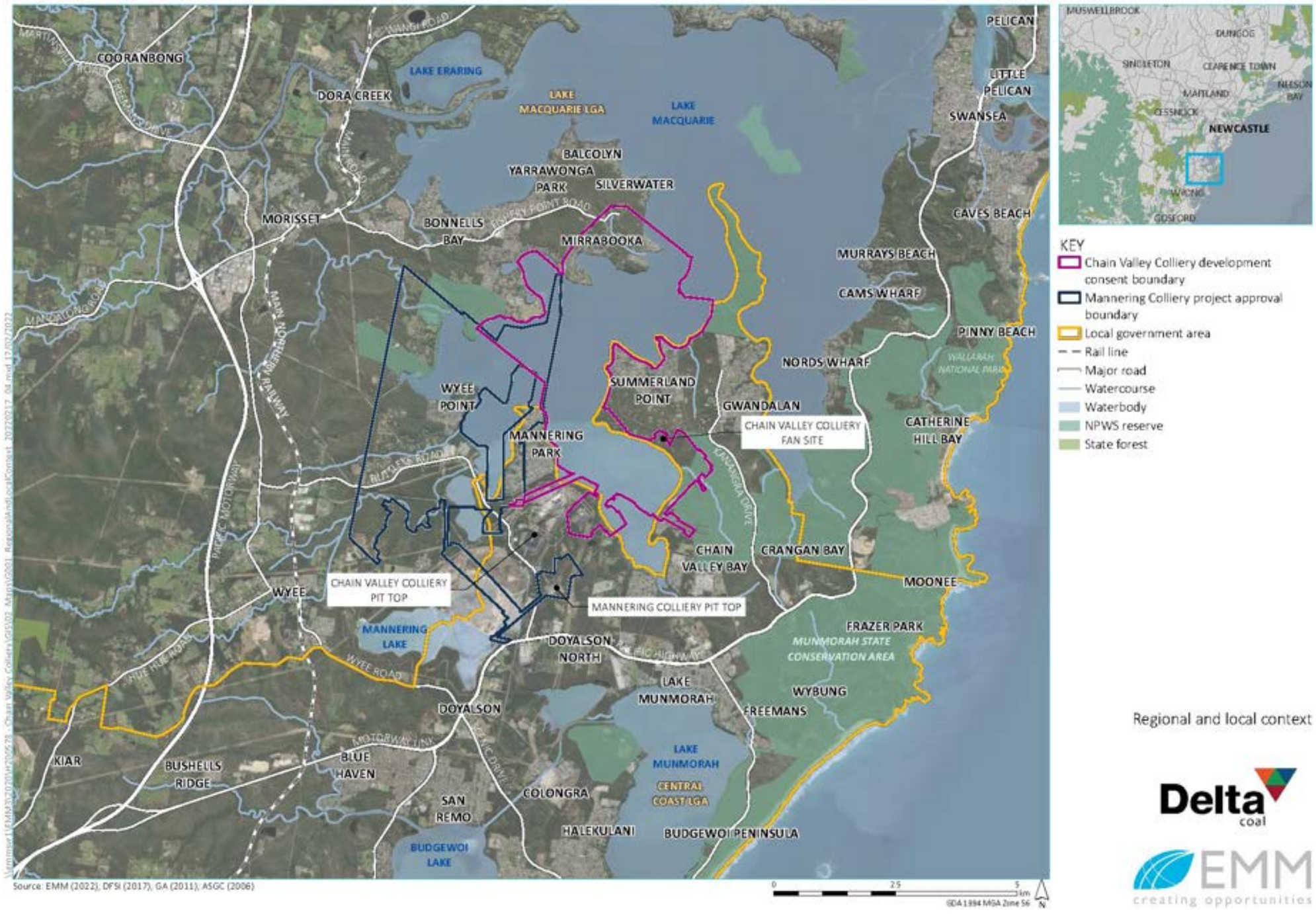
The surface infrastructure comprises limited facilities at the CVC 14 hectare pit top area adjacent to the VPPS, off Construction Road at Mannering Park, and another 0.3 hectare area at the ventilation facility situated at Summerland Point. Both the pit top and ventilation facilities have remained largely unchanged since their establishment.

As per the project approval PA 06_0311 all coal from MC is transported from CVC via the MC underground workings to the MC drift conveyor system to the surface, coal crushing facility and dedicated overland conveyor to VPPS for domestic energy generation.

On 26 June 2020 Delta Coal (DC) received approval for a modification (MOD 5) to PA 06_0311 to allow for:

- an increase in the rate of ROM coal handling at MC from 1.3 to 2.1 Mtpa;
- transport from MC to VPPS;
- an extension to the approved end date for mining operations to 31 December 2027; and
- the use of alternate bord and pillar mine designs.

Figure 1 - Site Locality



Regional and local context

1.4 Statement of Significance

1.4.1 The Awabakal and Guringai Peoples

Following is a Statement of Significance by the Awabakal and Guringai Peoples for the CVC Revised Heritage Management Plan 2014. No changes to the Statement of Significance have been made and the statement has been reproduced with permission.

"Awabakal and Guringai is one of the 600 or more language groups or 'nations' that existed across Australia at the time of European contact and are part of the oldest and continuous living Culture in human history.

Our People were recorded in this area and acknowledged in the first records ever made of the Aboriginal People of the Lake Macquarie, Newcastle and Central Coast areas. Prominent people such as L.E.Threlkeld, Jonathon Warner and many others documented our People, Cultural Heritage and Language in detail going back to the very early 1800's.

Our people believe that all Aboriginal sites and Traditional Culture that has existed for many thousands of years within our area are a tangible link to our Ancestors and our past. Surveys and assessments within the Chain Valley Colliery area has identified Aboriginal Cultural Heritage Sites (the tangible evidence of occupation) and (the intangible evidence) of landscape features of cultural value embedded within a landscape that provided physical and spiritual sustenance to the Awabakal and Guringai and those Aboriginal People they invited into their Country. The survival of these sites is significant to the continuation of collective knowledge and inspiration for our young people and coming generations of Awabakal and Guringai People. We acknowledge our Ancestors for passing on knowledge and also the legacy for us to continue what they put into place, to pass on our Cultural Heritage and to protect our sites for all those in the future.

The Awabakal and Guringai presence within the Chain Valley Colliery area extends from the present day back many thousands of years and is reflected in both tangible and intangible aspects of Aboriginal Culture and history. As Awabakal and Guringai People, we hold Cultural Knowledge that has been passed down from our Ancestors about our Traditional Country for thousands of years and a spiritual awareness, presence and connectedness of place that is what makes us one with the Land of our People. Therefore, the Awabakal and Guringai People have a continuing, contemporary history of trying to protect and preserve the Cultural Heritage within the surrounding areas.

We maintain concerns over Mining and Development licences being approved within the area and the adverse impacts this has on our Cultural Values and landscape features, and footprints of our Ancestors which are being impacted through cumulative and overlapping development, mining and unmonitored and unmanaged human recreational activities.

As indicated by the statements provided by the Traditional Owners, the mental, physical and spiritual wellbeing of the Awabakal and Guringai People and those Aboriginal Peoples that feel a connection to this landscape is also a contemporary phenomenon and not just 'a thing of the past'.

The Project Area contains Registered Aboriginal Cultural Heritage sites identified as having Aboriginal Cultural value and are numerous within LakeCoal Project area. The sites and landscape features link contemporary Awabakal and Guringai People with generations of their Ancestors and are extremely important teaching places and places of spiritual renewal.

We, as the Traditional People of these areas since colonisation of our land, have had to endure many deprivation and degradation along with the subsequent loss of not just our People and land but many aspects of our Culture and Heritage. This has been brought about through the damage and neglect of many ventures both modern and historically that have taken place, the result being, significant loss of Cultural places and artefacts that for thousands of years have given substance and meaning to the lives of Awabakal and Guringai People.

We as Traditional Owners today have vowed to protect our Cultural Heritage and those significant places remaining, so we and our young people and those to come will not go the way of many other Aboriginal People and their Culture and Heritage to become just a name in history books of what was. It has been quite a struggle for our people, with our numbers reduced to a handful after the white fella arrived in Australia in 1788.

It would seem we were doomed to the fate of many other First Peoples that have disappeared from countries all around the world, but we are still here, we have survived and are proud to be called Awabakal and Guringa.

Although the impact of European invasion dramatically changed Aboriginal life in Australia, not to mention the lives of our own People forever, the recent history of the Lake Macquarie area is also characterised by the Cultural resilience of Aboriginal Peoples, for both those who have retained connection to Country and those that are reconnecting to Country. Recent history is also characterised by the movement of other Aboriginal Peoples into the Country of the Awabakal and Guringai and the development of their own more recent attachments to the area. Whilst a diversity of attachment and experience is recognised, it is also necessary to recognise that the landscape, vegetation and watercourses of the Chain Valley Colliery area forms a unique part of the Cultural Heritage and Cultural landscape of the Awabakal and Guringai People.

Aboriginal lore requires that the Aboriginal cultural landscape of the Chain Valley Colliery area (which includes Aboriginal heritage sites, landscape features of Cultural value, the plants, animals and water) is cared for so that it will survive for future generations of Aboriginal Peoples.

The custodial rights and obligations of Aboriginal people Caring for Country underpin the principles of this HMP. It is highlighted, however, that the Awabakal and Guringai People in no way support any impact to Aboriginal sites, landscape features of Aboriginal cultural value or any aspect of the natural environment of the Chain Valley Colliery Area. Aboriginal people inherit the right and obligation to Care for Country, and endorsing any form of harm is assessed as culturally and ethically inappropriate". (**© Awabakal & Guringai 2014)**

1.4.2 The Biraban Local Aboriginal Land Council

Following is a Statement of Significance by the Biraban Local Aboriginal Land Council for the combined Heritage Management Plan 2020. No changes to the Statement of Significance have been made and the statement has been reproduced with permission.

"Biraban Local Aboriginal Land Council aim to promote, protect and foster the best interests of all Aboriginal people within its boundary and its members. As part of Biraban Local Aboriginal Land Council's role, we provide ongoing protection and conservation to all tangible and intangible Aboriginal cultural and heritage sites and cultural landscapes throughout our boundary being across both Awabakal and Wonnarua countries.

For generations Aboriginal people have cared for country and continue to care for country, some of whom are descendants of the Awabakal and Wonnarua nations, others who were born and/or raised in these countries and have a strong continual connection to country, and are now too custodians of these lands. Aboriginal people have a strong unwavering spiritual and emotional connection to country and take great pride in continuing the efforts of our Elders and our Ancestors by caring for the land, the waters, the plants, the animals, the Dreaming and now and into the future the last remaining evidence of the traditional occupation of our country by our Aboriginal Ancestors.

The archaeological evidence is of significance to Aboriginal people and culture as too are the cultural landscapes, the flora, the fauna and the connections each one has to the other, the intangible values of a place contribute significantly to an areas significance, with special care and protection given to the traditional occupation sites, shell middens, scarred trees, stone and wooden artefacts, grinding grooves, ceremonial grounds and sites, burial grounds, dreaming sites and hunting and gathering grounds.

Aboriginal people are the primary determinants of their Aboriginal culture and heritage, they are the knowledge holders and the caretakers, they have a strong connection to country and have cared for country for thousands of years and will continue to care for country for thousands of years to come." (**© Biriban LALC 2020)**

1.5 Consultation

1.5.1 Chain Valley Colliery Heritage Management Plan

The original draft of the CVC Heritage Management Plan (HMP) was issued to the previously identified Aboriginal stakeholders for comment on 7 August 2012. Responses were received from:

- Darkinjung Local Aboriginal Land Council (DLALC);
- Bahtabah Local Aboriginal Land Council (BLALC);
- Awabakal Traditional Owners Aboriginal Corporation (ATOAC); and
- Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC).

These stakeholders identified the issues of accurate background information, inclusion of Aboriginal stakeholders in certain management measures and timing of review. At meetings with BLALC, ATOAC and ADTOAC at the CVC offices on 30 August 2012 the wording of the HMP was discussed in more detail and amendments were incorporated into the final version of the HMP which was subsequently approved on the 1 July 2013.

Version 2 of the management plan was based on the work completed for the heritage assessment of SSD-5465 and subsequent site inspection and workshop held in September 2013. At this site inspection representatives of the ADTOAC, ATOAC, Guringai Tribal Link Aboriginal Corporation and Awabakal Local Aboriginal Land Council were present for the fieldwork and, although unable to attend the fieldwork, an additional representative from the DLALC was able to attend the subsequent workshop.

A number of actions arose from the site inspection and workshop in September 2013 with all actions completed and incorporated into the HMP.

The third version of the CVC HMP addressed actions resulting from Modification 2 to Development Consent SSD-5465, specifically the recommendations of the Aboriginal Cultural Heritage Assessment (ACHA) prepared for Chain Valley Colliery Modification 2 Statement of Environmental Effects (EMM, June 2015).

The fourth version of the CVC HMP while based substantially on the previously approved LakeCoal HMP, was updated to reflect the recommendations and minor changes of the Independent Environmental Audit (IEA) conducted by SLR in June 2019.

The updates were administrative only and there were no changes to activities, impacts, the mine footprint or development consent requirements associated with CVC. This version included consultation with the Registered Aboriginal Parties, the Biodiversity and Conservation Division (BCD) and the Department of Planning, Industry and Environment (DPIE) and was approved by DPIE on 21 April 2020.

1.5.2 Mannering Colliery Aboriginal Cultural Heritage Management Plan

The original MC Aboriginal Cultural Heritage Management Plan (ACHMP) prepared by RPS in 2012 for Centennial Coal's Northern Holding, which included MC, was issued to the previously identified Aboriginal Stakeholders for comment. Following amendments, the ACHMP was approved on 26 November 2012.

In accordance with the review and auditing process outlined in Chapter 8, a draft of the updated ACHMP developed for MC was provided to the Aboriginal Stakeholders for comment on 16 August 2019. There were no responses received.

The updates were administrative only and there were no changes to activities, impacts, the mine footprint or development consent requirements associated with MC. This version included consultation with the Registered Aboriginal Parties, BCD and DPIE and was later approved by DPIE on 13 November 2019.

1.5.3 Mannering Colliery Historic Heritage Management Plan

The original MC Non-Indigenous Cultural Heritage Management Plan (NICHMP) was previously prepared by Centennial Coal in February 2013. The plan was approved by the (former) Department of Planning and Infrastructure (DPI) on 10 September 2013.

The second version of this NICHMP, while based substantially on the approved Centennial Coal management plan, was updated to reflect the recommendations and minor changes of the Independent Environmental Audit (IEA) conducted by SLR in June 2019.

The updates were administrative only and there were no changes to activities, impacts, the mine footprint or project approval requirements associated with MC. This version of NICHMP was provided to NSW Environment Protection authority (EPA) and DPIE and was approved on 13 November 2019.

1.5.4 Combined Delta Coal Heritage Management Plan

Registered Aboriginal Parties (RAPs) who have registered an interest to participate in the consultation process comprise the four groups consulted for the original HMP draft and six further Aboriginal organisations. The complete list of ten RAPs are:

- ATOAC;
- ADTOAC;
- BLALC;
- DLALC;
- Biriban Local Aboriginal Land Council;
- Daniella Chedzey;
- Cacatua Culture Consultants;
- Guringai Tribal Link;
- Wonn 1 Contracting; and
- Yula - Punaal Aboriginal Education and Healing Centre.

In accordance with the review and auditing process, a draft of this combined HMP, developed for CVC and MC was provided to the RAPs, DPIE, Heritage NSW (inclusive of Aboriginal Cultural Heritage Advisory Council and Heritage Council of NSW) for comment on 22 October 2020. This HMP was provided to DPIE on 6 November 2020 following the 14-day consultation period. The HMP has been reviewed following completion of the CVC and MC Independent Environmental Audit in 2022 with only minor administrative updates made. The plan was only submitted to NSW DPE and Heritage NSW for comment.

A summary of the comments received, and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**. Evidence of consultation is provided in **Appendix 1**.

Table 1: Consultation Summary

Stakeholder	Comments	Response/Action
RAPs	• No comments provided (2020 HMP)	• NA
NSW DPE	• Update TARP per reporting requirements of Schedule 6 of SSD-5465.	• TARP in Section 5.3 updated.
Heritage NSW	• No comments provided (Heritage Council)	• NA

1.5.5 Ongoing community consultation and involvement

As part of the of the HMP, DC facilitates ongoing consultation and involvement of RAPs in the conversation and management of Aboriginal cultural heritage on CVC and MC sites. This is achieved by:

- providing relevant information about the cultural significance and values of the Aboriginal object(s) and/or place(s);
- providing for ongoing communication of information on mining operations and cultural heritage management and the Aboriginal community;
- providing advice on how to address community relationships; and
- commenting on future draft assessment reports and management plans before they are submitted to regulatory authorities.

1.5.6 Access to Aboriginal sites and stored Aboriginal objects

Local Aboriginal community access to Aboriginal sites and stored Aboriginal objects will be made available by DC subject to reasonable safety and security measures, such as availability of DC staff assistance. Any request to visit is to be made to the DC Environmental Compliance Coordinator.

2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

This HMP has been prepared in accordance with the principles of the Australia ICOMOS Burra Charter, 2013 (Burra Charter). The Burra Charter provides guidance for the conservation and management of places of cultural significance and sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians.

Items of heritage significance in NSW are protected by a series of acts whose purpose it is to ensure that change is appropriately managed to ensure that significance is not lost. In NSW, the *Heritage Act 1977* and the *Environmental Planning and Assessment Act 1979* (EP&A Act) are the primary statutory controls protecting historical heritage and archaeology within NSW. Listing on statutory registers provides legal protection for heritage items.

2.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important heritage places as well as places that are owned by the Commonwealth, such as defence lands and postal facilities.

2.2.1 Native Title Act 1993

The Commonwealth Government enacted the *Native Title Act 1993* to formally recognise and protect native title rights in Australia following the decision of the High Court of Australia in Mabo & Ors v Queensland (No.2) (1992) 175 CLR 1 (“Mabo”.)

2.2.2 Aboriginal Land Rights Act 1983

The purpose of this legislation is to provide land rights for Aboriginal people within New South Wales and to establish Local Aboriginal Land Councils (LALCs). The land able to be claimed by Aboriginal Land Councils on behalf of Aboriginal people are certain Crown lands as detailed in s36 of the *Aboriginal Land Rights Act 1983*. Claims for land are by application to the Office of the Registrar, *Aboriginal Land Rights Act 1983*.

2.2.3 National Parks and Wildlife Act 1974

The primary state legislation relating to the protection of Aboriginal cultural heritage in NSW is Part 6 of the *National Parks and Wildlife Act 1974* (NPW Act).

The *National Parks and Wildlife Regulation 2009* (NPW Regulation) is subsidiary legislation made under its parent act, the NPW Act. The NPW Regulation provides codes of practice, documents and guidelines that relate to the NPW Act, including:

- *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW 2010);
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010);
- *Aboriginal Consultation Requirements for Proponents 2010* (DECCW 2010); and
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011).

2.2.4 Heritage Act 1977

Historical archaeological relics, buildings, structures, archaeological deposits and features are protected under the *Heritage Act 1977* (as amended 1999) and may be identified on the State Heritage Register (SHR) or by an active Interim Heritage Order.

I. Relics Provision

Relics are defined by the Heritage Act are *"any artefact, object or material evidence which relates to the settlement of that area that comprises New South Wales, not being Aboriginal settlement, and is of State or local significance."* Relics are protected under Section 139 of the Heritage Act. Where the potential for relics exists, the land in which it is found cannot be disturbed or excavated without an excavation permit.

II. State Heritage Register

The SHR is a list of places and objects of particular importance to the people of NSW. When a place is listed on the SHR or is affected by an interim heritage order, approval under Section 60 of the Heritage Act is required for any major work. The purpose of this requirement is to ensure that change to significant places is managed appropriately and does not detract from the heritage significance of the place.

III. Section 170 Register

State government agencies have responsibilities under Section 170 of the *Heritage Act* that requires them to identify, conserve and manage heritage assets owned, occupied or managed by that agency. Each agency is required to maintain a s170 register of all heritage assets and assess the significance of each asset.

2.2.5 Environment Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act establishes the framework for cultural heritage values to be formally assessed in the planning and development consent process in NSW. The EP&A Act requires that environmental impacts are considered before land development; this includes impacts on cultural heritage items and places as well as archaeological sites and deposits.

The EP&A Act requires that local governments prepare planning instruments, such as Local Environment Plans (LEPs) and Development Control Plans (DCPs) to provide guidance on the level of environmental assessment. This includes identification of heritage items, as listed on the heritage schedules of an LEP.

The Act regulates a system of environmental planning and assessment for NSW. Land use planning requires that environmental impacts are considered, including the impact on cultural heritage and specifically Aboriginal heritage, assessment documents prepared to meet the requirements of the EP&A Act.

2.3 Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW

In 2010, the NSW Office of Environment and Heritage released the Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW. This code of practice is designed to assist individuals and organisations to exercise due diligence, when carrying out activities that may harm Aboriginal objects and to determine whether they should apply for consent in the form of an Aboriginal Heritage Impact Permit (AHIP).

The *National Parks and Wildlife Act 1974* (NPW Act) provides that a person who exercises due diligence in determining that their actions will not harm Aboriginal objects has a defence against prosecution for the strict liability offence if they later unknowingly harm an object without an AHIP.

The code sets out the reasonable and practicable steps which individuals and organisations need to take in order to:

- identify whether or not Aboriginal objects are, or are likely to be present in an area;
- determine whether or not their activities are likely to harm Aboriginal objects (if present);
- determine whether an AHIP application is required; and
- Aboriginal Cultural Heritage Consultation Requirements for Proponents.

Also, in 2010, the NSW Office of Environment and Heritage released the Aboriginal Cultural Heritage Consultation Requirements for Proponents. The purpose of the consultation guidelines is to establish the requirements for consultation with the registered Aboriginal parties as part of the heritage assessment process to determine potential impacts of proposed activities on Aboriginal objects and places and to also inform decision making for any application for an AHIP. The aims of the consultation guidelines are to facilitate positive Aboriginal cultural outcomes by:

- *affording an opportunity for Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal object(s) and/or place(s) in the area of the proposed project to be involved in consultation so that information about cultural significance can be provided to DECCW to inform decisions regarding applications for an AHIP; and*
- *providing Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal object(s) and/or place(s) in the area of the proposed project with the opportunity to participate in decision making regarding the management of their cultural heritage by providing proponents information regarding cultural significance and inputting into management outcomes.*

2.4 Approvals

This plan has been prepared in accordance with CVC Schedule 3, Condition 21 of Development Consent SSD-5465, and MC Schedule 3, Condition 18 of Project Approval 06_0311, which states the requirements of the Heritage Management Plan (HMP) and what it must address. Cultural heritage related requirements of the approvals, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

In accordance with Schedule 2, Conditions 2 and 2A, in addition to carrying out the works in accordance with the conditions of CVC Development Consent SSD-5465, DC will also carry out works generally in accordance with the Environmental Impact Statement (EIS), Statement of Environmental Effects (SEE) (Mod 1), SEE (Mod 2), SEE (Mod 3), SEE (Mod 4), Project Layout Plans, and Statement of Commitments.

In accordance with Schedule 2, Conditions 2, in addition to carrying out the works in accordance with the conditions of MC Project Approval 06_0331, DC will also carry out works generally in accordance with the Environmental Impact Statement (EIS), Statement of Environmental Effects (SEE) (Mod 1), SEE (Mod 2), SEE (Mod 3), SEE (Mod 4), SEE (Mod 5), Project Layout Plans, and Statement of Commitments.

3 Aboriginal Heritage Management

3.1 Background

The Awabakal is bordered generally by the Darkinjung to the south west, Wonnarua to the north west and by the Worimi to the north beyond Newcastle. The Awabakal language extended south to Brisbane Waters or even to Sydney Harbour North Head, if the Gringai (Kurringai) language is related to Awabakal (Shane Frost pers.comm. Aug 2012).

The Lake Macquarie area has been the focus of a number of surface investigations and a small number of excavations. In order to develop a predictive model of site location, distribution and type that occur in the vicinity of CVC and MC, previous archaeological work undertaken within the region was reviewed.

There have been numerous archaeological studies undertaken for the Lake Macquarie region, starting from the 1970s until the present (eg Haglund 1986; Navin Officer and Saunders 1996; Umwelt 2011; EMM 2012). These studies have largely been undertaken as part of commercial, linear infrastructure and mining developments.

Archaeological investigations have identified that Aboriginal subsistence was focused on the estuarine shell beds on the lake margins. There is a strong association with shell midden sites and the lake shore, whereas stone artefact sites are often mixed with midden sites but also distributed adjacent to watercourses in the hinterland of Lake Macquarie. Furthermore, studies have found that Aboriginal scarred or carved trees may be adjacent to water sources in areas of uncleared forest.

It was determined that there were no items of historic heritage significance within the existing or proposed disturbance or mining areas, although a number of items were located nearby. These are discussed further in Section 4. A number of Aboriginal heritage sites were identified within the CVC and MC site and areas of proposed mining, as discussed in further detail below.

3.2 Chain Valley Colliery Previous Assessments

3.2.1 Environmental Assessment (AECOM 2011)

For the EA (AECOM, 2011), a search of Office of Environment and Heritage (OEA) Aboriginal Heritage Information Management System (AHIMS) database was conducted on 30 September 2009 and revealed six registered Aboriginal sites within the area. In addition to this, as part of the EA process, consultation and field work was undertaken with Aboriginal stakeholders within the study area of the EA, which resulted in the identification of an additional five Aboriginal sites.

3.3 Environmental Impact Statement (EMM 2012)

An extensive search of the AHIMS register was also conducted during 2012 as part of the EIS for an area of 10 km by 10 km surrounding the CVC. The search revealed a total of 99 registered sites, the majority of which occurred along the Lake Macquarie foreshore. Middens accounted for 60% of the total sites registered, isolated finds accounted for 11% and scarred trees represented 10%. Subsequent fieldwork undertaken by EMM in conjunction with RAPs identified one new site (45-7-0339) and also redefined the extents of sites 45-7-0154 (at Fishery Point, Sunshine) and 45-7-0157 (at Casuarina Point, Sunshine).

Notwithstanding the high significance of Aboriginal sites and objects to Aboriginal people, Aboriginal stakeholders advise that all of the land is of significance to Aboriginal people.

In the 2014 HMP it was noted that the Awabakal and Guringai People had a Registered Native Title claim over the site and surrounding areas including the Lake Macquarie City Council and Wyong Shire Council Local Government Areas (LGAs) along with other LGAs. The Native Title claim was registered on 13 June 2013 and discontinued as at 30 June 2017.

In addition, there is a current claim by Johnson and Kendall Grange. The Native Title claim was registered on 27 April 2007 and is not yet determined.

3.3.1 ACHA (EMM, 2015)

In addition to the above assessments, an Aboriginal Cultural Heritage Assessment (ACHA) was completed as part of the Statement of Environmental Effects prepared for Chain Valley Colliery Modification 2 (EMM, June 2015). This report identified Aboriginal site 45-7-0157 would be subject to subsidence impacts at a negligible level as a result of the proposed modification, and recommended monitoring requirements. The assessment also recommended Aboriginal site 45-7-0154 be removed from the monitoring program as it will no longer be undermined.

3.3.2 Aboriginal due diligence assessments for subsidence monitoring (EMM, 2017 and 2019)

EMM was engaged in 2017 and 2019 to undertake Aboriginal due diligence assessments in relation to the installation of subsidence monitoring lines along Summerland Point/Chain Valley Bay foreshore (2017) and the Point Wollstonecraft Foreshore (2019). The assessments were a part of ongoing subsidence monitoring associated with mining operations. Although both assessments identified shell material associated with naturally occurring deposits, and cultural deposits at existing AHIMS site, no further sites were identified. No impacts to Aboriginal sites or objects were proposed by the subsidence monitoring activities.

3.3.3 Management Plan Reviews (EMM, 2020)

Methods used to identify potential Aboriginal cultural heritage sites and/or objects for inclusion in this revised HMP were as follows:

- a review of the previous archaeological investigations undertaken at CVC and its surrounds;
- an extensive search of the AHIMS database to identify previously recorded Aboriginal sites; and
- objects in and around the CVC project approval boundary.

An updated AHIMS search was conducted on 14 October 2020 with results provided in **Appendix 3**. A total of 86 Aboriginal sites were identified within the search area, the majority of which were located around the Lake Macquarie foreshore. Of these sites, 29 are located within the current CVC project area boundary as detailed in **Table 2** and shown on **Figure 2**. Fifteen additional Aboriginal sites have been included in this HMP within or near the CVC development consent boundary in comparison with the 2014 HMP.

Table 2: AHIMS registered sites within/near the CVC project area (as at 19 October 2020)

No.	AHIMS ID(s)	Site name	Site type/features
1	45-3-0334	Tiembula Creek Midden	Shell Midden
2	**45-7-0131**	Summerland Point	Shell Midden
3	**45-7-0166**	M8, Sugar Bay	Shell Midden
4	**45-7-0167**	Camp Brightwaters	Shell Midden
5	**45-7-0176**	Gwandalan	Shell Midden

No.	AHIMS ID(s)	Site name	Site type/features
6	45-7-0178	Hembula Creek	Scarred Tree (x2)
7	45-7-0179	Black Neds Point	Shell Midden
8	45-7-0181	Chain Valley Bay 1	Shell Midden
9	45-7-0182	Chain Valley Bay 2	Shell Midden
10	45-7-0189	Sandy Beach 1	Shell Midden
11	**45-7-0227**	St Johns 1	Artefact
12	**45-7-0255**	Trinity Point GG2	Grinding Groove
13	**45-7-0257**	Trinity Point Ochre	Ochre Quarry
14	**45-7-0258**	Trinity Point IF1	Artefact
15	**45-7-0262**	SJOG 7	Grinding Groove
16	**45-7-0263**	SJOG 6	Shell Midden
17	45-7-0271	CV-08-09	Shell Midden
18	45-7-0272	CV-09-09	Shell Midden
19	45-7-0273	CV-10-09	Shell Midden
20	45-7-0277	CV-16-09	Shell Midden
21	**45-7-0279**	CV-18-10	Shell Midden
22	**45-7-0281**	CV-20-10	Shell Midden
23	45-7-0282	CV-21-10	Shell Midden
24	**45-7-0293**	RPS MP3	Modified Tree (Carved or Scarred)
25	45-7-0154	M7	Shell Midden
26	45-7-0157	M10	Shell Midden
27	45-7-0339	CV-001	Isolated artefact
28	**45-7-0412**	**DC1**	**Shell**
29	**45-7-0413**	**DC2**	**Shell**

Sites listed in bold are sites not included in the 2014 HMP. It may be that some are located just outside the development consent boundary but have been included in this management plan for completeness.

3.4 Mannering Colliery Previous Assessments

3.4.1 Aboriginal Cultural Heritage Management Plan (ACHMP) (RPS 2012)

In 2012, RPS prepared an ACHMP for Centennial Coal's Northern Holdings. The Northern Holdings included Newstan Colliery, Awaba Colliery, Myuna Colliery, Mannering Colliery and Mandalong Mine.

A search of the Aboriginal Heritage Information Management System (AHIMS) database conducted on 21 March 2012 identified a total of 332 Aboriginal sites within the boundaries of Centennial's Northern Holdings. Of these sites, 28 were located within the MC project area boundary (RPS 2012: Attachment 3).

The most common site types identified were artefact scatters or isolated finds, grinding groove sites, shell middens and rock shelters. Modified trees, which included both scarred and carved trees, were present in moderate numbers. Potential archaeological deposits and shelters with art had been identified in relatively few numbers and have been considered less common in the region. The remainder of sites within Centennial's Northern Holdings were multi-component sites ranging between one and three instances, which most likely represent places where a range of subsistence activities took place. Multi component sites are places where a variety of activities may have taken pace and therefore have a range of site types within the overall assemblage.

3.4.2 Modification 3 Environmental Assessment (EMM 2015)

The current previous approved modification, Modification 3 Environmental Assessment for Mannering Colliery (EMM 2015) outlines an extensive AHIMS search conducted by EMM Consulting on 17 August 2014. The search was for an area of 5 km by 5 km encompassing MC (the search area), and adjacent catchments. The search identified a total of 112 registered sites, with middens being the most common site type recorded.

No Aboriginal sites were identified in the Modification 3 area.

3.4.3 Aboriginal Cultural Heritage Management Plan (ACHMP) Review 2019

The current review has been completed to extract relevant information from the previous Centennial Coal Northern Holdings ACHMP, and to develop an ACHMP specific to the MC project area.

Methods used to identify potential Aboriginal cultural heritage sites and/or objects for inclusion in this revised ACHMP were as follows:

- a review of the previous archaeological investigations undertaken at MC and its surrounds; and
- an extensive search of the AHIMS database to identify previously recorded Aboriginal sites and objects in and around the MC project approval boundary.

An updated AHIMS search was conducted on 14 October 2020 with results provided in **Appendix 3**. A total of 86 Aboriginal sites were identified within the search area, the majority of which were located around the Lake Macquarie foreshore. Of these sites, 10 are located within the current MC project area boundary as detailed in **Table 3** and shown on **Figure 2**. Only one additional Aboriginal site, 45-7-0363, has been recorded within the MC project area since completion of the 2012 ACHMP and has been shown in bold on the following table.

Table 3: AHIMS registered sites within/near the MC project area (as at 19 October 2020)

No.	AHIMS ID(s)	Site name	Site type/features
1	45-3-1553	Wyee Bay,Ruttleys Road	Midden
2	45-7-0001	Morisset Hospital	Midden
3	45-7-0003	Vales Point, Lake Macquarie	Midden
4	45-7-0190	Wyee Point	Midden/artefact
5	45-7-0207	The Hole (TH1)	Open Camp site
6	45-7-0291	RPS HSO M1	Shell
7	45-7-0316	RPS Wyee Point 2	Shell
8	45-7-0320	RPS Mannering 1	Shell
9	45-7-0321	RPS Mannering 2	Modified tree (carved or scarred)
10	45-7-0363	Woods Repatriation Site	Burial/modified tree (carved or scarred)

It may be that some are located just outside the development consent boundary but have been included in this management plan for completeness.

3.5 Items of Significance

Obligation to Avoid Harm

All employees, contractors, sub-contractors and visitors to CVC and MC have an obligation to avoid harming Aboriginal heritage unless engaged in an Aboriginal heritage management activity described in this plan.

The *National Parks and Wildlife Act 1974 (*NPW Act) defines "harm" to an object or place as any act or omission that:

(a) destroys, defaces or damages the object or place, or

(b) in relation to an object-moves the object from the land on which it had been situated, or

(c) is specified by the regulations, or

(d) causes or permits the object or place to be harmed in a manner referred to in paragraph (a), (b) or (c),

(e) desecrates the object or place, or

(f) is trivial or negligible, or

(g) is excluded from this definition by the regulations.

Any Aboriginal objects or sites at CVC and/or MC will be made aware for all employees, contractors and sub-contractors by the Environmental Compliance Coordinator or the Approvals Coordinator. This will include a message detailing:

- that the objects or sites are protected by law;
- potentially be distributed across the project area and that new sites may be exposed in areas outside of the disturbance footprints;
- are of significance to the Aboriginal community, and important to the wider community and must be treated with respect;
- have included stone tool sites; and
- can be hard to recognise, therefore reference must be made to the Aboriginal heritage maps in this management plan in order to clearly identify them.

In the process of undertaking any mining activities there is potential to impact Aboriginal objects or sites. Any activity which results in the disturbance of the surface has the potential to harm Aboriginal heritage sites. The level of impact to Aboriginal sites depends on the nature of the surface works/subsidence and the physical characteristics of the Aboriginal site types. The Mannering Colliery project approval currently allows for first workings mining only in the Great Northern and Fassifern seams, with <20 mm surface, negligible subsidence effects. This is less than the average natural ground swell movement of 29 mm (Delany et al). This first working mining method is the key management tool to avoiding harm to aboriginal heritage.

3.5.1 Artefact Scatters and Isolated Finds

The distinction between artefact scatters and isolated finds comes down to the interpretive value of these sites. An isolated find, as the name suggests, comprises of a single stone artefact which often cannot be contextualised by other artefacts in the landscape. Artefact scatters contain more than one artefact and have more interpretive value because they may provide information on processes such as procurement, manufacture, usage and discard (Holdaway et al 2002). These two types of sites are usually classified as “open” because they are usually set in exposed landscape (i.e. not a rock shelter) and the extent of these sites are based on an arbitrary boundary according to changes in density level and/or landform units (for artefact scatters). Isolated finds occur as a single artefact and are not generally found within 50 m of another artefact/artefact scatter.

3.5.2 Middens

Shell middens are commonly made up of the remains of edible shellfish and could be the result of a single meal or many meals at the same location over many years. A midden may also contain fish and animal bones, stone tools, or charcoal. They can vary in size and depth. Middens are sometimes associated with burials. Middens can be found on headlands, sandy beaches and dunes, around estuaries, swamps and tidal stretches of creeks and rivers, and along the banks of inland rivers, creeks and lands. Middens may also be found in the open or in rock shelters. Middens can indicate that a place was, and may continue to be, a key meeting place of significance. Middens can also provide information about the environment that existed when Aboriginal people collected the shellfish, such as changes in species, and tools or raw materials that were used. Middens which contain burials are particularly significant. Middens are amongst the most fragile cultural sites. They can be exposed by wind or degraded by human and animal activity. Effective management of midden sites may include stabilising the surface, such as by encouraging vegetation cover, or by restricting access to the site by erecting fencing (Excerpt from due diligence guidelines, DECCW 2010).

3.5.3 Stone Arrangements

Aboriginal stone arrangements are places where Aboriginal people have positioned stones deliberately in the landscape to form shapes or patterns. Although it is not certain why stone arrangements were made, scholars (O’Conner et al 2007) have suggested that they may have served a spiritual function (ie: rituals and ceremonial usage) or for practical subsistence purposes (ie: demarcating territorial boundaries or as fish traps along coastal regions). There are over 1000 known stone arrangements in NSW and Qld alone (Mulvaney & Kamminga 1999:25).

Stone arrangements are characterised as low height constructions, usually less than a metre high, and generally occur where there is a plentiful supply of boulders and suitable rock material to arrange. Although inferences can be made as to the reasons why particular stone arrangements were created based on research and intensive archaeological investigation, it is not possible to assign a generic function to stone arrangements. These types of sites can vary in size and shape and the choice of materials used in their construction can also vary greatly based on the availability of resources and selectivity of material. The spatial distribution of these arrangements may also have an interpretive implication on their function and usage.

Ground surface clearing activities and subsidence/upsidence can potentially harm stone arrangements. In terms of the potential harm associated with ground surface works, this can take place in the form of earth works activity directly where the site is located. However, these types of sites are more clearly identifiable in the natural landscape than artefact scatters and isolated finds because they are more physically imposing. Subsidence/upsidence may harm stone arrangements if the movement of the ground surface cause the stones move; thus, altering their original arrangement. Secondary effects of subsidence may include changes in drainage patterns which can also pose a risk to moving the stones in the arrangement.

3.5.4 Historic/Social/Ceremonial/Spiritual/ Dreaming Sites

Aboriginal ceremonial/Dreaming/spiritual sites are linked to cultural traditions and their function and significance are determined by the Traditional Owners. These types of sites can be for different types of purposes and would therefore need to be assessed individually. Although it is possible that archaeological remains can be associated with these types of sites, this however is not a necessary qualifier because their value largely hinges on the oral histories and traditions passed down in Aboriginal culture.

3.5.5 Grinding Grooves and Rock shelters

Natural processes such as the constant water flow over sandstone structures can cause erosion. Surface exfoliation can occur due to the heat of bush fires. Mining activities can also cause harm to grinding groove and rock shelter sites. It is observed that natural ground swell movement in Lake Macquarie region range between 7 mm and 58 mm with an average of 29 mm (Delany et al). This research suggests that any movement of the ground surface <58 mm could be attributed to natural processes rather than the result of mining inducted ground subsidence.

3.5.6 Scarred Trees/ Carved Trees

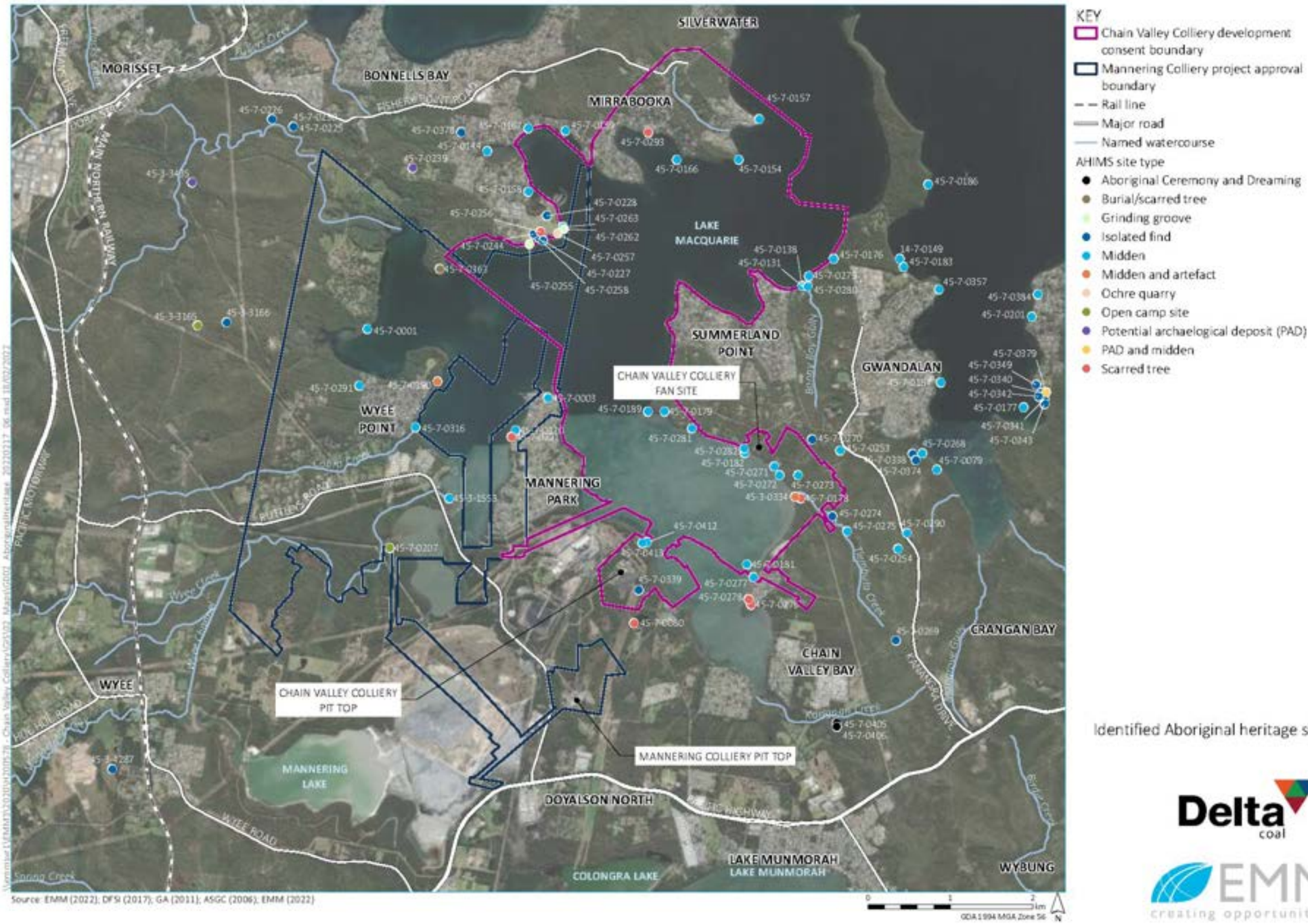
Aboriginal modified trees are trees which have been scarred or carved by Aboriginal people through the deliberate removal of bark or wood (Long 2005:6). There are numerous reasons why Aboriginal people removed bark from trees because it is a versatile and plentiful material. It can be used for a range of domestic activities including the manufacture of shelters, watercrafts, containers, weapons (shields/woomeras), etc.

All Aboriginal scarred trees are protected under state legislation and are recognised as sites. Given that the coastal margins of NSW and the valley are among the oldest European settlements in Australia, dating to the 1780s around Sydney and the 1800s in the Newcastle region (Long 2005:52), modified trees in the northern holdings would be expected to be older than 240 years.

The potential risk of subsidence/upsidence to scarred/carved tree sites is largely dependent on the condition of the tree (health) and where it is located in the landscape. If mature scarred/carved trees are healthy and alive, they generally have well established root systems which can keep them firmly affixed to the ground surface at the onset of subsidence.

Although a tree might be healthy, the ground condition and location of the site can also affect the sites stability. If the site is located on a precarious ledge along a ridge line or in loose or eroded soils, this would impact on how firmly affixed the tree is to the ground surface. Ground surface activity such as earthworks (including the construction of buildings, roads, vents, pollution ponds, stockpile areas) can harm scarred tree sites if they are within the area of proposed works. Changes in ground water levels or ponding areas, as a result of subsidence, may also lead to changes in tree health and potentially increase the risk of impact.

Figure 2 - Regional Aboriginal Heritage Sites



Identified Aboriginal heritage sites

4 Historic Heritage Management

This management plan included searches of the EPBC Act Matters of National Significance Register, the NSW State Heritage Register, Heritage and Conservation (Section 170) Register, Commonwealth Heritage List, World Heritage List, Lake Macquarie City Council LEP 2014, Wyong Local Environmental Plan 2013 and City of Lake Macquarie Heritage Study (1993). The following items were identified in the vicinity of the project area but are not expected to be impacted by CVC or MC. The locations of these sites are shown on **Figure 3**.

4.1 Morisset Hospital Precinct

Morisset Hospital site comprises almost 100 historic buildings on 1,244 hectares. It is approximately 3 km south-west of the township of Morisset. The Morisset Hospital Precinct is listed by Heritage NSW under the *NSW Heritage Act 1977.* Within the Morisset Hospital Precinct, 31 heritage items are individually listed by Local Government and State agencies. As outlined by Heritage NSW, the heritage items in the Morisset Hospital Precinct meet one or more criteria for listing on the SHR. The precinct is listing number 00827 and is of high state significance in the category of Health Services. Significant items also include impressive specimens of indigenous and introduced tree species, vegetation groups and native fauna.

The heritage item is listed as of state significance, item number 118 under the Lake Macquarie Local Environmental Plan 2014.

The Morisset Hospital Precinct area extends from the shoreline of Lake Macquarie and is west of the approval area.

4.2 Eaton Bulk Store Building

The Eaton Bulk Store Building is located at 464 Ruttleys Road, Mannering Park (Lot 11 DP 1091396), approximately 1.9 km south-west of the entrance road to CVC.

The heritage item is listed as of local significance, item I39 under the Wyong Local Environmental Plan 2013. The Council statement of significance:

'The bulk store building is significant locally as a representative example of a riveted steel building structure of the early twentieth century, which is historically part of nearby Wyee Colliery and illustrates the practice of building relocation and re-use typical of the mining industry in New South Wales. As a relocated structure, it provides evidence of the integrated management of multiple mining and generation sites. It retains this value despite its alterations for its reconstruction in a new site. It is a relic of the period of State ownership of electricity generation undertakings, including their fuel supplies in New South Wales. It is a type of building unusual in its vicinity and may have additional association significance arising from its origins at another site, possibly the Harbour Bridge Workshops.'

4.3 Great Northern Railway

The Great Northern Railway line passes through Lake Macquarie from Wyee to Garden Suburbs. The line is listed by Lake Macquarie City Council LEP 2014 as a heritage item (item 189) of local significance.

4.4 Wyee Coal Conveyor Rail Loop

The Wyee coal conveyor rail loop is located on the eastern side of the Great Northern Railway, north of Wyee. The line is listed in the Lake Macquarie City Council LEP 2014 as a heritage item (item 225) of local significance.

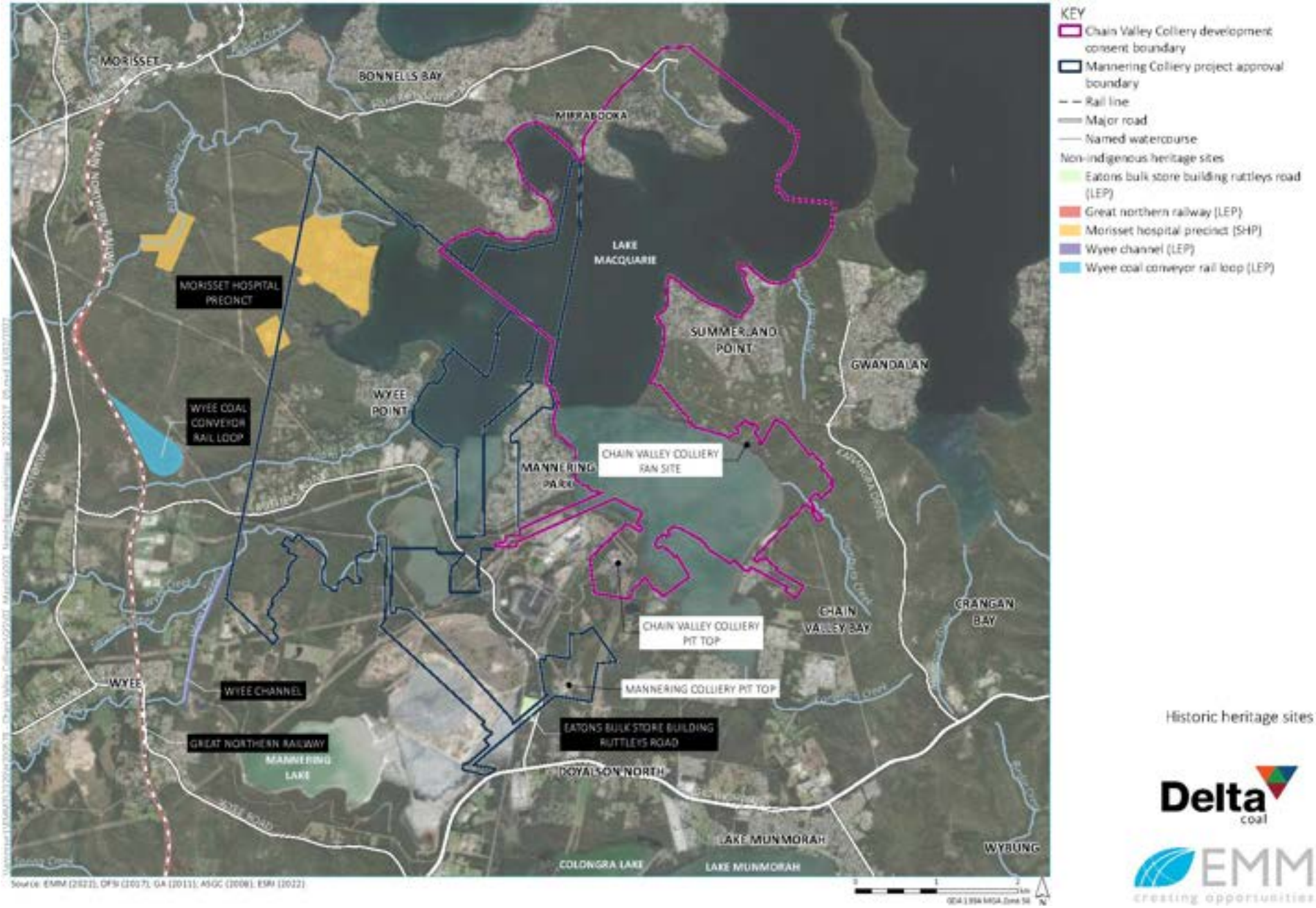
4.5 Wyee Channel

Wyee Channel is listed as a heritage item (Item 226) of local significance under the Lake Macquarie City Council LEP 2014.

Wyee Channel extends north from the Wyee Dam to Wyee Bay, extending under Summerhayes Road.

4.6 Vales Point Power Station

The WSC Heritage Review (Scobie Architects Pty Ltd 2010) investigated the historical context of the Wyong LGA and it identified the VPPS, located approximately 200 m west of CVC as an item of local heritage significance. It was recommended for inclusion in the Schedule of Heritage items within the Draft Wyong LEP by Scobie Architects Pty Ltd (2010) though it was ultimately not listed and is, therefore, not considered to have local or state heritage significance.



Historic heritage sites

Delta coal

EMM creating opportunities

5 Monitoring, Management and Mitigation Measures

5.1 Aboriginal heritage

5.1.1 Identified Aboriginal Sites

As shown in **Figure 2**, all but two of the identified Aboriginal sites are located outside the pit top area, ventilation facility area or subsidence footprint at CVC. Site 45-7-0189 is located above existing or proposed areas of first workings on Summerland Point, with the remaining site identified at the pit top area in the vicinity of the dams (45-7-0339).

Monitoring of one site (45-7-0189) was previously committed to as part of the Statement of Commitments and the original Heritage Management Plan. Monitoring of site 45-7-0189 commenced in January 2013 (1st year), 2015 (3rd year) and concluded in 2017 (5th year) with no site impacts identified relating to subsidence caused by the mining activities (AECOM, 2018).

In addition to the above monitoring program, a due diligence site inspection of the area to be disturbed by the sediment dam D10 embankment and spillway upgrade was completed (AECOM) prior to commencement of works in those areas. Site CV-001 (45-7-0339) was fenced to exclude access to the area during upgrade works. No additional sites were found during the due diligence inspection or construction works.

Procedures for the discovery of previously unidentified sites or skeletal remains are covered in **Section 5.1.6** and **Section 5.1.7** respectively.

5.1.2 Monitoring of Aboriginal Sites

If monitoring is required for any future underground workings or surface works which could result in disturbance an initial visual inspection of the site by an archaeologist and Aboriginal stakeholders will be conducted. In order to identify any changes to the land surface over time, particularly in view of the negligible subsidence expected, monitoring of each site will be assisted by the:

- establishment of fixed datum point with defined relative level to Australian Height Datum (AHD) by registered surveyor;
- placement of stakes with horizontal markings on either extent of the site to enable accurate recording of landscape shifts;
- installation of a control reference point with defined Relative Level (RL) established outside proposed subsidence area such as a building;
- collecting photographic records from the fixed datum point to enable inter survey photographic comparisons. Photos will be large format with clear distinguishable features; and
- production of a letter report to be retained by DC with copies provided to Aboriginal stakeholders as requested.

A clear distinction will be made between natural processes of bioturbation, erosion, sand shifting events and landscape modification due to subsidence.

No additional monitoring aside from the above is considered necessary due to all secondary extraction and resultant subsidence occurring beneath Lake Macquarie.

5.1.3 Management of Aboriginal Heritage Sites

If mine-induced subsidence levels exceed 20 mm, a review will be undertaken to identify any potential impacts to cultural heritage in consultation with DPIE.

In the event of disturbance, the following management strategy should be implemented. The strategy will include an accurate recording of the heritage item including:

- mapping of the site;
- photographic recording; and
- detailed survey.

In addition, a monitoring program is to be established based on the placement and monitoring of control points. If there is unforeseen impact on the heritage item, appropriate remediation works should be implemented following advice from DPIE, the DC Environment Compliance Coordinator and the heritage consultant.

DC will endeavour to protect the heritage site from harm wherever practicable. Where relevant, this will be in consultation with RAPs by using non-invasive measures which may include barrier fencing, erosion control, supports or bracing.

DC will undertake all mining operations, Aboriginal stakeholder consultation, site surveys, reporting, impact assessment, site assessment, monitoring and management of Aboriginal sites in accordance with this HMP that has been developed in consultation with the RAPs.

It is advised that if the sites are at risk of harm, a Section 90 AHIP to salvage or destroy the site should be applied for (if the project is not under the State Significant Development or Part 3A provisions of the EP&A Act). In any instance where Aboriginal artefacts are salvaged, a care and control application will also need to be lodged for storage arrangements of artefacts.

Remediation measures must aim to repair the site to maintain the cultural significance and reduce any further impacts to the site. Remediation measures may include infilling of cracks in sandstone rock bars or overhangs to reduce the natural weathering process, which can result in further damage, or undertake repairs to areas of erosion upstream of grinding grooves. Mitigation measures may involve not undertaking any actions at all if it is determined culturally inappropriate to do so by the relevant Aboriginal parties.

With the exception of site CV-001 45-7-0339, all Aboriginal sites identified do not occur within CVC and MC approved boundaries or land controlled by Delta Coal, nor are these sites in areas that would be impacted by the proposed mining activities.

For the Aboriginal sites that are both outside potential impact areas and not within land controlled by DC, passive management is proposed. Passive site management will comprise avoidance of mapped site localities in accordance with this HMP. Passive site management is preferable to active management as there are no activities proposed in these areas and active management measures such as fencing and signage would likely draw unwanted attention to sites.

5.1.4 Obligation to Avoid Harm

All employees, contractors, sub-contractors and visitors to CVC and MC have an obligation to avoid harming Aboriginal heritage unless engaged in an Aboriginal heritage management activity described in this plan.

The Environmental Compliance Coordinator will ensure all employees, contractors, and sub-contractors are aware of any Aboriginal objects or sites at CVC and/or MC. This will include a message detailing that:

- the objects or sites are protected by law;
- they may potentially be distributed across the project area and that new sites may be exposed in areas outside of the disturbance footprints;
- they are of significance to the Aboriginal community, and important to the wider community and must be treated with respect;
- they have included stone tool sites; and

- they can be hard to recognise, therefore reference must be made to the Aboriginal heritage map in this HMP in order to clearly identify them.

In the process of undertaking any mining activities there is potential to impact Aboriginal objects or sites. Any activity which results in the disturbance of the surface has the potential to harm Aboriginal heritage sites. The level of impact to Aboriginal sites depends on the nature of the surface works/subsidence and the physical characteristics of the Aboriginal site types. The MC project approval currently allows for first workings mining only in the Great Northern and Fassifern seams, with <20 mm surface, negligible subsidence effects. This is less than the average natural ground swell movement of 29 mm (Delany et al). This first working mining method is the key management tool to avoiding harm to aboriginal heritage.

5.1.5 Assessment of Potential Impact

If mining or mining associated activities have the potential to harm Aboriginal site/s, an assessment of the potential and likely impact must be undertaken in the form of an Aboriginal Cultural Heritage Impact Assessment (ACHIA). It is important that all aspects of Aboriginal heritage be considered in the assessment and technical information is appropriately balanced with an assessment of cultural values.

The ACHIA must be developed in accordance with the *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011) and any other relevant guidelines applicable to the planning instrument. As a minimum, The ACHIA must contain the following:

- a description of the Aboriginal object/s and declared Aboriginal places located within the area of the proposed activity;
- a description of the cultural heritage values, including the significance of the Aboriginal objects and declared Aboriginal places that exist across the whole area that will be affected by the proposed activity and the significance of these values for the Aboriginal people who have a cultural association with the project area and the surrounding land;
- how the requirements for consultation with Aboriginal people have been met;
- actual or likely harm posed to the Aboriginal object/s or declared Aboriginal places from the proposed activity with reference to the cultural heritage values identified and any practical measures that may be taken to protect and conserve those Aboriginal object/s or declared Aboriginal places; and
- any practical measures that may be taken to avoid or mitigate actual or likely harm, alternatives to harm or, if this is not possible, to manage (minimise) harm in accordance with this HMP and in consultation with the registered Aboriginal parties.

5.1.6 Unexpected Finds Procedure

As identified in the EA (AECOM, 2011), the following predictions were made with respect to the distribution of Aboriginal archeology in the vicinity of the site:

- Aboriginal shell midden sites are likely to occur in areas adjacent to lakes, creeks and coastal areas in the region;
- Aboriginal scarred or carved trees may be present where mature native trees remain, particularly in areas adjacent to lake foreshores and creek lines;

- stone artefacts, comprising artefact scatters or isolated finds, may occur associated with Aboriginal shell midden sites; and
- stone artefacts may occur across the landscape as random occurrences but are most likely to be associated with water bodies.

In light of the above predictive statements, Aboriginal archaeological sites including shell middens and artefact scatters are likely to occur on the Lake Macquarie foreshore and in areas adjacent to creek lines, particularly higher order creek lines.

In the event any new Aboriginal sites are discovered as part of any future archaeological investigations, or should unanticipated Aboriginal objects be found during approved site clearing or construction activities, the following actions will be undertaken:

- work will halt in the vicinity of the site;
- the Mine Manager, Environmental Compliance Coordinator and Approvals Coordinator are to be notified;
- the site will be assessed by a qualified archaeologist in consultation with the RAPs;
- where possible the site should be avoided, but if this is not feasible and the site is likely to be impacted, appropriate mitigation measures will be determined in consultation with the Aboriginal stakeholders;
- work will only recommence once the Environmental Compliance Coordinator advises that the site can be avoided or statutory approval for impact has been obtained; and
- an AHIMS site card will be completed and submitted in compliance with s.89A of the NPW Act within 21 days of discovering the site.

5.1.7 Discovery of Human Skeletal Remains

In the event that known or suspected burial site or suspected human skeletal remains are encountered within the CVC mine area and the MC project approval area, the following procedure must be followed:

- the immediate vicinity will be secured to protect the find and the find will be immediately reported to the work supervisor who will immediately advise the site supervisor or other nominated senior staff member, including the Mine Manager, Environmental Compliance Coordinator and Approvals Coordinator;
- the Environmental Compliance Coordinator or other nominated senior staff member will notify the police and the state coroner on the same day of the find (as required for all human remains discoveries);
- if the remains are historical and not of Aboriginal origin, Heritage NSW will be notified for further instruction; and
- works will not recommence until written approval is received.

5.1.8 Artefact records and storage facility

All cultural heritage items salvaged under the HMP will be held in an appropriate facility or location. The design and exact placement of the facility or location will be selected and established in consultation with the relevant RAPs.

All materials will be packaged and labelled generally in accordance with Australian Museum standards (refer to http://australianmuseum.net.au/document/Archaeological-CollectionDeposition-Policy).

All materials will be retained at the artefact storage facility for the life of the mine unless otherwise approved by Heritage NSW in a Section 85 Care and Control Permit under the NPW Act. At mine closure, the materials will be transferred to a facility nominated by the RAPs subject to approval by Heritage NSW in a Section 85 Care and Control Permit under the NPW Act.

The relevant material may alternatively be reburied within the CVC or MC area in a secure manner that allows later retrieval. The location must be chosen following consultation with the relevant Aboriginal stakeholders and Heritage NSW notified.

Where an agreed facility or burial location cannot be nominated, consideration will be given to lodging the material with either the Australian Museum (subject to its acceptance), a local Aboriginal cultural centre (if one is present) or a local heritage museum that can provide secure ongoing storage and curation.

5.2 Historic Heritage

There are no identified historic heritage items within the development consent or project approval boundary and therefore no management actions are currently proposed. Notwithstanding, unidentified historical relics are protected under Section 139 of the Heritage Act and if potential relics are uncovered during project-related activities, the land in which it is found cannot be disturbed or excavated without an excavation permit or other approval under SSD and PA conditions.

Considering the above, the following unexpected finds protocol applies for historic heritage:

- work will halt in the vicinity of the site;
- the Mine Manager, Environmental Compliance Coordinator and Approvals Coordinator are to be notified;
- the site will be assessed by a qualified archaeologist;
- where possible the site should be avoided, but if this is not feasible and the site is likely to be impacted, appropriate assessment, approvals and mitigation measures will be determined in consultation with Heritage NSW; and
- work will only recommence once the Environmental Compliance Coordinator advises that the site can be avoided or statutory approval for impact has been obtained.

If monitoring of any unexpected historic heritage finds indicate that mine-induced subsidence levels occur, a review will be undertaken to identify any potential impacts to unexpected finds in consultation with DPIE.

5.3 Heritage Management Trigger Action Response Plan

A Trigger Action Response Plan (TARP) has been developed for Delta Coal heritage management and is provided below.

	NORMAL	LEVEL 1 TRIGGER	LEVEL 2 TRIGGER
ABORIGINAL HERITAGE ITEMS	Aboriginal heritage site monitoring and subsidence monitoring indicates no detectable environmental consequences to heritage site(s).	• Aboriginal heritage site and or subsidence monitoring indicates potential detectable environmental consequences, or potential impacts have been reported to Delta Coal.	• Aboriginal heritage site monitoring indicates environmental consequence to heritage site(s)
ACTION	• No Action	• Have impacted sites inspected by archaeologist to determine if impacted. • Review monitoring program and modify if necessary. • Investigate actual and predicted subsidence in the vicinity of the reported heritage site(s).	• Notify (in writing) the NSW DPE, Heritage NSW and RAPs immediately upon becoming aware of impact to heritage site(s) • Co-ordinate a site inspection with RAPs • Investigate and implement any additional management measures as required in consultation with RAPs, Heritage NSW and NSW DPE.
HISTORICAL HERITAGE	• No observed impact to historical heritage site.	• Potential detectable environmental consequences but with negligible impacts to heritage site.	• Historical heritage site damage incurred as a result of mining operations.
ACTION	• No Action	• Monitor of site if underground workings being undertaken in vicinity of historic heritage site (not currently forecasted).	• Notify (in writing) the NSW DPE and Heritage NSW immediately after becoming aware of impact to historic heritage site(s). • Investigate and implement any additional management measures as required in consultation with Heritage NSW and DPE.

6 Reporting

6.1 Reporting impact to Aboriginal sites

An Aboriginal Site Impact Recording Form must be completed following impacts to AHIMS sites that are:

a) a result of test excavation carried out in accordance with the Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW;

b) authorised by an AHIP issued by Heritage NSW;

c) undertaken for the purpose of complying with Secretary's environmental assessment requirements issued by the DPIE for:

i) State Significant Development (SSD),

ii) State Significant Infrastructure (SSI), or

iii) a major project, or

d) authorised by an SSD/SSI/former Part 3A consent/approval under the EP&A Act.

Completed forms must be submitted to the AHIMS Registrar at the DPIE website. Aboriginal Site Impact Recording Forms can be downloaded from the DPIE website.

6.2 Annual Review

The results of the monitoring of any heritage sites will be reviewed upon receipt and a summary of any heritage monitoring undertaken will be included in the relevant Annual Review, along with a description of any actions being implemented or planned with respect to the known heritage sites. The Annual Review will be forwarded to the relevant authorities.

The Annual Review will also be forwarded to members of the Community Consultative Committee, local Councils (Central Coast and Lake Macquarie), to the Aboriginal stakeholders and be placed on the company's website.

6.3 Incident or Non-Compliance Reporting

If site inspections reveal that, as a direct result of CVC or MC, there has been unpredicted damage to a site, then DC will conduct an investigation into the source of the damage with a suitably qualified and experienced archaeologist. The report will be provided to relevant people and/or groups, including Councils, the Secretary of DPIE, RAPs and Heritage NSW.

The report will:

- describe the date, time and nature of the observation;
- identify the cause (or likely cause) of the damage;
- describe what action has been taken to date; and
- describe the proposed measures to address the damage and prevent further such occurrences.

DC will implement any recommendations in order to prevent future occurrences. Confidential information about Aboriginal site location will not be included in any report that enters the public domain. Additional details of the incident reporting process are provided in the Environmental Management Strategy (EMS). Any incident or complaint will be recorded and fully investigated to find root causes and corrective actions implemented where necessary.

7 Stakeholder Management and Response

7.1 Meetings

Regular meetings are to be held with RAPs on a minimum of an annual basis which will provide a project update and any required revisions to this management plan. These meetings may be on site or via teleconference.

7.2 Complaint Protocol

DC has a 24-hour telephone hotline (1800 687 260) through which members of the public can lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters.

All complaints are recorded and responded to and if, for some reason, no action is taken then the reason why is recorded. The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or, if no action was taken, the reason why; and
- follow up contact with the complainant.

7.3 Independent Review

As detailed in Condition 2, Schedule 5 of CVC SSD-5465 and Condition 1, Schedule 4 of MC PA 06_0311, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review.

7.4 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environmental Compliance Coordinator. If the response by DC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, the Mine Manager together with the Approvals Coordinator and Environmental Compliance Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by DC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in CVC Schedule 5, Condition 2 of SSD-5465 and in MC Schedule 4, Condition 1 of PA 06_0311.

7.4.1 Conflict of Interest

The mediator must, prior to the commencement of the mediation, disclose to the parties to the best of his or her knowledge any prior dealings with any of the parties as well as any interests in the dispute. If in the course If, in the course of the mediation the mediator becomes aware of any circumstances that might reasonably be considered to affect the mediator's capacity to act impartially, the mediator must immediately inform the parties of these circumstances. In this instance, the parties will then decide whether the mediation will continue with that mediator or with a new mediator appointed by the parties.

7.5 Training, Awareness and Competence

Training is an essential component of the implementation phase of this HMP. The Environmental Compliance Coordinator will ensure that training and awareness processes are implemented to manage, identify and minimise potential impacts of CVC and MC, and to ensure personnel are aware of their roles and responsibilities in terms of cultural heritage management.

Generally training at DC consists of induction training for new starters and contractors along with environmental awareness training at two-year intervals and ongoing "toolbox" training for all permanent employees as required.

As the document owner, the Approvals Coordinator is the contact point for any person that does not understand this document or their specific requirements and will provide guidance and training to any person that requires additional training regarding this HMP.

7.5.1 Heritage Induction

Health safety and environment inductions will include content on the nature of heritage items present or likely to be present within the CVC and MC leases. Records of inductions will be kept according to DC's standard practices.

The induction includes the following content:

- Historic heritage sites have not been identified nor are considered likely to occur within the CVC and MC project area;
- CVC and MC are within the traditional land of the Darkinjung and Awabakal peoples for whom Lake Macquarie was a key feature of their territories;
- three Aboriginal sites, a single artefact and two midden sites have been identified, fenced off and signposted within the CVC pit top area;
- Aboriginal sites are known to occur above current and future mining areas, and along certain parts of the Lake Macquarie foreshore;
- Aboriginal sites known to occur are scarred trees and middens. Middens are made up of concentrations of mature shellfish such as oyster, cockle and club whelk;
- the burial remains of Aboriginal people have been found in some middens. Some middens also include Aboriginal stone artefacts which generally have the appearance of chipped stone; and
- all Aboriginal sites are protected by the NPW Act, which provides significant penalties for harm to Aboriginal objects and sites. Any shellfish deposits or stone artefacts encountered must not be collected.

8 Audit and Review

8.1 Review and Improvement

In accordance with Schedule 6, Condition 5 of CVC Development Consent SSD-5465 and Schedule 5, Condition 4 of MC Project Approval 06_0311 this HMP shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the development consent.

Changes to this HMP will be made in the following circumstances:

- where new Aboriginal sites are discovered, they must be added to the inventory in this HMP within three months of the find; and
- where an AHIP is issued, this HMP will be reviewed and updated where necessary to comply with the requirements of any AHIP conditions.

Where changes are made to the HMP, a draft of the modified plan will be provided to RAPs for review. RAPs will not be required to review the HMP for minor plan updates. This comprises:

- when a new Aboriginal site is discovered and is at no risk of impact by the project. In this instance, the inventory of the HMP will be updated to acknowledge the site, but RAPs will not be required to review the HMP; and
- when the status of a site needs to be updated on the inventory of the HMP. For example, once a site has been salvaged the HMP will be updated to reflect the site's status. However, RAPs will not be required to review this action.

Although RAPs are not required to review the HMP for minor plan updates, they will be notified if new sites are identified and of updates relating to the status of Aboriginal cultural heritage sites.

Matters raised in consultation which are specific to the changes in the plan will be acknowledged and addressed in the modified plan.

Any changes made to this HMP will be made in consultation with Heritage NSW, with a copy of the revised management plan provided for approval.

8.2 Auditing

The objectives of an audit are to maintain compliance with the HMP. Audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

Any audit non-conformances and/or improvement opportunities will have corrective and preventative actions implemented to avoid recurrence, these actions will be loaded into the site Incident Database to ensure the actions are assigned to the relevant people and completed.

External audits will be conducted utilising external specialists and will consider this document and related documents. External auditors shall be determined based on skills and experience and upon what is to be accomplished.

An Independent Environmental Audit (IEA) was undertaken during June 2019. In accordance with SSD-5465 Schedule 6, Condition 9 and PA 06_0311 Schedule 5, Condition 8, IEA's will be scheduled for every three years thereafter (unless the Secretary directs otherwise) by an audit team whose appointment has been endorsed by the Secretary.

9 Records and Document Control

9.1 Records

Generally, the Environmental Compliance Coordinator or delegate will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

If the relevant RAPs would like to undertake further documentation and archival recording of particular sites and places of spiritual significance or would like to document and record their oral histories about the County, these matters should be internally resourced from within their own organisations. However, if the RAPs seek assistance from DC to facilitate any cultural requests, then a meeting will be held to discuss the nature of the assistance, the scope of works involved and whether DC is able to facilitate the request.

In the event that DC agrees to assist with any cultural requests, a written agreement must be produced which specifies who will be undertaking the archival recording and lodgement of information (being either the Aboriginal parties or Delta Coal), the recording methodology to be adopted and matters related to the care and control of the intellectual property.

9.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Approvals Coordinator.

A copy of this document is available on the DC website. Document revision details are provided in **Table 4**.

Table 4: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
1	06/11/2012	Original HMP	LakeCoal	N. Baker C. Ellis
2	23/06/2014	Reviewed	LakeCoal	Peter Campbell Robert Corbett C. Ellis
3	01/12/2019	Updated to Delta Coal format	Delta Coal	K. Weekes R. Desic C. Armit
4	19/10/2020	Combined CVC and MC HMP	Delta Coal	K. Weekes N. Lane-Kirwan M. Wilcox C. Armit
5	06/10/2022	Review of HMP following completion of 2022 Independent Environmental Audit.	Delta Coal	L. McWha

10 Roles and Responsibilities

All employees and contractors at DC are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this plan are identified in **Table 5**.

Table 5: Heritage Management Plan Roles and Responsibilities

Role	Responsibilities
Managing Director	• Ensure that adequate financial and personnel resources are made available for the implementation of the HMP.
Manager of Mining Engineering (Mine Manager)	• Maintain overall responsibility for environmental compliance with Mining Lease, EPL, development consent and other mining approvals as they pertain to the management of Aboriginal and historic heritage. • Ensure that adequate training is provided to staff to minimise impacts to cultural heritage.
Environmental Compliance Coordinator or delegate	• Point of contact of all onsite personnel regarding heritage. • Document owner responsible for managing the implementation of the plan. • Arrange for reviews of HMP. • Inclusion of any heritage monitoring summarised within the Annual Review. • Document owner responsible for managing the implementation of the plan. • Coordinate relevant specialist personnel to conduct regular monitoring at the required time and frequencies if required. • Ensure inclusion of heritage in worker inductions through delivery or input to induction documents. • Arrange inductions and training for all personnel involved in implementing this HMP. • If inadvertent impact on a listed heritage item occurs, implement remediation works following consultation with Heritage NSW and the heritage consultant. • Distribution of HMP copies as required. • Maintain a contact list for organisations and individuals who may need to be contacted under this HMP. • Be aware of the potential for further unrecorded heritage sites to occur.

Role	Responsibilities
Heritage Consultant	• Assist with the implementation of this HMP, as required. • Provide advice on remediation, if through unforeseen circumstances impact occurs on a heritage item. • Undertake the recording of new sites in accordance with government guidelines. • Provide heritage advice in accordance with relevant legislation. • Undertake recording of new sites in accordance with government guidelines. • Assist with updating this HMP when necessary.
All employees and contractors	• Comply with the requirements of this HMP. • Immediately notify Environmental Compliance Coordinator of possible heritage item or damage.

11 References

Documents referenced in the preparation of the HMP are detailed in **Table 6**.

Table 6: References

Reference	Title
Australian Standards	AS/NZS ISO 14001:2004 Environmental management systems – Requirements with guidance for use AS/NZS ISO 14004:2004 Environmental management systems – General guidelines on principles, systems and support techniques
Legislation and Regulations	*Environmental Planning and Assessment Act 1979* (EP&A Act) *Environment Protection and Biodiversity Act 1999* (EPBC Act) Environment Protection and Biodiversity Regulations 2000 *Mining Act 1992* *Protection of the Environment Operations Act 1997* (POEO Act) *Heritage Act 1977* Environment Protection Licence (EPL) 191 Environmental Protection Licence (EPL) 1770 Lake Macquarie City Council LEP 2014 Wyong Local Environmental Plan 2013 Project Approval (PA) 06_0311 (as modified) Development Consent SSD 5465 (as modified)
Delta Coal documents	Delta Coal Environmental Management Strategy
External documents	Delany et al 2005, Field Monitoring of Expansive Soil behaviour in the Newcastle-Hunter Region, Australian Geomechanics, Vol 40, Issue 2. Department of Environment, Climate Change and Water (DECCW) 2010, Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales. Department of Environment, Climate Change and Water (DECCW) 2010, Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales. Department of Environment, Climate Change and Water (DECCW) 2010, Aboriginal Consultation Requirements for Proponents. Department of Environment, Climate Change and Water (DECCW) 2011, Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in New South Wales. Department of the Environment and Energy (2013), EPBC Act Protected Matters Search Tool, Australian Commonwealth Government

Reference	Title
	Department of Environment (2013), Matters of National Environmental Significance, Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999, Commonwealth of Australia. Holdaway S et al. 2002, Artefact Visibility at Open Sites in Western New South Wales, Australia, Journal of Field Archaeology, Vol: 29, Number3/4, PP: 255-271 ICOMOS, (1999) The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, Australia ICOMOS Inc. Long A (2005) Aboriginal Scarred Trees in New South Wales: A field Manuel, Department of Environment and Conservation NSW. Mulvaney J & Kamminga J 1999, Prehistory of Australia, Allen and Unwin Publishing, NSW O'Connor S et al 2007, Stone Construction on Rankin Island, Kimberley, Western Australia, Australian Archaeology, Number 64, PP: 15-22 Office of Environment and Heritage (OEH) 2011, Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW. Report to State of NSW and the Office of Environment and Heritage, Department of Premier and Cabinet. OEH (2019), State Heritage Register, NSW Government, Office of Environment & Heritage

12 Definitions

ACHA Aboriginal Cultural Heritage Assessment

ACHCR Aboriginal Cultural Heritage Consultation Requirements

AHIMS Aboriginal Heritage Information Management System

AHIP Aboriginal Heritage Impact Permit

BCD Biodiversity and Conservation Division, DPIE

CCC Community Consultative Committee

CVC Chain Valley Colliery

DC Delta Coal

DPIE NSW Department of Planning, Industry and Environment

EL Exploration Licence

EA Environmental Assessment

EMS Environmental Management System

EP&A Act *Environmental Planning and Assessment Act 1979*

EPBC Act *Environment Protection and Biodiversity Act 1999*

EPL Environment Protection Licence

HMP Heritage Management Plan

ICOMOS International Council on Monuments & Sites

LEP Local Environment Plan

LGA Local Government Area

LMCC Lake Macquarie City Council

MC Mannering Colliery

NPW Act *National Parks and Wildlife Act 1974*

NPW Regulation National Parks and Wildlife Regulation 2009

NSW New South Wales

OEH Office of Environment & Heritage

PA Project Approval

PAD Potential Archaeological Deposits

POEO *Protection of the Environment Operations Act 1997*

RAPs Registered Aboriginal Parties

ROM Run of Mine

Secretary Secretary of the Department of Planning & Environment, or nominee

SHR State Heritage Register

Appendix 1 – Consultation, Endorsement Letter and Management Plan Approval

Delta Coal Heritage Management Plan Approval

Department of Planning and Environment

NSW GOVERNMENT

Our ref: SSD-5465-PA-106

Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd
Off Construction Road Off Ruttleys Road
Mannering Park NSW 2259

27/09/2023

Subject: Chain Valley Extension - Heritage Management Plan

Dear Mr McWha

I refer to the Heritage Management Plan submitted in accordance with condition 21A of Schedule 3 of the consent for the Chain Valley Extension Project (SSD-5465). I also acknowledge your response to the Department's request for additional information.

The Department has carefully reviewed the document and is satisfied that it meets the requirements of the relevant conditions of consent.

Accordingly, as nominee of the Planning Secretary, I approve the Heritage Management Plan (revision 5, dated 06 October 2023).

You are reminded that if there are any inconsistencies between the Plan and the conditions of approval, the conditions prevail.

Please ensure you make the document publicly available on the project website at the earliest convenience.

If you wish to discuss the matter further, please contact Kristina Robinson on 02 9860 1543.

Yours sincerely



James McDonough
Team Leader
Resource Assessments

As nominee of the Planning Secretary

Delta Coal Heritage Management Plan Consultation – RAPs

From: Chris Armit <CArmit@deltacoal.com.au>
Sent: Thursday, 22 October 2020 3:11 PM
To: ceo@birabanlalc.com.au; Barry Williams <barry.williams@dlalc.org.au>; Amanda Shields <amanda.shields@dlalc.org.au>; kerrie@awabakal.com.au; peterleven@y7mail.com; bahtabahnsick@hotmail.com; tracey@guringai.com.au; cacatua@resetdsl.net.au; darkinjung@dlalc.org.au; daniellachedzey@yahoo.com.au; wonn1sites@gmail.com; kauwul@gmail.com; heritage@heritage.nsw.gov.au; HERITAGEMailbox@environment.nsw.gov.au; Laura.Dafter@environment.nsw.gov.au; rog.hcc@environment.nsw.gov.au
Cc: Lachlan McWha <LMcWha@deltacoal.com.au>; Chris Nicholas <CNicholas@deltacoal.com.au>; angela@insiteheritage.com.au; Morgan Wilcox <mwilcox@emmconsulting.com.au>; Katie Weekes <kweekes@emmconsulting.com.au>
Subject: Unexpected find at Mine Cottages and Draft DC HMP for comment

Dear All,

Please also find attached as promised the draft Delta Coal (combined Chain Valley Colliery and Mannering Colliery) Heritage Management Plan for comment. We will finalise and forward on to DPIE after 14 days.

Regards,
Chris

Delta Coal Heritage Management Plan Consultation - Heritage NSW

NSW GOVERNMENT | Heritage NSW

Our ref: HMS ID 2091

Lachlan McWha
Environmental Compliance & Approvals Coordinator
Department of Planning and Environment
PO BOX 404, PARRAMATTA NSW 2124

By email: lmcwha@deltacoal.com.au

Dear Mr McWha

Delta Coal is seeking consultation on it's combined Heritage Management Plan (HMP) for Chain Valley Colliery and Mannering Colliery. The HMP has been updated following submission and approval of an independent environmental audit in 2022, and is a revision to an existing approved document. (SSD-5465-PA-106)

Thank you for your referral dated 19 December 2022 inviting comments from the Heritage Council of NSW on the above State Significant Development (SSD) proposal.

The proposed development involves:

- Consolidating the existing operations and associated development consent and project approval under a single development consent; and
- Allow for secondary extraction in the approved Mannering Colliery (MC) mining areas located under Lake Macquarie to maintain consistency with the existing Chain Valley Colliery (CVC) consent and provide an extension of the life of mine for an additional two years to 2029

The proposed SSD affects the following State Heritage Register (SHR) item and other places:

- Morisset Hospital Precinct (SHR no. 00827) 84 Bridge Street Morisset NSW 2264.
- Lake Macquarie Resting Place (Aboriginal Place).
- Lake Macquarie State Conservation Area.

The following reports were considered in our assessment:

- *Environmental Management System, Delta Coal, Heritage Management Plan.* Prepared by Delta Coal, 12 December 2022.

As delegate of the Heritage Council of NSW, I provide the following comments:

- Previous assessments determined that there would be no impacts to items on the SHR and recommended an unexpected heritage finds procedure.
- This Heritage Management Plan details the unexpected heritage finds procedure and heritage inductions for all staff.
- The Heritage Management Plan is sufficient for historical (non-Aboriginal) archaeology and no updates are required.

As the project area contains two local heritage items, and other local items are in the vicinity, advice should be sought from the relevant local council.

From: Nicole Davis
To: lmcwha@deltacoal.com.au,
Cc: Morgan Wilcox
Subject: Heritage NSW - Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - Delta Coal Heritage Management Plan (SSD-5465-PA-106)
Date: Saturday, 10 December 2022 10:34:00 AM
Attachments: image001.png
image002.png

Hi Lachlan and Morgan,

We will require an extension if you would like Heritage NSW to review your revised HMP Version 5, the is presently due of the 23 Dec, which is not sufficient time given our current MP workload. As the matter is post approval, we are not required to review, so unless you are willing to provide an extension until 16 Jan 2023, I will note that we will not be reviewing this version of the HMP. Please re-refer to us via the MPP with a revised date, if you are seeking our review and comment.

Kind Regards
Nicole Davis

Nicole Davis
Manager Assessments
Heritage NSW
Department of Planning and Environment

Delta Coal Heritage Management Plan Endorsement

Department of Planning and Environment

NSW GOVERNMENT

Lachlan McWha
Environmental Compliance Coordinator
Great Southern Energy Pty Ltd t/as Delta Coal
Off Construction Road
Mannering Park, NSW, 2259

13/09/2022

Approval of Suitably Qualified and Experienced Persons

Dear Mr McWha

I refer to your request seeking the Planning Secretary's approval of suitably qualified and experienced persons to revise several management plans and strategies required under the Chain Valley Colliery (CVC) and Mannering Colliery (MC) development consents (SSD 5465 and MP06_0311 respectively), as set out in the following table:

Name	Management Plan	Scope of Review
Rachael Thelwell	Land MP (includes Bushfire MP)	Combining CVC and MC Land MP, and addressing stakeholder comments
Morgan Wilcox	Heritage MP	Combining CVC and MC Heritage MP and addressing stakeholder comments
Lachlan McWha	Environmental Management Strategy, Noise MP, Air Quality and Greenhouse Gas MP, Rehabilitation MP, Water MP, Biodiversity MP, Segrass MP, Benthic Communities MP, Public Safety MP, Built Features MP, Subsidence Monitoring Program MWS5 and NMA Pillar Extraction, Subsidence Monitoring Program NMA First Workings and Lake M Extraction, Water MP	Minor administrative revisions

The Department is satisfied that the nominees are suitably qualified and experienced to undertake the scope of work described abve. Accordingly, I can advise the Planning Secretary approves Rachael Thelwell, Morgan Wilcox and Lachlan McWha to revise the abovementioned plans and strategies.

If you wish to discuss the matter further, please contact Tanvir Islam on (02) 9995 6389 or tanvir.islam@dpie.nsw.gov.au.

Yours sincerely

James McDonough
Team Leader
Resource Assessments

As nominee of the Planning Secretary

4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150 www.dpie.nsw.gov.au 1
Locked Bag 5022, Parramatta NSW 2124

NSW GOVERNMENT | Planning, Industry & Environment

Mr Chris Armit
Approvals Coordinator
Great Southern Energy Pty Ltd (t/as Delta Coal)
By Email: Carmit@DeltaCoal.com.au

09/10/2020

Dear Mr Armit

Chain Valley Colliery (SSD-5465) and Mannering Colliery (MP06_0311)
Request to Combine Management Plans and Approval of Experts

I refer to your letter of 2 October 2020 requesting the Planning Secretary's approval to combine specific management plans required under both the Chain Valley Colliery (SSD-5465) and Mannering Colliery (MP06_0311) development consents, in accordance with conditions 23(d) of Schedule 2 of SSD-5465 and 16(d) of Schedule 2 of MP06_0311 respectively.

The Department acknowledges the common ownership and management of both collieries by Great Southern Energy (trading as Delta Coal) and understands that they are managed in an integrated manner. Accordingly, the Department supports Delta Coal's request to combine specific management plans required under both consents to improve the on-site environmental management of the collieries.

Therefore, the Planning Secretary grants approval for Delta Coal to produce the following combined management plans:

- Heritage Management Plan – as required by condition 21A of Schedule 3 of SSD-5465 and condition 18A of Schedule 3 of MP06_0311;
- Land Management Plan – as required by condition 14 of Schedule 3 of MP06_0311;
- Noise Management Plan – as required by condition 9 of Schedule 3 of SSD-5465 and condition 3C of Schedule 3 of MP06_0311; and
- Air Quality and Greenhouse Gas Management Plan – as required by condition 13 of Schedule 3 of SSD-5465 and condition 17 of Schedule 3 of MP06_0311.

I also refer to your letter and supporting curriculum vitae requesting the Planning Secretary's approval of suitably qualified and experienced persons to prepare and review a number of management plans for the SSD-5465 and MP06_0311, in accordance conditions 21A(a) of Schedule 3 of SSD-5465 and 18A(a), 3C(a), 14(b), 17(a) of Schedule 3 of MP06_0311.

The Department has reviewed the nominations and information provided and is satisfied that the experts listed below are suitably qualified and experienced to assist in preparing the specified management plans. Consequently, the Planning Secretary approves the appointment of the following persons to prepare the listed management plans in accordance with the relevant conditions of SSD-5465 and MP06_0311.

Name	Organisation	Management Plan
Morgan Wilcox	EMM Consulting	Heritage Management Plan
Katie Teyhan	EMM Consulting	Noise Management Plan
Katie Weekes	EMM Consulting	Land Management Plan
Judith Cox	SLR Consulting	Air Quality and Greenhouse Gas Management Plan

For clarity, I would like to confirm that this approval is limited to the combining of the nominated management plans and does not extend to other requirements with respect to the preparation of, or required consultation for, other management plans for either of the development consents.

If you wish to discuss the matter further, please contact Melissa Anderson on 8275 1392.

Yours sincerely



Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

As nominee of the Planning Secretary

Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

This HMP has been prepared in accordance to Schedule 3, Condition 21A of SSD-5465 (MOD3), which states the requirements of the HMP and what it must address. **Table A2** outlines the requirements of the HMP and where this document addresses these requirements.

Table A2: Requirements from Chain Valley Colliery Development Consent (SSD-5465)

Condition No.	Requirement	Relevant section of this document
	Schedule 2 Administrative Conditions	
23	***Staging, Combining and Updating Strategies, Plans or Programs*** *With the approval of Planning Secretary, the Applicant may:*	**Section 8**
	a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);	**This Document**
	b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined);	**This Document**
	c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and	**Section 8.1**
	d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining mining consent or approval, in common ownership or management.	**This Document**
	Schedule 3 Environmental Conditions - General	
	Heritage	
21	*The Applicant must ensure that the development does not cause any direct or indirect impact on any identified heritage item located outside the approved disturbance area, beyond those predicted in the documents listed in condition 2(e) of Schedule 2.*	**This document**
21A	*The Applicant must prepare a Heritage Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:*	**This Document**
	a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary;	**This HMP has been prepared by EMM Consulting in accordance with correspondence**

Condition No.	Requirement	Relevant section of this document
		from DPIE dated 9 October 2020
	b) *be prepared in consultation with BCD and Registered Aboriginal Parties;*	**Submission letter dated 20 November 2012; approval letter dated 1 July 2013**
	c) *include consideration of the Aboriginal and non-Aboriginal cultural context and significance of the site;*	**Section 3 and 4**
	d) *describe the procedures and management measures to be implemented on the site or within any offset area to:*	**Section 5**
	i) *ensure all workers receive suitable Aboriginal cultural heritage inductions prior to carrying out any activities which may cause impacts to Aboriginal objects or Aboriginal places, and that suitable records are kept of these inductions;*	**Section 7.5.1**
	ii) *protect, monitor and manage identified non-Aboriginal heritage, Aboriginal objects and Aboriginal places (including any proposed archaeological investigations of potential subsurface objects and salvage of objects within the approved disturbance area) in accordance with the commitments made in the document/s listed in condition 2(e) of Schedule 2 and including the ongoing monitoring of site 45-7-0189 at Summerland Point*	**Section 4, 5.1.1 and 5.1.2**
	iii) *protect non-Aboriginal heritage, Aboriginal objects and Aboriginal places located outside the approved disturbance area from impacts of the development;*	**Section 5.2**
	iv) *manage the discovery of suspected human remains and any new Aboriginal objects or Aboriginal places, including provisions for burials, over the life of the development;*	**Section 5.1.6 and 5.1.7**
	v) *maintain and manage reasonable access for relevant Aboriginal stakeholders to Aboriginal objects and Aboriginal places (outside of the approved disturbance area); and*	**Section 1.5.6**
	vi) *facilitate ongoing consultation and involvement of Registered Aboriginal Parties in the conservation and management of Aboriginal cultural heritage on the site; and*	**Section 1.5.5**
	e) *include a strategy for the care, control and storage of Aboriginal objects salvaged on site, both during the life of the development and in the long term.*	**Section 5.1.8**

Condition No.	Requirement	Relevant section of this document
	The Applicant shall implement the approved management plan as approved from time to time by the Secretary.	
	Schedule 6 Environmental Management, Auditing and Reporting	
3	***Management Plan Requirements*** *Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:* *(a) a summary of relevant background or baseline data;* *(b) details of:* • *the relevant statutory requirements (including any relevant approval, licence or lease conditions);* • *any relevant limits or performance measures/criteria; and* • *the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;* *(c) any relevant commitments or recommendations identified in the document/s listed in condition 2(e) of Schedule 2;* *(d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;* *(e) a program to monitor and report on the:* • *impacts and environmental performance of the development; and* • *effectiveness of the management measures set out pursuant to condition 2(e) of Schedule 2;* *(f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;* *(g) a program to investigate and implement ways to improve the environmental performance of the development over time;* *(h) a protocol for managing and reporting any:* • *incident, non-compliance or exceedance of any impact assessment criterion or performance criterion;* • *complaint; or* • *failure to comply with other statutory requirements;* *(i) public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and* *(j) a protocol for periodic review of the plan.* *Note: The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.*	**This document**

Condition No.	Requirement	Relevant section of this document
4	*The Applicant must ensure that management plans prepared for the development are consistent with the conditions of this consent and any EPL issued for the site.*	**This Document**
5	*Revision of Strategies, Plans and Programs* *Within Three months of:* *a) the submission of an incident report under condition 6;* *b) the submission of an Annual Review under condition 8;* *c) the submission of an Independent Environmental Audit under condition 9; or* *d) the approval of any modification of the conditions of this consent (unless the conditions require otherwise),* *the suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant. If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary. Where revisions are required, the revised document must be submitted to the Planning Secretary for approval within six weeks of the review.* *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the development.*	**Section 8**
	Appendix 9: Statement of Commitments	
	Management and monitoring of heritage will continue to be undertaken in accordance with the Colliery's HMP, which will be reviewed and updated as required to include the commitments made below. Great Southern Energy Pty Limited will:	
	• *review and revise the HMP to remove site #45-7-0154 and incorporate any other changes as a result of the proposed modification;*	**Section 5.1.1**
	• *update the HMP following approval of the Proposal to include the extended area to which it relates;*	**This document**
	• *ensure that should unanticipated Aboriginal or historic heritage artefacts be found during dam embankment and diversion works, work will cease and the site assessed by an archaeologist; and*	**Dam works complete**
	• *ensure that in the unlikely event that skeletal remains are found during dam embankment and diversion works, work will cease immediately in the area and the NSW Police Coroner called to determine if the material is of Aboriginal origin. BCD and relevant Aboriginal community stakeholders will be notified if the remains are positively identified as being of Aboriginal origin to determine their appropriate management prior to works recommencing.*	**Dam works complete**

Appendix 3: Project Approval Summary

Mannering Colliery Project Approval PA 06_311 Summary

This HMP has been prepared in accordance to Schedule 3, Condition 18 and 18A of PA 06_0311 (MOD5), which states the requirements of the HMP and what it must address. **Table A3** outlines the requirements of the HMP and where this document addresses these requirements.

Table A3: Requirements from Mannering Colliery Project Approval (PA-06_0311)

Condition No.	Requirement	Relevant section of this document
	Schedule 2 – Administrative Conditions	
16	*Staging, Combining and Updating Strategies, Plans or Programs* *With the approval of the Planning Secretary, the applicant may:*	
	a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);	**This Document**
	b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined);	**This Document**
	c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and	**Section 8.1**
	d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining mining consent or approval, in common ownership or management	**This Document**
	Schedule 3 – Specific Environmental Conditions	
	Heritage	
18	*Protection of Aboriginal Heritage* *The Applicant must ensure that the development does not cause any direct or indirect impact on any identified heritage item located outside the approved disturbance area, beyond those predicted in the documents listed in condition 2(e) of Schedule 2.*	**This document**
18A	*The Applicant must prepare a Heritage Management Plan for the development to the satisfaction of the Planning Secretary. This Plan must:*	**This document**
	a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary;	**This HMP has been prepared by EMM Consulting in accordance with correspondence from DPIE dated 9 October 2020**
	b) be prepared in consultation with BCD and Registered Aboriginal Parties;	**Letter submitted; approval letter dated 26 November 2012**
	c) include consideration of the Aboriginal and non-Aboriginal cultural context and significance of the site;	**Section 3 and 4**
	d) describe the procedures and management measures to be implemented on the site or within any offset area to:	

Condition No.	Requirement	Relevant section of this document
	i) ensure all workers receive suitable Aboriginal cultural heritage inductions prior to carrying out any activities which may cause impacts to Aboriginal objects or Aboriginal places, and that suitable records are kept of these inductions;	**Section 7.5.1**
	ii) protect, monitor and manage identified non-Aboriginal heritage, Aboriginal objects and Aboriginal places (including any proposed archaeological investigations of potential subsurface objects and salvage of objects within the approved disturbance area) in accordance with the commitments made in the document/s listed in condition 2(e) of Schedule 2;	**Section 4 and 5.1.2**
	iii) protect non-Aboriginal heritage, Aboriginal objects and Aboriginal places located outside the approved disturbance area from impacts of the development;	**Section 5.2**
	iv) manage the discovery of suspected human remains and any new Aboriginal objects or Aboriginal places, including provisions for burials, over the life of the development;	**Section 5.1.6 and 5.1.7**
	v) maintain and manage reasonable access for relevant Aboriginal stakeholders to Aboriginal objects and Aboriginal places (outside of the approved disturbance area); and	**Section 1.5.6**
	vi) facilitate ongoing consultation and involvement of Registered Aboriginal Parties in the conservation and management of Aboriginal cultural heritage on the site; and	**Section 1.5.5**
	e) include a strategy for the care, control and storage of Aboriginal objects salvaged on site, both during the life of the development and in the long term. *The Applicant must implement the Heritage Management Plan approved by the Planning Secretary.*	**Section 5.1.8**
	Schedule 5 – Environmental Management, Monitoring, Auditing and Reporting	
3	***Management Plan Requirements*** *Management Plans required under this consent must be prepared in accordance with relevant guidelines, and include:* • *a) a summary of relevant background or baseline data;* *b) details of:* • *the relevant statutory requirements (including any relevant approval, licence or lease conditions);* • *any relevant limits or performance measures and criteria; and*	**This Document**

Condition No.	Requirement	Relevant section of this document
	• *the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;* c) *any relevant commitments or recommendations identified in the document/s listed in condition 2(e) of Schedule 2;* d) *a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;* e) *a program to monitor and report on the:* • *impacts and environmental performance of the development; and* • *effectiveness of the management measures set out pursuant to condition 2(e) of Schedule 2;* f) *a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;* g) *a program to investigate and implement ways to improve the environmental performance of the development over time;* h) *a protocol for managing and reporting any:* • *incident, non-compliance or exceedance of any impact assessment criterion or performance criterion;* • *complaint; or* • *failure to comply with other statutory requirements;* i) *public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and* j) *a protocol for periodic review of the plan.* *Note: The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans*	
4	*The Applicant must ensure that management plans prepared for the development are consistent with the conditions of this consent and any EPL issued for the site*	**This Document**
5	***Revision of Strategies Plans and Programs*** *Within three months of:* a) *the submission of an incident report under condition 6;* b) *the submission of an Annual Review under condition 8;* c) *the submission of an Independent Environmental Audit under condition 9; or* d) *the approval of any modification of the conditions of this consent (unless the conditions require otherwise),* *the suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant. If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary. Where revisions are required, the revised document must be submitted to the Planning Secretary for approval within six weeks of the review.* *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the development.*	**Section 8**
	Appendix 3: Statement of commitments – Aboriginal Heritage	
	Activities will continue to be managed in accordance with the Colliery's Aboriginal Cultural Heritage Management plan (ACHMP).	**This Document**

Condition No.	Requirement	Relevant section of this document
	If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to cultural heritage in consultation with BCD.	**Section 5.1.2**
	All relevant Mannering staff and contractors will be made aware of their statutory obligations for Aboriginal cultural heritage under the NP&W Act as part of the existing mine induction process.	***Section 5.1 and 7.5***
	An Aboriginal Cultural Heritage Management Plan (ACHMP) will be developed and implemented for the identified Aboriginal heritage items within the Development Site in consultation with the relevant Aboriginal stakeholders. If additional sites are identified they will be assessed for cultural significance and be incorporated into the ACHMP.	**Section 1.5 and 5.1**
	In the unlikely event that skeletal remains are identified, the NSW Police Coroner will be contacted to determine if the material is of Aboriginal origin. If determined to be Aboriginal, contact will be made with the BCD, a suitably qualified archaeologist and representatives of the relevant Aboriginal stakeholder groups to determine an action plan for the management of the skeletal remains and formulate management recommendations if required.	**Section 5.1.7**
	Appendix 3: Statement of commitments – European Heritage	
	If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to non-indigenous heritage.	**Section 5.2**
	All relevant Mannering staff and contractors will be made aware of their statutory obligations for European cultural heritage under the Heritage Act 1977 as part of the existing mine induction process.	**Section 5.2 and 7.5**
	If, during the course of development works, significant non-indigenous cultural heritage material is uncovered within the Development Site, the Heritage Branch of BCD will be notified, and any required monitoring or management strategies instigated.	**Section 6.3**

Appendix 4: AHIMS Search

Office of Environment & Heritage NSW

AHIMS Web Services (AWS)

Your Ref/PO Number : IE200578
Client Service ID : 542698

Note: This Excel report shows the sites found in AHIMS on the 19/10/2020. If this date is not the same as the original date of the Search Results letter obtained during the Basic Search, then the search results might be different. The PDF version of this report will always coincide with the Basic Search Results letter.

Site ID	Site	Datum	Zone	Easting	Northing	Context	Site status	Primary contact	Site features	Site types	Recorders	Reports
45-7-0131	Summerland Point;	AGD	56	366820	6332970	Open site	Valid		Shell : -, Artefact : -	Midden	Helen Brayshaw	
45-7-0138	Bonny Boy Gully;	AGD	56	366820	6332970	Open site	Valid		Shell : -, Artefact : -	Midden	Helen Brayshaw	1846
45-7-0144	Windermere Ck 1;	AGD	56	363000	6334800	Open site	Valid		Shell : -, Artefact : -	Midden	Anne Lloyd	2237
45-7-0154	M7 Fishery Point	AGD	56	366050	6334500	Open site	Valid		Shell : 2, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0157	M10 Casuarina Point Reserv	AGD	56	366300	6334990	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0158	M11;Lakeview Road, Barden	AGD	56	363500	6334110	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0159	M12;Bulgonia Road, Barden	AGD	56	363950	6334850	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0166	M8;Dandaraga Road, Sugar	AGD	56	365300	6334500	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0167	M9;Camp Brightwaters;	AGD	56	363500	6334880	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	2665
45-7-0176	Gwandalan;	AGD	56	367200	6333300	Open site	Valid		Shell : -, Artefact : -	Midden	Tom Griffiths	2465,102129
45-7-0177	Camp Kanangra;	AGD	56	369500	6331500	Open site	Valid		Shell : -, Artefact : -	Midden	Mr David Lambert,Mr Gavin Newton	
45-7-0178	Hemibula Creek - Scarred Tr	AGD	56	366800	6330400	Open site	Valid		Modified Tree (Carved or Scarred) : -	Scarred Tree	Mr Gavin Newton	
45-7-0179	Black Neds Point;	AGD	56	365150	6331450	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	
45-7-0181	Chain Valley Bay 1	AGD	56	366150	6329600	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	101093
45-7-0182	Chain Valley Bay 2;	AGD	56	366120	6330950	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	
45-7-0183	Diamond Drill Pt. North;	AGD	56	368050	6333200	Open site	Valid		Artefact : -, Shell : -	Midden	L.M Nelson	102129
45-7-0184	Gwandalan;	AGD	56	368500	6331800	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	
45-7-0186	Pt Wolstonecraft 1;	AGD	56	368350	6334200	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	
45-7-0189	Sandy Beach 1;	AGD	56	364950	6331450	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson	
45-7-0201	Nord 1 (N1)	AGD	56	369600	6332600	Open site	Valid		Shell : -, Artefact : -	Midden	Iain Stuart	3022
45-7-0207	The Hole 1 (TH1)	AGD	56	361820	6329800	Open site	Valid		Artefact : -	Open Camp Site	Kerry Navin,Mr Kelvin C	3697,101093
14-7-0149	Gwandalan	AGD	56	368000	6333300	Open site	Valid		Shell : -, Artefact : -	Midden	Tom Griffiths	102129
45-3-3435	RPS HSO MwP1	AGD	56	359424	6334225	Open site	Valid		Shell : -, Potential Archaeological Deposit (PAD		RPS Australia East Pty Ltd - Blacktown	
45-7-0290	Gwandalan 1	AGD	56	368088	6329979	Open site	Valid		Shell : -		Doctor.Tim Owen,ERM Australia Pty Ltd- Sydne	
45-7-0316	RPS Wyee Point 2	GDA	56	362237	6331450	Open site	Valid		Shell : -		RPS Australia East Pty Ltd - Hamilton,Ms Larair	
45-7-0293	RPS MP3	GDA	56	365058	6335017	Open site	Valid		Modified Tree (Carved or Scarred) : -		RPS Australia East Pty Ltd - Hamilton,Ms Larair	
45-7-0190	Wyee Point	AGD	56	362398	6331810	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson,RPS Australia East Pty Ltd - Hamilt	
45-7-0291	RPS HSO M1	GDA	56	361555	6331952	Open site	Valid	Koompahtoo LALC	Shell : -		RPS Australia East Pty Ltd - Hamilton,Ms Larair	
45-7-0357	Noamunga CR Midden	GDA	56	369583	6333118	Open site	Valid		Shell : -		Ms Sharon Hodgetts	
45-3-4287	Wyee 7	GDA	56	359559	6327310	Open site	Valid		Artefact : -		Insite Heritage Pty Ltd,Ms Elizabeth Wyatt	
45-3-4337	Mannering Creek AS1	GDA	56	358875	6328046	Open site	Valid		Artefact : -		Umwelt (Australia) Pty Limited - Individual users	
45-7-0226	K 4 Koompahtoo	AGD	56	360390	6334990	Open site	Valid		Artefact : -	Isolated Find	William Smith	99218
45-3-3165	K 1 Koompahtoo	AGD	56	359490	6332490	Open site	Valid		Artefact : -	Open Camp Site	William Smith	99218
45-7-0225	K 3 Koompahtoo	AGD	56	360650	6334900	Open site	Valid		Artefact : -	Isolated Find	William Smith	99218
45-7-0079	Crangan Bay;Stranger Gully;	AGD	56	368450	6330750	Open site	Valid		Shell : -, Artefact : -	Midden	ASRSYS	
45-7-0001	Morisset Hospital	AGD	56	361550	6332450	Open site	Valid		Shell : -, Artefact : -	Midden	L.M Nelson,A.J Barnett	1263
45-7-0003	Vales Point;Lake Macquarie;	AGD	56	363738	6331615	Open site	Valid		Shell : -, Artefact : -	Midden	Wyong Shire Council	
45-3-1553	Wyee Bay;Ruttleys Road;	AGD	56	362540	6330400	Open site	Valid		Shell : -, Artefact : -	Midden	Val Attenbrow,Glen Morris	
45-7-0262	SJOG 7	GDA	56	364036	6333848	Open site	Valid		Grinding Groove : 6		Mrs.Angela Besant	
45-7-0263	SJOG 6	GDA	56	364026	6333875	Open site	Valid		Shell : -		Mrs.Angela Besant	
45-7-0239	MP 1	AGD	56	362100	6334400	Open site	Valid	T Russell	Potential Archaeological Deposit (PAD) : -		Mrs.Angela Besant	
45-7-0253	Gwandalan 2	GDA	56	367386	6331169	Open site	Valid		Shell : -		Doctor.Tim Owen	
45-7-0254	gwanddalan 1	GDA	56	368088	6329979	Open site	Valid		Shell : -		Doctor.Tim Owen	
45-3-3166	K 2 Koompahtoo	AGD	56	359840	6332530	Open site	Valid		Artefact : -	Isolated Find	William Smith	99218
45-7-0255	Trinity Point GG2 (Catherine	GDA	56	363618	6333664	Open site	Valid		Grinding Groove : -		Mrs.Angela Besant	
45-7-0256	Trinity Point Scarred Tree 2 (	GDA	56	363749	6333815	Open site	Not a Site		Modified Tree (Carved or Scarred) : -		Mrs.Angela Besant,Insite Heritage Pty Ltd,Urba	
45-7-0257	Trinity Point Ochre (Catherin	GDA	56	363958	6333791	Open site	Valid		Ochre Quarry : -		Mrs.Angela Besant	
45-7-0258	Trinity Point IF1 (Catherine H	GDA	56	363730	6333744	Open site	Valid		Artefact : -		Mrs.Angela Besant	
45-7-0338	RPS GWANDALAN IF1	GDA	56	368263	6331126	Open site	Valid		Artefact : 1		RPS East Australia Pty Ltd - Echuca Victoria	

Report generated by AHIMS Web Service on 19/10/2020 for Morgan Wilcox for the following area at Datum : GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6326206 - 6336206 with a Buffer of 1000 meters. Additional Info : Update to heritage management plan. Number of Aboriginal sites and Aboriginal objects found is 99

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Site ID	Site	Datum	Zone	Easting	Northing	Context	Site status	Primary contact	Site features	Site types	Recorders	Reports
45-7-0320	RPS Mannering 1	GDA	56	383449	6331411	Open site	Valid		Shell : 1		Ms.Laraine Nelson	
45-7-0321	RPS Mannering 2	GDA	56	383401	6331331	Open site	Valid		Modified Tree (Carved or Scarred) : 1		Ms.Laraine Nelson	
45-7-0339	CV 001	GDA	56	384943	6329478	Open site	Valid		Artefact : 1		Mrs.Rebecca Newell,EI	104283
45-7-0374	Gwan IF1	GDA	56	388302	6331050	Open site	Valid		Artefact : -		Mrs.Angela Besant,Insite Heritage Pty Ltd	
45-7-0379	Nords Wharf PAD	GDA	56	389683	6331871	Open site	Destroyed		Artefact : -, Potential Archaeological Deposit (P		MCH - McCardle Cultural Heritage Pty Ltd,MCH	
45-7-0378	Dungutti Elders office Clonec	GDA	56	382791	6335021	Open site	Valid		Artefact : -		Miss.Jessica Wegener,Mount Grenfell Aborigin	
45-7-0384	32 marine parade	GDA	56	389777	6333058	Open site	Valid		Shell : -		Mr.david ahoy,lower hunter aboriginal incorpora	
45-3-0334	Tiembula Creek Midden;Tien	AGD	56	386730	6330420	Open site	Valid		Shell : -, Artefact : -	Midden	Mary Dallas Consulting	1076
45-7-0227	St Johns 1	AGD	56	383680	6333520	Open site	Valid		Artefact : -		Mrs.Angela Besant	100896
45-7-0228	St Johns 2	AGD	56	383720	6333820	Open site	Valid		Artefact : -		Mrs.Angela Besant	100896,101024
45-7-0230	K3 KOOMPAHTOO	AGD	56	380650	6334900	Open site	Valid		Artefact : -		Stephen Griffen	
45-7-0080	Mannering Park;	AGD	56	384780	6328890	Open site	Valid		Modified Tree (Carved ; Scarred Tree		ASRSYS	101093
45-7-0244	St Johns 3	AGD	56	383580	6333600	Open site	Valid	T Russell	Artefact : 1		Mrs.Angela Besant	100896,102504
45-7-0268	CV-04-09	GDA	56	388381	6331136	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0269	CV-06-09	GDA	56	388061	6329867	Open site	Valid		Artefact : 1		Mr.Geordie Oakes	
45-7-0270	CV-07-09	GDA	56	387043	6331305	Open site	Valid		Artefact : 1		Mr.Geordie Oakes	
45-7-0271	CV-08-09	GDA	56	386587	6330975	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0272	CV-09-09	GDA	56	386650	6330868	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0273	CV-10-09	GDA	56	386675	6330868	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0274	CV-12-09	GDA	56	387290	6330372	Open site	Valid		Artefact : 1		Mr.Geordie Oakes	
45-7-0275	CV-14-09	GDA	56	387468	6330191	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0276	CV-15-09	GDA	56	386304	6329303	Open site	Valid		Modified Tree (Carved or Scarred) : 1		Mr.Geordie Oakes	
45-7-0277	CV-16-09	GDA	56	386335	6329635	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0278	CV-17-09	GDA	56	386273	6329369	Open site	Valid		Modified Tree (Carved or Scarred) : 1		Mr.Geordie Oakes	
45-7-0279	CV-18-10	GDA	56	387003	6333279	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0280	CV-19-10	GDA	56	386998	6333151	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0281	CV-20-10	GDA	56	385568	6331434	Open site	Valid		Shell : 1		Mr.Geordie Oakes	
45-7-0282	CV-21-10	GDA	56	386221	6331192	Open site	Valid		Shell : -		Mr.Geordie Oakes	
45-7-0340	Nords Wharf 1	GDA	56	389821	6331865	Closed si	Destroyed		Artefact : 1		MCH - McCardle Cultural Heritage Pty Ltd,Ms.P	
45-7-0341	Nords Wharf 2	GDA	56	389858	6331788	Open site	Destroyed		Artefact : 1		MCH - McCardle Cultural Heritage Pty Ltd,Ms.P	
45-7-0342	Nords Wharf 3	GDA	56	389788	6331822	Open site	Valid		Artefact : 1		Mr.Aaron Fogel	
45-7-0349	NWR NORDS WHARF ROA	GDA	56	389760	6331962	Open site	Valid		Artefact : -		Miss.Philippa Sokol	
45-7-0383	Woods Point Repatriation sit	GDA	56	382530	6333367	Open site	Valid	Doctor User Test	Burial : 1, Modified Tree (Carved or Scarred) : 1		Ms.Mary Temple (nee Ghosn)	
45-7-0405	HN-LM-T01	GDA	56	387338	6327869	Open site	Valid		Aboriginal Ceremony and Dreaming : -		Mrs.Tessa Boer-Mah,Heritage Now - Belmont	
45-7-0406	HN-LM-T02	GDA	56	387343	6327823	Open site	Valid		Aboriginal Ceremony and Dreaming : -		Mrs.Tessa Boer-Mah,Heritage Now - Belmont	
45-7-0412	DC1;	GDA	56	385049	6330081	Open site	Valid		Shell : -		Mrs.Angela Besant,Insite Heritage Pty Ltd	
45-7-0413	DC2;	GDA	56	385006	6330070	Open site	Valid		Shell : -		Mrs.Angela Besant,Insite Heritage Pty Ltd	

Report generated by AHIMS Web Service on 19/10/2020 for Morgan Wicks for the following area at Datum :GDA, Zone : 56, Eastings : 369462 - 389462, Northings : 6328206 - 6334206 with a Buffer of 1000 meters. Additional Info : Update to heritage management plan. Number of Aboriginal sites and Aboriginal objects found is 84

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Appendix 5: Criteria for Listing on the State Register

Heritage Council of New South Wales

Heritage Act 1977

CRITERIA FOR LISTING ON THE STATE HERITAGE REGISTER

The State Heritage Register is established under Part 3A of the Heritage Act (as amended in 1998) for listing of items of environmental heritage[1] which are of state heritage significance[2].

To be assessed for listing on the State Heritage Register an item will, in the opinion of the Heritage Council of NSW, meet more than one of the following criteria[3] or if an item satisfies only one of the criteria, the item is of such particular significance that it should be listed.

a) an item is important in the course, or pattern, of NSW's cultural or natural history;

b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;

c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;

d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons;

e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history;

f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;

g) an item is important in demonstrating the principal characteristics of a class of NSW's
- cultural or natural places; or
- cultural or natural environments.

An item is not to be excluded from the Register on the ground that items with similar characteristics have already been listed on the Register.

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[1] ***environmental heritage*** means those places, buildings, works, relics, moveable objects, and precincts, of state or local heritage significance (section 4, *Heritage Act, 1977*).

[2] ***state heritage significance***, in relation to a place, building, work, relic, moveable object or precinct, means significance to the State in relation to the historical, scientific cultural, social, archaeological, architectural, natural or aesthetic value of the item (section 4A(1), *Heritage Act, 1977*).

[3] Guidelines for the application of these criteria may be published by the NSW Heritage Division.

Appendix 10 Built Features Management Plan

Delta coal	Doc Owner: **Approvals Coordinator** Doc No:

CHAIN VALLEY COLLIERY

Built Features Management Plan

ENVIRONMENTAL MANAGEMENT PLAN

Author/s	Chris Armit – Delta Coal
Authorised by:	Chris Armit - Approvals Coordinator
Date:	19 March 2021

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1 Introduction

1.1 Purpose and Scope

The purpose of this Built Features Management Plan (BFMP) is to outline the process for management of built features within the subsidence affected zone associated with miniwall S5, pillar extraction area in the Northern Mining Area (Northern Pillar Area - NPA) and first workings beneath Morisset Peninsula. The primary objectives of the document are to:

- ensure compliance with SSD-5465 and relevant mining lease conditions and Extraction Plan approvals;
- identify all existing surface and subterranean infrastructure that may be potentially impacted by the secondary extraction of Miniwall S5, NPA pillar extraction and first workings underneath the Morisset Peninsula area;
- outline the process for developing monitoring and management protocols with the respective asset owners;
- describe the review and reporting requirements as well as the relevant frequencies and duration of monitoring and
- allocate roles and responsibilities within the Chain Valley Colliery (CVC) management structure such that all actions emanating from this document have specific task owners.

The scope of this document includes all land and subterranean man-made features that are located within the projected subsidence affected zone associated with above areas.

The timing of this management plan is such that the actions emanating from it shall be initiated prior to the commencement of the appropriate extraction area and will continue for a minimum of 12 months after the completion of extraction.

Data collected under this management plan shall be supplied to all relevant stakeholders and any exceedance of predicted subsidence effects or impacts shall be reported as soon as practicable. Prior to ceasing ongoing monitoring, all captured data is to be assessed for stability and mutual agreement to the cessation of monitoring reached between all relevant stakeholders and DC.

A formal Environmental Management System (EMS) has been developed as a systematic and structured approach to managing environmental issues at the operation. This has been developed in general accordance with the requirements of the international standard ISO 14001.

This BFMP is an element of the DC EMS.

1.2 Background

CVC is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see Figure 1). The pit-top is located approximately 1 km south-east of the township of Mannering Park at the southern extent of Lake Macquarie.

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam, commenced with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963.

Great Southern Energy Pty Ltd (trading as Delta Coal) took over as owner and operator of CVC and as operator of MC on 1 April 2019.

Mining is currently undertaken at CVC, with the coal being transported underground to MC where the coal is crushed and screened and sent directly to VPPS.

2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities. A number of legislative requirements, government policies and guidelines are applicable. Key items relevant to this management plan are:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Mining Act 1992*;
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*;
- Department of Primary Industries (2013), *Policy and guidelines for fish habitat conservation and management*; and
- ANZECC 2000, Australian *and New Zealand Guidelines for Fresh and Marine Water Quality*.

Delta lands are within the LMCC and Central Coast Council local government areas (LGAs).

2.2 Development Consent SSD-5465 Requirements

This BFMP has also been completed to satisfy the requirement of Condition 7(g), Schedule 4 of Development Consent SSD-5465 (Modification 3).

Built features related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

Condition No.	Requirement	Relevant section of this document
	Schedule 4 Environmental Conditions – Underground Mining	
7(g)	include a Built Features Management Plan, which has been prepared in consultation with RR and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which;	**This BFMP plan** **Section 2.3**
	addresses in appropriate detail all items of public infrastructure and all classes of other built features;	**Section 3**
	• has been prepared following appropriate consultation with the owner/s of potentially affected feature/s;	**Section 2.3**
	• recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner	**Section 6**

2.3 Consultation

The BFMP is required to be prepared in consultation with the Resources Regulator (RR) and the owners of the affected public infrastructure to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings as per Schedule 4 (Specific Environmental Conditions) condition 7 (g). A draft for comment copy of the BFMP was provided to Delta Coal employees with roles and responsibilities under the BFMP on the 8 September 2020. A draft for comment copy of the BFMP including updates for miniwall S5 and the northern mining pillar extraction area was provided to DPIE, RR, Lake Macquarie City Council (LMCC), Central Coast Council (CC Council), Subsidence Advisory NSW (SA), combined CVC and MC CCC, Roads and Maritime Services (TfNSW) on 16 December 2020. An update with consultation from these stakeholders was uploaded onto the Planning Portal on 18 January 2020. Comments were received from DPIE and updated in March 2020. This management plan is an Appendix to the CVC Miniwall S5 and NPA Extraction Plan. Evidence of consultation is provided in **Appendix 1**.

TfNSW who are the managers of the Pelican Rock navigational marker and other navigational markers, have been previously consulted on the development of the S2/S3 and S4 Built Features management plans and have provided guidance on the serviceability limits of the marker. Lake Macquarie Marine Rescue were originally consulted on the Pelican Rock Navigational Marker.

All DC workers affected by the requirements of this management plan shall have access to a copy of this document and associated documents via the workplace document control system for review purposes.

MC and CVC have a combined Community Consultation Committee (CCC) made up of various members from the surrounding communities. The planned development of the miniwalls S2, S3,S4, S5 and northern pillar area and the predicted subsidence effects and impacts were discussed during the 2020 quarterly CCC meetings.

The resultant monitoring and inspection report prior, during and subsequent to the miniwalls S2, S3,S4, S5 and NPA development will continue to be presented and discussed at future CCC meetings. In the event of an unexpected subsidence impact and/or an exceedance of predicted subsidence effects or impacts, the CCC members will be notified as soon as practicable.

Closer to the mining being undertaken home owners along the shoreline will receive a letter detailing the current mining operations and proposed foreshore subsidence monitoring and most owners, where house are inhabited, have been previously been amendable to allowing access to their property to conduct this monitoring.

Table 1: Consultation Summary

Stakeholder	Comments	Response / Action
DPIE-Resource Assessments	• Request for information (RFI) provided on 5 March 2020. See attached DPIE RFI letter and attachment (Appendix 1).	• Section 2.3 updated • See tracked changed document provided on planning portal for updated consent references and mining panel numbering
Resource Regulator	• See Appendix 1 for consultation • Applicability for High Risk Activity and clause 67 for secondary extraction	• See Appendix 1 for High Risk Activity Management Report submission
LMCC	• No comments	• Nil
Subsidence Advisory	• No comments	• Nil
TfNSW – Maritime	See Appendix 1 for consultation • 1-Notification requirements for construction • 2 Vessel safety requirements • 3 Vessel safety requirements • 4 Notification/Action requirements	• Plan updated for comments and consultation included in Appendix 1 • Site survey personnel notified of TfNSW -Maritime vessel requirements • See Section 7.3 for updated notification requirements

Stakeholder	Comments	Response / Action
	• 5 Confirmation request on subsidence at NLM045 • 6 and 7 Acknowledgement of acceptable subsidence on Navigational markers	• See Section 4.1.1 for updated acceptable subsidence limits of navigational markers • Response provided by DC on xx/1/2021 on subsidence at NLM045
CCC	• No comments	• Nil

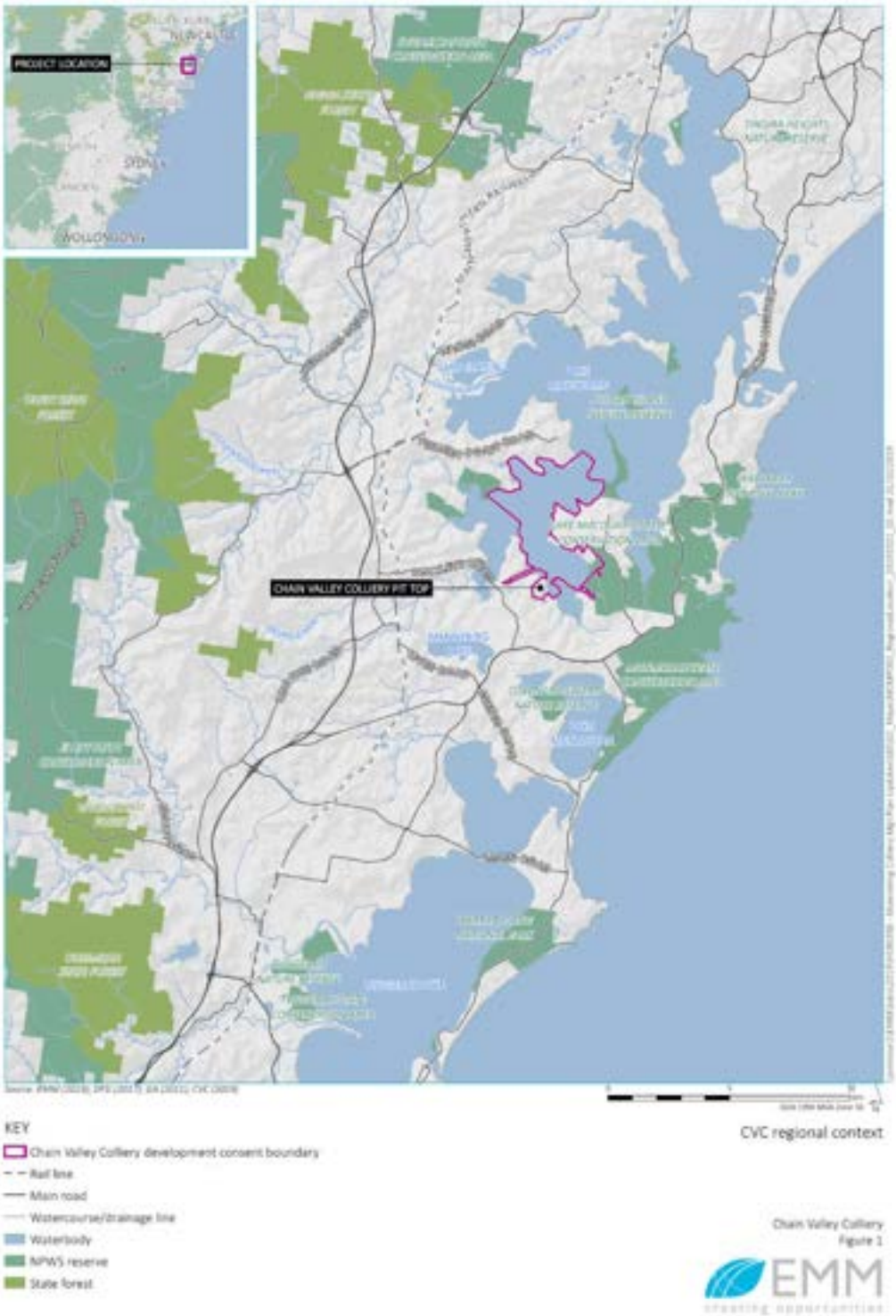


Figure 1: Regional Context

3 Built Features Management

3.1 Identification

A surface field mapping exercise has been undertaken by DC above the S5 Miniwalls and Northern Pillar Area extraction and Morisset Peninsula with the intent of identifying surface-built features which could be potentially affected by the completion of secondary extraction. The following sections list the identified built features as well as a description of each.

3.2 Navigational Markers



Figure 2: Navigational Markers on Lake Macquarie

The Pelican Rock Navigational Marker NLM045 (Isolated Danger) is located above Tailgate S2 (TGS2) (Figure 2).

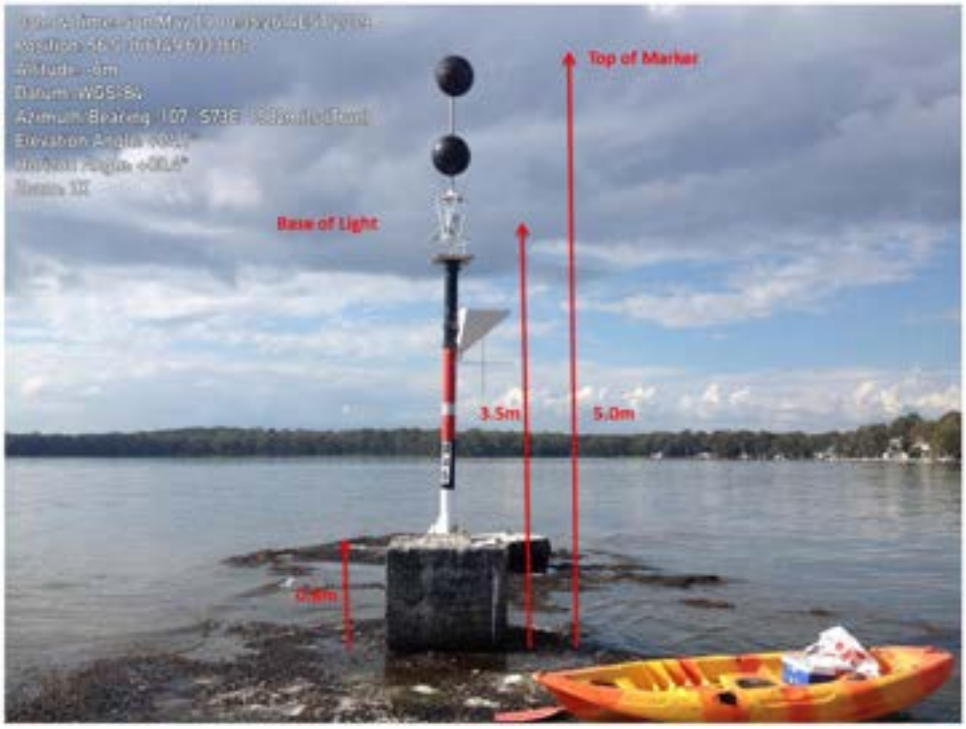


Figure 3: Pelican Rock Isolated danger Navigational Marker NLM045

The navigational marker on Pelican Rock falls into the category of 'Other buoys and signs – Isolated danger' (Figure 5)

The Isolated Danger beacon indicates specific dangers with generally safe waters all around (e.g. a wreck). It is advised to sailors to pass them on any side but not to pass too close. If lit, it shows a white light flashing in groups of two (RMS, 2019). There is a lit isolated danger beacon (NLM062) on the rock/point south of Sugar Bay

There are 2 navigational markers (NLM063) and (NLM064) off Morisset East Peninsula within SSD5465 project area that fall into the category of 'Cardinal Marks' (see Figure 6). Cardinal Marks take their name from the compass quadrant in which they are placed and indicate the safe side of a danger on which to pass, eg north of the north mark, (RMS, 2020).



Figure 5: Other Buoys and Signs – Isolated Danger

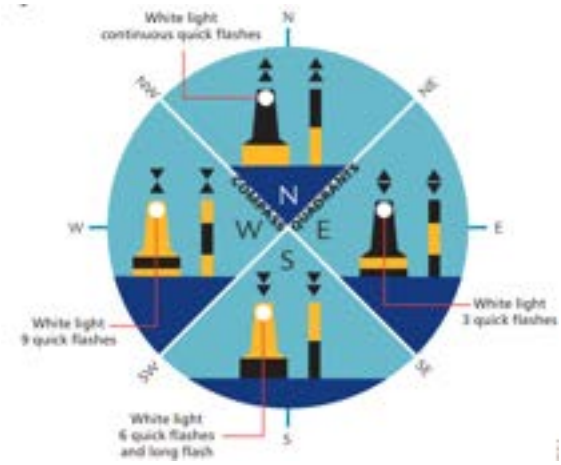


Figure 6: Cardinal Marker

3.3 Houses and other structures along the Summerland Point Foreshore and Morisset Peninsula Foreshore

Many of the built features along the foreshores can be seen in Figure 7 (photo) and Figure 8. These include houses, other associated structures, jetties, moorings, roads and services. There are workings adjacent in the stratigraphically overlying Wallarah seam as shown in Figure 9 and adjacent Myuna Colliery Fassifern workings.



Figure 7: Aerial Photography of the Built Features along the Foreshore adjacent to MWS5



Figure 8: Aerial Photography of the Built Features along the Foreshore at Fishery Point, Morisset Peninsula

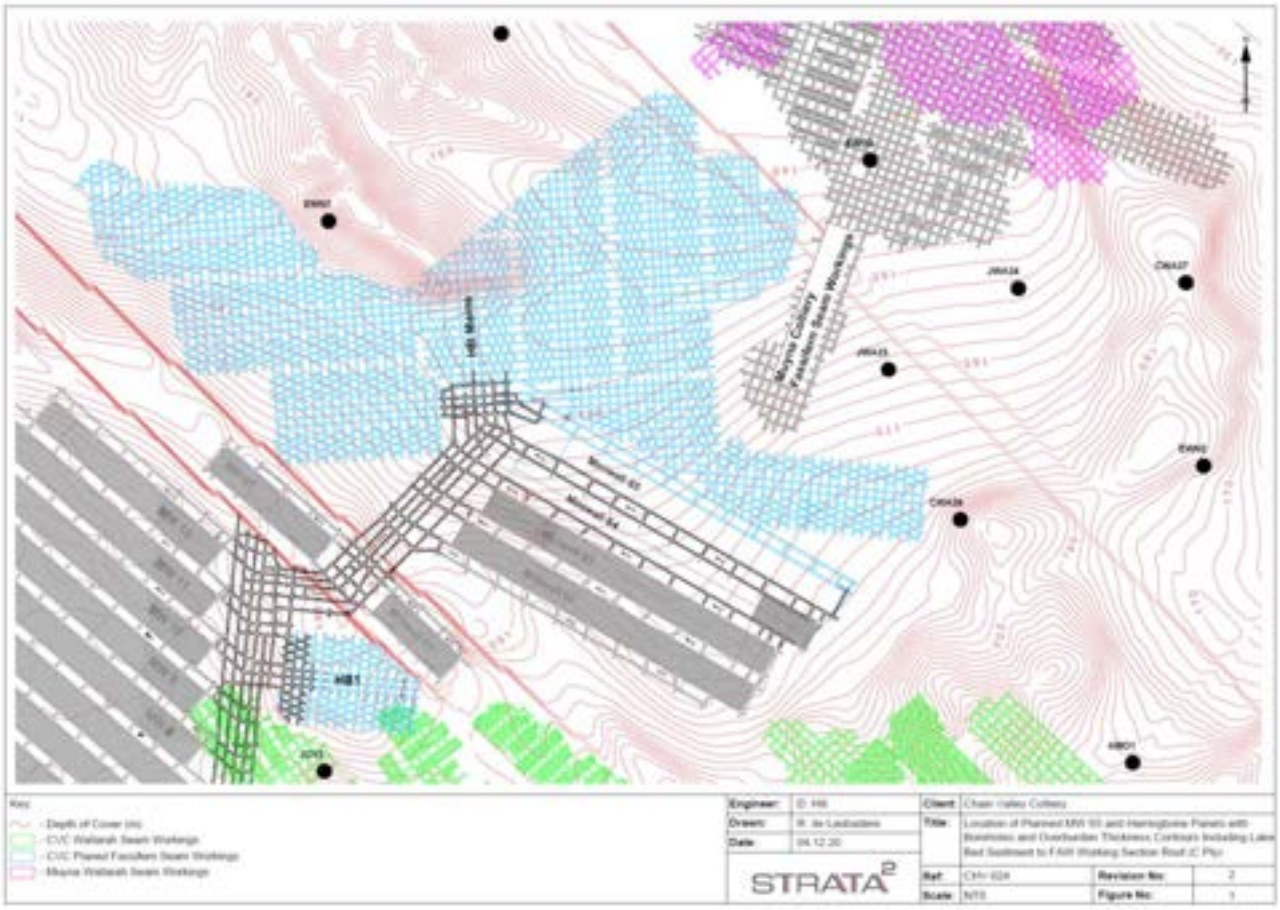


Figure 9: Overlying Wallarah workings and Myuna workings (Wallarah and Fassifern seams)

4 Subsidence Predictions and Management Procedures

4.1 Subsidence Predictions

Subsidence effect predictions have been undertaken for Miniwalls S5, NMA and Morisset Peninsula by Strata 2 Ground Control Consulting. (Strata2, 2019). A site-specific geotechnical model has been developed by Strata2, taking into consideration the design of the mining geometries, a review of previous subsidence performances, and an assessment of pillar behaviour as well as roof and floor stability in the Fassifern Seam workings.

These predicted subsidence effects have then be used in conjunction with the location of the identified surface built features to predict the subsidence effects at each identified feature.

4.1.1 Navigational Markers

The predicted vertical subsidence for the Pelican rock navigational marker (NLM045)due to MWS2, MWS3, MWS4 and MWS5 is 155 mm and tilt values <4 mm/m. The predicted subsidence has been provided to TfNSW- Maritime and the resources regulator. Subsidence monitoring and management strategies have been developed for the marker. TfNSW-Maritime serviceability criteria of the Pelican Rock Navigational marker (NLM045) and Sugar Bay Rock Navigational marker are <500 mm vertical subsidence and <5 degrees tilt. At the time of this document review both S2 and S3 miniwalls have been extracted with 30mm change in height measured with no change in tilt from vertical (0 degrees).

Navigational Marker	Vertical Subsidence Predictions	Tilt predictions
Pelican Rock (NLM045)	• 155mm	• <4mm/m
Sugar Bay Rock (NLM062)	• < 20mm	• N/A
Fishery Point (NLM063)	• <20mm	• N/A
Casuarina Point (NLM064)	• <20mm	• N/A

NSW Maritime acknowledged that the 4mm/m tilt on NLM045 is less than 0.25 degrees and using this same criteria for NLM062 the 20mm movement and 0 tilt is also acceptable. The NLM063 and NLM064 are buoys so the tide has more impact on the aid to navigation height than the mining with the effect on the chain length and <20mm vertical subsidence is almost undetectable. Therefore, the subsidence values for these features were deemed acceptable by TfNSW-Maritime.

4.1.1 Houses and other structures along the Summerland Point and Morisset East Peninsula Foreshores

The predicted vertical subsidence at the mapped sea grass beds, and hence at the lake foreshore is less than 20 mm. It is unlikely, therefore that there would be adverse impacts on the surface features located above the sea grass beds (i.e. jetties and moorings) or along the lake foreshore, including houses, other associated structures, roads and services.

The state survey control marks located near MWS2, MWS3, MWS4 and MWS5 could experience low-level horizontal movements. NSW Spatial services will be notified so that the affected state survey marks can be managed and re-established after the active subsidence, as required.

4.2 Subsidence Management

Subsidence management is mainly controlled via the geotechnical assessment, mine design and subsidence predictions and impact assessment process. There are no built features located directly above S5 miniwall

panel and the Northern Mining Area Pillar Extraction Area with adequate subsidence barriers in place for the identified nearby built features. There is a Subsidence Management Trigger Action Response Plan (TARP) which details Monitoring triggers, actions and adaptive management responses.

5 Subsidence Monitoring

DC survey department utilise a number of different subsidence monitoring methods including bathymetric surveys, terrestrial land based surveys, remote sensing (LiDAR) and visual inspections. Subsidence monitoring areas, survey types and frequencies are outlined in the MWS5 and NMA Pillar Extraction Subsidence Monitoring Program.

6 Subsidence Remediation

Subsidence remediation is outlined in the Delta Coal Rehabilitation Management Plan. As per Table 7 in the CVC consent DC commits to mitigating, monitoring, repairing to pre-mining condition at full cost or equivalent unless the owner agrees otherwise or the damage is fully restored, repaired or compensated under the Coal Mine Subsidence Compensation Act 2017 features which are damaged by mining operations. The timely repair is also required from a public safety aspect. This is detailed further in the CVC Public Safety Management Plan.

7 Reporting

7.1 Regular Reporting

In accordance with Schedule 6, Condition 8, the Applicant shall provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of the development consent.

The subsidence monitoring results will be reviewed as survey reports are received to confirm compliance/non-compliance with the applicable conditions specified in the development consent and above in Section 5 and the applicable stakeholders will be notified.

7.2 Annual Review

In accordance with Schedule 6, Condition 4, the Applicant shall review the environmental performance of the development to the satisfaction of the Secretary, by the end of March each year, or other timing as may be agreed by the Secretary.

The Annual Review will also include a summary of monitoring results during the past year, discussion with reference to the impact assessment criteria, and any relevant details related to comparisons between actual results and predictions in the Environmental Impact Statement. The Annual Review will be forwarded to the relevant authorities including DPIE, and EPA. The Annual Review will also be forwarded to members of the Community Consultative Committee (CCC) and local Councils (Central Coast and Lake Macquarie). It will also be placed on the company's website along with a summary of environmental monitoring results.

7.3 Incident or Non-Compliance Notifications and Reporting

If there is a built features incident as a direct result of CVC operations, DC must immediately notify DPIE and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name) and set out the location and nature of the incident. If subsidence monitoring detects an exceedance as per Section 4.1.1. criteria to the navigational markers, TfNSW-Maritime should be notified immediately.

Within seven days of becoming aware of a non-compliance, the DC must notify DPIE of the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name), set out the condition of the consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance. A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

The investigation into the incident/non-compliance will consider any activities, plant operations or other factors that may have caused or contributed. The investigation will consider any activities or other factors that may have generated the non-compliance.

The report will:

- describe the date, time and nature of the exceedance / incident;
- identify the cause (or likely cause) of the exceedance / incident;
- describe what action has been taken to date; and
- describe the proposed actions to address the exceedance / incident

DC will implement the recommendations of the investigation in order to minimise the potential for any similar future incident or non-compliance. Additional details of the incident reporting process are provided in the DC Environmental Management Strategy.

8 Stakeholder Management, Response and Training

8.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 115 277) through which members of the public can lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters.

All complaints are recorded and responded to and if, for some reason, no action is taken then the reason why is recorded. The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or, if no action was taken, the reason why; and
- follow up contact with the complainant.

8.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review.

8.3 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environmental Compliance Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager together with the Environment and Community Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in Schedule 5 of SSD-5465.

8.4 Training, Awareness and Competence

Training is an essential component of the implementation phase of this BFMP. The Environmental Compliance Coordinator will ensure that training and awareness processes are implemented to manage, identify and minimise potential impacts of CVC and to ensure personnel are aware of their roles and responsibilities in terms of built features management.

Generally training at CVC consists of induction training for new starters and contractors along with environmental awareness training at two-year intervals and ongoing “toolbox” training for all permanent employees as required.

As the document owner, the Approvals Coordinator is the contact point for any person that does not understand this document or their specific requirements, and will provide guidance and training to any person that requires additional training regarding this BFMP.

9 Audit and Review

9.1 Review and Improvement

This document shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the development consent.

As outlined in **Section 7.2**, the Annual Review will include a review of the seasonal monitoring program and mine plans to ensure that any reference sites that have been impacted by mining reclassified as impacted impact sites, and replacement reference sites identified and sampled. Survey methods will be reviewed every two years to refine the sampling program if required. Improvements identified during reviews or audits will be incorporated into the BFMP.

9.2 Auditing

Where required, audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

DC has an external independent Environmental Audit every three years. Due to the timing and relatively small geometry of the miniwall panels, a review of the finalised document will not be required as mining will have been completed within a year from authoring.

10 Records and Document Control

10.1 Records

Generally, the Environment and Community Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

10.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system which is in compliance with the site Document Control Standard which is available to all site personnel. Any proposed change to this document will be via the Environment and Community Coordinator. A copy of this document is available on the DC website. Document revision details are provided in **Table 2**.

Table 2: Document Revision Details

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
0	16/12/2020	Draft Prepared using S4 BFMP as a base document including proposed S5 and NMA pillar extraction workings. Review following SSD5465 Modification 3 approval.	Delta Coal	Chris Armit
0.1	18/01/2021	Plan including stakeholder consultation (DPIE comments not yet received)	Delta Coal	Chris Armit

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
0.2	19/03/2021	Plan including DPIE consultation	Delta Coal	Chris Armit

11 Roles and Responsibilities

All employees and contractors at CVC are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this plan are identified in **Table 3**.

Table 3: Built Features Management Plan Roles and Responsibilities

Role	Responsibilities
Manager of Mining Engineering (Mine Manager)	• Ensure that adequate financial and personnel resources are made available for the implementation of the BFMP. • Maintain overall responsibility for environmental compliance with Mining Lease, EPL, development consent and other mining approvals as they pertain to the management of built features • Ensure that adequate training is provided to staff to minimise impacts to built features.
Technical Services Manager	• Oversee the implementation of the BFMP for applicable areas
Mine Surveyor	• Identify all built features within the S5 miniwall and NPA Pillar extraction footprint • Ensure that all survey monitoring is conducted and reported appropriately to stakeholders • Report triggers and monitoring to applicable stakeholders • Conduct pre and post mining inspections
Environment Compliance Coordinator or delegate	• Write the BFMP in consultation with relevant government agencies and stakeholders • Undertake reviews of this document • Undertake or coordinate the required audits of this document • Develop management actions in consultation with regulatory agencies as/if required from the monitoring results • Compile the Annual Review (including a summary of the built features monitoring) • Conduct pre and post mining inspections • Report triggers and monitoring to applicable stakeholders • Organise remediation if required • Notify relevant agencies if there are any exceedances in impact thresholds • Ensure complaint handling and response is undertaken
All employees and contractors	• Comply with the requirements of this BFMP. • Immediately notify Environment Compliance Coordinator of possible incident.

12 References

Documents referenced in the preparation of the BFMP are detailed in **Table 4**.

Table 4: References

Reference	Title
Australian Standards	AS/NZS ISO 14001:2004, *Environmental management systems – Requirements with guidance for use* AS/NZS ISO 14004:2004, *Environmental management systems – General guidelines on principles, systems and support techniques* ANZECC 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
Government Department	Roads and Maritime Services, 2019. https://www.rms.nsw.gov.au/maritime/safety-rules/rules-regulations/navigation-marks-and-signs.html SSD-5465 Development Consent SSD-5465 (Modification 2), 16 December 2015 NSW EPA Environment Protection Licence: EPL 1770, 2 April 2019
Delta Coal documents	EMS Environmental Management Strategy Public Safety Management Plan Rehabilitation Management Plan
External documents	Strata Ground Control Consulting, 2019. *S4 Panel: Geotechnical Environment, Subsidence Estimates and Impacts,* prepared for Delta Coal Chain Valley Colliery

13 Definitions

BCD Biodiversity Conservation Division

Built Features Any building or work erected or constructed on land or water, and includes dwellings and infrastructure such as any formed road, street, path, walk, marina or driveway; any pipeline, water, sewer, telephone, gas or other service main

CVC Chain Valley Colliery

DA Development approval

DC Delta Coal

DP&E Department of Planning & Environment (former)

DPIE Department of Planning, Industry and Environment

DPI Fisheries Department of Primary Industries – Fisheries NSW

EMS Environment Management System

EPA NSW Environment Protection Authority

EPL Environmental Protection License

EP&A Act *Environmental Planning and Assessment Act 1979*

LMCC Lake Macquarie City Council

MC Mannering Colliery

POEO Act *Protection of the Environment Operations Act 1997*

ROM Run-of-mine

RR Resource Regulator

Planning Secretary Planning Secretary of the Department of Planning and Environment, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

SA NSW Subsidence Advisory NSW

TARP Trigger Action Response Plan

TfNSW Transport for New South Wales

Appendix 1: Consultation

TfNSW Consultation

From: Lynda Hourigan **On Behalf Of** Navigation Advice North
Sent: Monday, 1 February 2021 1:18 PM
To: Kumar Kuruppu <Kumar.Kuruppu2@transport.nsw.gov.au>; Navigation Advice North <navigationadvicenorth@rms.nsw.gov.au>
Cc: Mike Baldwin <Mike.Baldwin@transport.nsw.gov.au>; Brett Boehm <Brett.Boehm@transport.nsw.gov.au>; Chris Austen <Chris.Austen@transport.nsw.gov.au>; Peter Browne <Peter.Browne@transport.nsw.gov.au>; Nicole Waller <Nicole.Waller@transport.nsw.gov.au>; Lun Yeung <lun.yeung@transport.nsw.gov.au>; Sonia Mckay <Sonia.McKay@transport.nsw.gov.au>; Nathan Koch <Nathan.Koch@transport.nsw.gov.au>
Subject: RE: Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - CVC Built Features Management Plan (SSD-5465-PA-38) (Central Coast,Lake Macquarie City)

Hello Kumar

Thank you for your email requesting TfNSW Maritime's comment on the CVC Built Features Management Plan below.

Transport for NSW (TfNSW) Maritime is responsible for the ongoing maintenance of safe navigation throughout NSW under the Marine Safety Act 1998. As such, proposals like this are reviewed to ensure that any disruption to navigation for vessels is minimised as much as is practical.

The project documentation provided has been assessed as having minimal impact on the safety of navigation to vessels operating in this area and Maritime has no objections to the proposed works.

TfNSW Maritime advises the following matters need to be considered and addressed when preparing the REF and / or the Scope of Works for the Chain Valley Extension Project:

1. Any works impacting on navigation during the construction phase must seek TfNSW Maritime support 21 days prior to works commencing. A full scope of works including dates is to be provided to *navigationadvicenorth@rms.nsw.gov.au.*
2. All associated work boats to comply with the relevant NSW Marine Legislation for survey, registration and safety equipment, and comply with the Marine Safety (Domestic Commercial Vessels) National Law Act 2012.
3. Vessels must exhibit lights and shapes in accordance with International Regulations for Preventing Collisions at Sea.
4. *"That If the subsidence was >500mm or the pylon ends up with more than 5° of lean on it, then there would need to be action taken."* and NSW Maritime is to be notified immediately.
5. For pelican rock NLM045, please confirm if this is an additional 155mm vertical subsidence to the 130mm already predicted for the mining of Miniwall S2-S4. NSW Maritime is seeking confirmation that the vertical subsidence is still within the limits allowing the project to go ahead without any action needed to be taken on NLM045.
6. NSW Maritime acknowledges that the 4mm/m tilt on NLM045 is less than 0.25 degrees so this is not an issue and using this same criteria for NLM062 the 20mm movement and 0 tilt is also acceptable.
7. NSW Maritime notes that NLM063 and NLM064 are both buoys so the tide has more impact on the Aid to Navigation height than the mining with the effect on the chain length and scope being almost undetectable. Therefore the subsidence values for these are also acceptable.

Subsequently, NSW Maritime advises that "There is no action required for these 4 navigation aids for the predicted subsidence and tilts and no further action required unless the subsidence and tilt exceed the values that have previously stipulated"

For more information, please direct all correspondence to *navigationadvicenorth@rms.nsw.gov.au*.

Kind regards

Lynda Hourigan
Project Officer North Maritime Greater Sydney **Transport for NSW M** 0409 483 676 PO Box 426 BALLINA NSW 2478

Resource Regulator Consultation

CA

RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Hi Ray,

Thanks for your email re: BFMP. To answer your question, yes, we are currently seeking approval under a modification application (CVC MOD 4) to mine under the greater Morisset Peninsula.

However, Chain Valley Colliery already has approval under SSD 5465 to mine under a smaller section of Morisset Peninsula (see below Appendix 3 from SSD5465 – I've added a red box to outline the location of consent approval area.

Mining under Fishery Point has been referenced in the last MOP approval letter and is included in the current approved MOP plans (cc'ed Dan and Melissa, if you wish to consult with them on MOP/Consent approval from an internal regulator perspective).

The BFMP scope has been outlined in the draft for consent doc' (see below excerpt). I'm compelled by the consent as part of the extraction plan application process to have a BFMP for secondary extraction (i.e. MW55 and MMA Pillar extraction) but thought it good practice to include the first workings area under the Peninsula to get some buy in from the Resource Regulator given existing built features. If you don't deem this approach necessary, happy to remove mention of it from this BFMP. Let me know if you have any comments on the draft BFMP and can make appropriate amendments if necessary.

Cheers,
Chris

APPENDIX 3
DEVELOPMENT LAYOUT



1 Introduction

1.1 Purpose and Scope

The purpose of this Built Features Management Plan (BFMP) is to outline the process for management of built features within the subsidence affected zone associated with miniwall 55, pillar extraction area in the Northern Mining Area and first workings beneath Morisset Peninsula. The primary objectives of the document are to:

CA Chris Arndt

RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

From: Resources Regulator <[redacted]>
Sent: Monday, 21 December 2020 1:47 PM
To: Chris Arndt <[redacted]>
Cc: [redacted]
Subject: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Dear Chris,

Further to your submission of a Built Features Management Plan (BFMP), dated 17 December 2020, to the Resources Regulator (RR) I require some clarification.

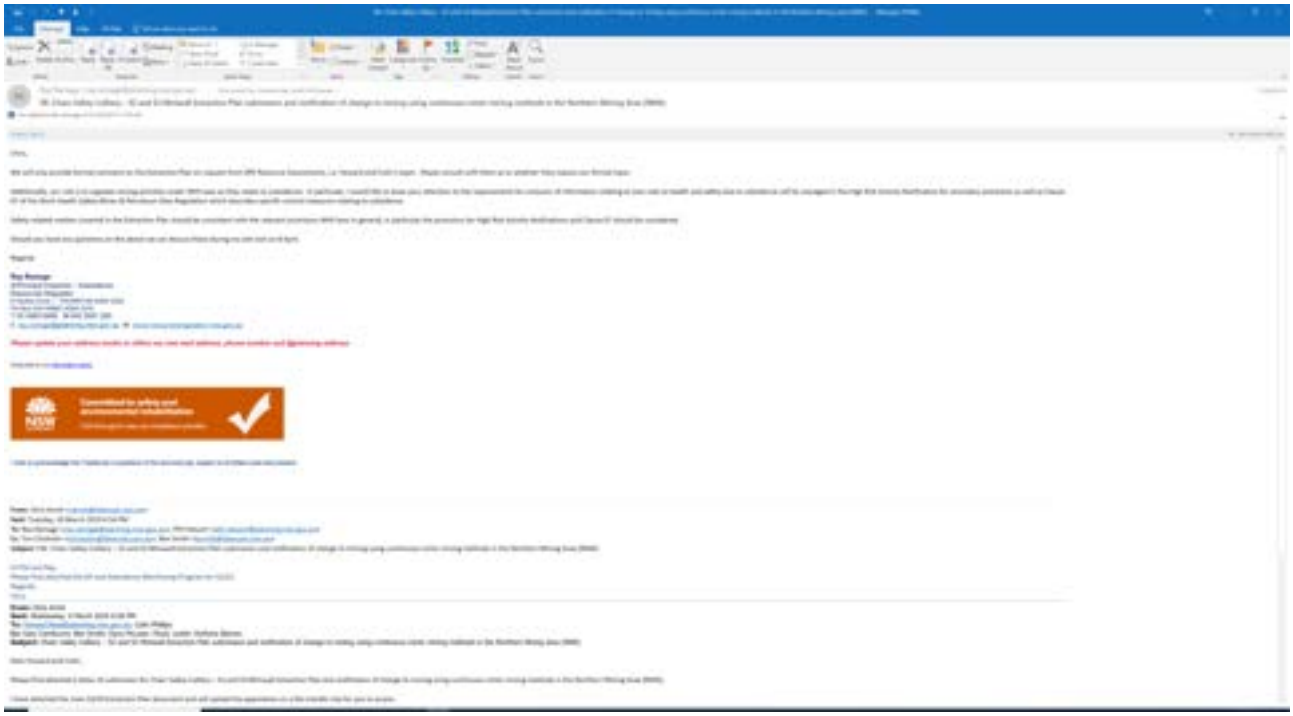
I understand that the BFMP has been submitted to RR for the purposes of consultation as required under Schedule 4, Condition 7(g) of SSD-5465.

The BFMP makes reference to Mininwall SS, first workings under Mormet Peninsula and the Northern Mining Area. It is also understood that the mine operator is currently seeking planning approval for mining in the Northern Mining Area including the suburbs of Brightwaters, Mirrabooka and Sunshine.

It is not clear to me whether Northern Mining Area subject of the BFMP has current planning approval and therefore it is not possible to provide comment in relation to that area. Can you please clarify the extents to which the BFMP applies and the status all relevant planning approvals.

Regards,

Ray Ramage
Senior Mine Safety Officer Subsidence
Subsidence Engineering | Resources Regulator
M 0422 551 293




HBA
Admin
Notification Details

DPIE Consultation



Planning, Industry & Environment

Chris Armit
Approvals Coordinator
Chain Valley Colliery

Off Construction Rd (Off Ruttleys Rd)
MANNERING PARK, NSW, 2259

05/03/2021

Dear Mr Armit

Chain Valley Colliery
Extraction Plan – Miniwall S5 and Northern Pillar Area

I refer to the Extraction Plan dated January 2021 for Miniwall S5 and the Northern Pillar Area (NPA) at the Chain Valley Colliery, submitted in accordance with condition 7 of Schedule 4 of the Chain Valley Extension Project development consent (SSD 5465).

The Department has reviewed the Extraction Plan and identified several clarifications and minor matters that must be addressed by way of improvements to various parts of the Extraction Plan and its sub-plans (see Attachment A). The Department is satisfied that these matters can be addressed in a timely manner and would not materially change the ability of Delta Coal to effectively manage subsidence impacts.

In summary, the revised Extraction Plan should:

- include the detailed plans of existing and proposed first and second workings that clearly indicate the High Water Mark Subsidence Barrier (Plan 2) and show that all areas of proposed extraction are outside of the Seagrass Protection Barrier;
- where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls;
- include detailed performance indicators and contingencies for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent;
- include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP;
- include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments; and
- align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions.

The attached comments on the Extraction Plan and its sub-plans must be addressed to the satisfaction of the Secretary prior to the Department granting its final approval of the Extraction Plan. As noted above, the Department believes that they can be readily addressed in a timely manner. It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review.

If you require any more information, please contact James McDonough on 9585 6313.

Yours sincerely

DPIE Request for Information Letter - Response Summary Table

DPIE Review	Response
include the detailed plans of existing and proposed first and second workings that clearly indicate the High Water Mark Subsidence Barrier (Plan 2) and show that all areas of proposed extraction are outside of the Seagrass Protection Barrier	Plan 2 updated to include clear indication of the High Water Subsidence Barrier. All secondary workings extraction areas are located outside of Seagrass Protection Barrier.
where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls	Document updated for legacy miniwall naming (see tracked changes)

include detailed performance indicators and contingencies for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent	Subsidence Management TARP updated to include Threatened Species or Endangered Populations
include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP	Incident and non-compliance reporting timeframes included. Timeframes of contingency measures implementation added to the Subsidence Management TARP
include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments	See updates in section 2.5 Table 1 and Appendix 1 which includes specific stakeholder comment details and communications.
align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions	Consent references updated to changes in SSD5465 Modification 3 numbering and conditions.
It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review	A Microsoft Word document has been provided with tracked changes included at the start of the document change process. Plan 2 amendment and Subsidence Management TARP were not able to be tracked changed as they were drafted in software without the tracked changes option.

Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

Table A2 outlines the consent requirements of the BFMP and where this document addresses these requirements.

Table A2: Requirements from Chain Valley Colliery Development consent SSD-5465

Condition No.	Requirement	Relevant section of this document
	Schedule 2 Administrative Conditions	
23	*STAGING, COMBINING AND UPDATING STRATEGIES, PLANS OR PROGRAMS* *With the approval of the Planning Secretary, the Applicant may:* *(a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);* *(b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined);* *(c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and* *(d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining mining consent or approval, in common ownership or management.*	**Section 10**
27	Unless the Applicant and the applicable authority agree otherwise, the Applicant must: (a) repair, or pay the full costs associated with repairing, any public infrastructure[a] that is damaged by carrying out the development; and (b) relocate, or pay the full costs associated with relocating, any public infrastructure[a] that needs to be relocated as a result of the development. [a] *This condition does not apply to any damage to roads caused as a result of general road usage or to damage that has been compensated under the Mining Act 1992.*	**Section 6**
28	The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply with, the conditions of this consent relevant to activities they carry out in respect of the development.	**Section 8.4**
	Schedule 3 Environmental Conditions – Underground Mining	
25	The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the *Mining Act 1992*. This rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the EIS, and comply with the objectives in Table 5. Table 7: Rehabilitation Objectives Feature | Objective	**Section 6**

	Built features damaged by mining operations • Repair to pre-mining condition or equivalent unless: – the owner agrees otherwise; or – the damage is fully restored, repaired or compensated under the *Coal Mine Subsidence Compensation Act 2017*.	
	Schedule 4 Specific Environmental Conditions	
4	***Performance Measures- Built Features*** The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7, to the satisfaction of the Planning Secretary. *Table 7: Subsidence Impact Performance Measures – Built Features* **Built Features** / **Performance Measure** 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. *Notes:* *• The Applicant will be required to define more detailed performance indicators for each of these performance measures in Built Features Management Plans or a Public Safety Management Plan (see Condition 7 below).* *• Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.* *• The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of this development consent.* *• Requirements regarding safety or serviceability do not preclude preventative actions or mitigation being taken prior to or during mining in order to achieve or maintain these outcomes.* *Requirements under this condition may be met by measures undertaken in accordance with the Coal Mine Subsidence Compensation Act 2017.*	**This document**
5	Any dispute between the Applicant and the owner of any built feature over the interpretation, application or implementation of the subsidence performance measures in Table 7 is to be settled by the Planning Secretary, following consultation with the SA NSW and MEG. Any decision by the Planning Secretary shall be final and not subject to further dispute resolution under this consent.	**Noted**
7	***Extraction Plan*** *(g) include a Built Features Management Plan, which has been prepared in consultation with RR and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which* *• addresses in appropriate detail all items of public infrastructure and all classes of other built features;* *• has been prepared following appropriate consultation with the owner/s of potentially affected feature/s;* *• recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and;* *• The Applicant shall implement the approved management plan as approved from time to time by the Planning Secretary.*	**This document**
8	*The Applicant must ensure that the management plans required under conditions 7(g)-(j) above include: (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this*	**Section 4 and 6**

	consent; and (b) a detailed description of the measures that would be implemented to remediate predicted impacts	
	Schedule 6 – Environmental Management, Reporting and Auditing	
6	***Reporting and Auditing*** **Incident Notification** *The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name) and set out the location and nature of the incident.*	**Section 7.3**
7	**Non-compliance notification** *Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.* ***Note**: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.*	**Section 7.3**

Appendix 11 Public Safety Management Plan

Delta coal	Doc Owner: **Approvals Coordinator** Doc No:

CHAIN VALLEY COLLIERY

Public Safety Management Plan Miniwall S5, NMA Pillar Extraction and Morisset Peninsula

ENVIRONMENTAL MANAGEMENT PLAN

Reviewers	
	Chris Armit
Authorised by:	Chris Armit
	Approvals Coordinator
	Delta Coal
Date:	19 March 2021

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1 Introduction

1.1 Purpose and Scope

The purpose of this Public Safety Management Plan (PSMP) is to:

- ensure compliance with SSD-5465, relevant mining lease conditions and Extraction Plan approvals;
- outline subsidence predictions associated with the mining of miniwall panels S2 to S5 and pillar extraction;
- identify potential public safety risks arising out of subsidence from secondary extraction of Miniwall S5, Northern Pillar Area pillar extraction and first workings underneath the Morisset Peninsula area
- identify public safety monitoring requirements;
- identify public safety reporting requirements;
- ensure negligible additional public safety risk as a result of subsidence arising from extraction associated with the mining areas; and
- allocate roles and responsibilities within the CVC Management structure such that all actions emanating from this document have specific task owners

A formal Environmental Management System (EMS) has been developed as a systematic and structured approach to managing environmental issues at the operation. This has been developed in general accordance with the requirements of the international standard ISO 14001.

This PSMP is an element of the Chain Valley Colliery (CVC) Environmental Management System (EMS).

1.2 Background

Chain Valley Colliery (CVC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle and 80 km north of Sydney (see Figure 1). The pit-top is located approximately 1 km south-east of the township of Mannering Park at the southern extent of Lake Macquarie.

In August 1960, J&A Brown and Abermain Seaham Collieries Ltd commenced clearing the present site with drift and shaft sinking starting a few months later. Production of coal from the Wallarah Seam, commenced with the first delivery to the adjacent Delta Electricity's Vales Point Power Station (VPPS) in April 1963.

Great Southern Energy Pty Ltd (trading as Delta Coal) took over as owner and operator of CVC and as operator of MC on 1 April 2019.

Mining is currently undertaken at CVC, with the coal being transported underground to MC where the coal is crushed and screened and sent directly to VPPS.

1.3 Consultation

The PSMP is required to be prepared in consultation with the Department of Planning, Industry and Environment (DPIE) and Resource Regulator (RR) as per Schedule 4 (Specific Environmental Conditions) conditions 7 (j). A draft for comment copy of the PSMP was provided to Delta Coal employees with roles and responsibilities under the PSMP on the 7 September 2020. This PSMP includes updates for miniwall S5 and the northern mining pillar extraction area was provided to DPIE, RR, Lake Macquarie City Council (LMCC), Central Coast Council (CC Council), Subsidence Advisory NSW (SA), combined CVC and MC CCC, Transport for NSW (TfNSW) on 18 December 2020 as part of the extraction plan drafting process. This management plan is an Appendix to the CVC Miniwall S5 and Northern Pillar Area Extraction Plan submitted on the planning portal on the 19 January 2021. Evidence of consultation is provided in **Appendix 1**.

A summary of the comments received, and amendments subsequently made to the document prior to finalisation are detailed in **Table 1**.

Table 1: Consultation Summary

Stakeholder	Comments	Response/Action
DPIE-Resource Assessments	• Request for information (RFI) provided on 5 March 2020. See attached DPIE RFI letter and attachment (Appendix 1).	• Section 2.3 updated • Tracked changes document provided on planning portal for updated consent references and mining panel numbering
Resource Regulator	• No comments	• Nil required
Transport for NSW	• Comments from TfNSW as part of the Built Features Management Plan (Appendix 1).There is no action required for these 4 navigation aids for the predicted subsidence and tilts and no further action required unless the subsidence and tilt exceed the values that have previously stipulated	• Sections 3.3 and 5 updated
LMCC	• No comments	• Nil required
CC Council	• No comments	• Nil required
Combined CVC and MC Community Consultative Committee	• No comments	• Nil required

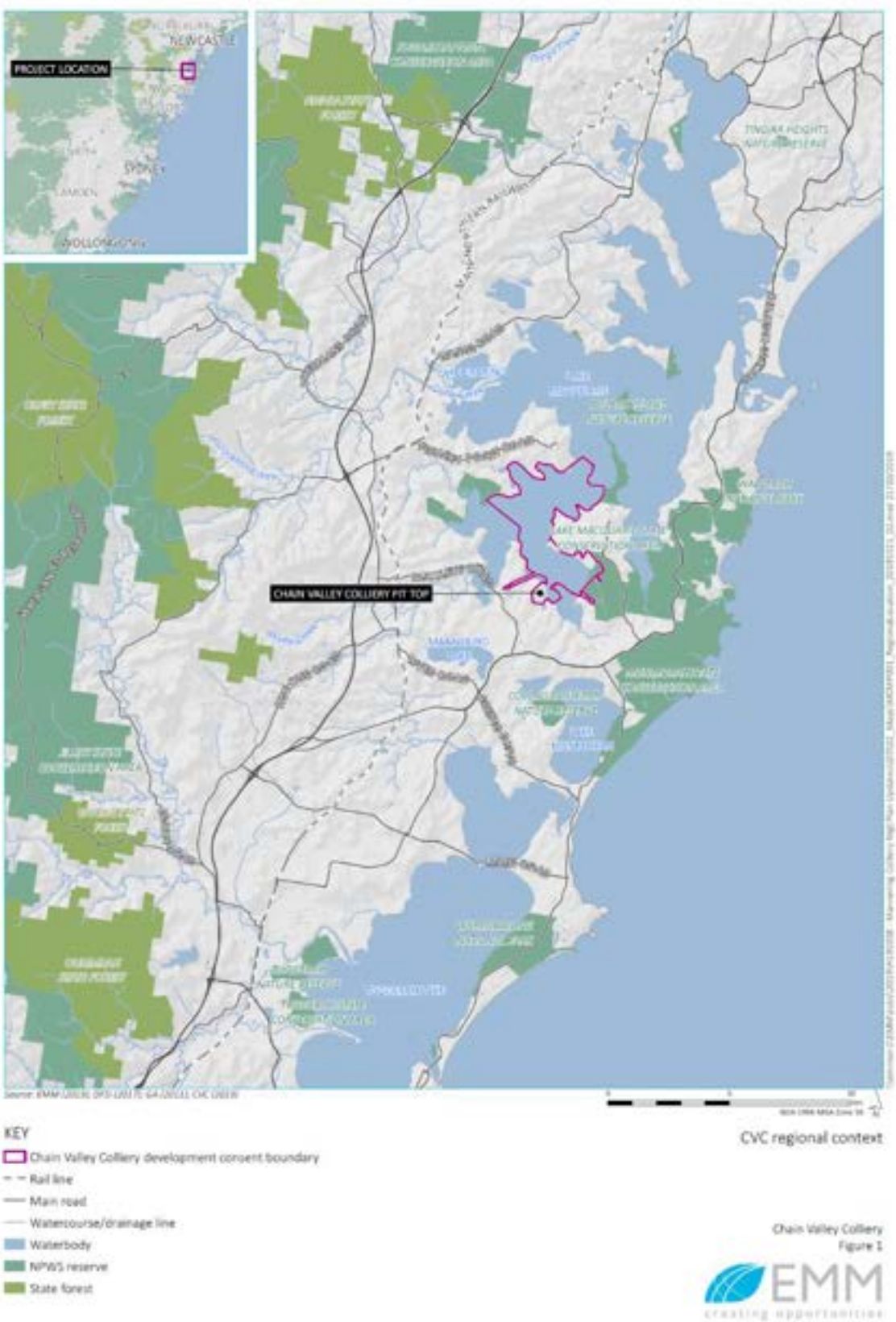


Figure 1: Regional Context

2 Statutory Requirements

2.1 Key Legislation, Policy and Guidelines

Both State and Commonwealth environmental legislation applies to DC's operation and activities. A number of legislative requirements, government policies and guidelines are applicable. Key items relevant to this management plan are:

- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act); and
- *Mining Act 1992*.

Delta lands are within the LMCC and Central Coast Council local government areas (LGAs).

2.2 Development Consent SSD-5465 Requirements

An Extraction Plan has been developed in order to manage the process of mining layout design and mitigate any subsidence impacts on surface infrastructure, natural features and/or stakeholders. A part of the S5 and Northern Mining Area Pillar Extraction Plan is this PSMP, which have been developed from the risks identified in the S5/Pillar Extraction Plan risk assessment process.

The PSMP is an element of the Chain Valley Colliery (CVC) Extraction Plan, and has been developed to satisfy the requirements of Development Consent SSD-5465, Condition 4, Condition 7(j) and Table 5 in Schedule 3.

Public safety related requirements of SSD-5465, including specific requirements that are to be addressed in this plan, and where they are addressed, are detailed in **Appendix 2**.

3 Background

3.1 Operations

CVC is an underground coal mine with current coal mining methods including development of roadways in the coal seam known as first workings and secondary extraction (miniwall). These first workings develop panels to support the installation of a miniwall, a modern secondary coal extraction method.

Lake Macquarie is the largest saline lake in New South Wales. It lies on the central coast between Sydney and Newcastle within the local government areas of Wyong and Lake Macquarie. Lake Macquarie has a catchment of 700 km^2 and a water surface area of 125 km^2 (Bell & Edwards, 1980). The lake has a permanent entrance to coastal waters at Swansea and has an average depth of around 6 m (Laxton, 2005).

The catchment of Lake Macquarie is largely rural with large areas of bush land and grazing land. The shoreline of Lake Macquarie is heavily urbanised, especially the eastern, western and northern shorelines. The region has a relatively long history of coal mining and power generation, with mining occurring since the late 1800s and the first power station at Lake Macquarie commencing operations in 1958.

CVC is situated on the southern shores of Lake Macquarie near Mannering Park, NSW. The mine has been operating since 1962. Mining is currently undertaken using bord and pillar and miniwall methods with first workings to support the development in advance of each Miniwall or pillar extraction panel. All secondary extraction is currently occurring in the Fassifern Seam, in line with Development Consent SSD–5465. The general layout of the CVC Extension Project in respect to Lake Macquarie is shown on **Figure 2**.

3.2 Subsidence Predictions

Subsidence modelling has predicted up to approximately 500 mm of subsidence to the lake floor associated with the planned miniwall mining of panels S2 to S5 within the sites Northern Mining Domain (**Figure 2**), with an approved maximum of 780 mm (SSD-5465). No additional subsidence is expected to occur within the seagrass or foreshore areas as a result of Fassifern extraction due to the application of High Water and Seagrass Protection Barriers (extraction separation).

It is emphasized, however, that future workings will require detailed planning to address the full range of relevant issues, including pillar stability and subsidence. (Strata 2, 2020).

Important features of the S5 panel area are:

- the Karingal Conglomerate, beneath the Great Northern (GN) Seam, thins from 39m in the NW to 6m in the SE,
- the Teralba Conglomerate, immediately above the GN Seam, thins from 30m in the SE to 12m in the NW,
- the interburden from the Fassifern Seam extraction horizon to the GN Seam floor thins from 62m in the NW to 44m in the south and
- the other major unit in the overburden is the Munmorah Conglomerate, which is typically around 50m thick and 100m above the Fassifern Seam.

The Fassifern Seam floor includes interbedded coal / carbonaceous shale beds, plus moisture sensitive claystone. The individual claystone beds are 50mm to 300mm thick and the cumulative thickness of claystone in the first 2m of floor in the vicinity of MW S5 and the NMA Herringbone Panels is 0.9m to 1.2m, slightly thinner than that encountered in the MW7-12 area. The claystone typically has a strength of <5MPa and is considered weak.

3.3 Public Safety Management – Scope

3.3.1 Identified Features

All secondary extraction mining activities within the Extraction Plan application area are to occur beneath Lake Macquarie and as such will have no direct impact on surface facilities and infrastructure due to negligible vertical subsidence. Despite this, CVC will monitor the foreshore for change and if impacts were observed to be occurring, a review of public safety would be triggered via the Subsidence Management TARP. This focuses on potential changes to flooding and drainage.

The Pelican Rock and Sugar Bay navigational markers located off Summerland Point and Fishery Point respectively is not predicted to see any significant impacts as a result of the mining of panels S2 to S5 or from pillar extraction. The marker located above the Tailgate S2 gate road on Pelican Rock (**Figure 2**) is expected to see approximately 145 mm of vertical subsidence. Transport for NSW (TfNSW) have been consulted in relation to the navigational markers and the level of subsidence impact and have concluded that no direct management will be required, and the marker will be monitored as a part of their routine inspections.

A Built Features Management Plan was developed for Miniwalls S2/S3, S4 and has been compiled for the S5/NMA Pillar extraction plan.

The predicted low strains indicate a very low likelihood of impact to any sensitive features such as steep slopes/cliffs, retaining walls or jetties as a result of the extraction of panels S2 to S5 and the northern pillar extraction area. As such routine visual inspections during subsidence monitoring is proposed to identify any changes outside those expected.



Figure 2: General underground layout and Predicted Limit of Subsidence Associated with Panels S2 and S5 and the Northern Pillar extraction area

4 Public Safety Monitoring

4.1 Subsidence Monitoring Methods

4.1.1 Bathymetric Surveys

Bathymetric Surveys of the lake beds will occur across the area as described by the Subsidence Monitoring Program. These routine surveys will allow for identification of subsidence starting to develop outside predicted levels and thus trigger a review of any potentially new public safety concerns.

4.1.2 Foreshore Monitoring

Established and proposed (subject to access restrictions) survey monitoring points will be monitored around the southern and northern foreshore areas about the extraction plan area. These will consist of either star pickets, feno pegs or survey pins (**Figure 3**). The marks will be monitored as per the Subsidence Monitoring Program. These routine surveys prior, during and after extraction will allow for the identification and review of any subsidence starting to develop outside predicted levels and thus trigger a review of any potentially new public safety concerns. NPWS approved a Conservation Risk Assessment in 6 November 2019 to allow the installation of the Miniwall S4 and S5 survey markers on the Lake Macquarie foreshore within the State Conservation area. During the routine foreshore monitoring, observations and records for change will be noted as outlined in the Subsidence Monitoring Program. This will include observations for surface cracking, embankment movement, cracking, and validation of impacts to drainage or dwellings in areas of measured subsidence increase outside predicted.



Figure 3: Example of subsidence monitoring point with safety cap

5 Public Safety Management

5.1 Management Practices

Survey pegs installed for monitoring will be clearly identified and as appropriate have 'safety caps' placed on them as per **Figure 3**. Survey pins will be the main type of marks installed and are smaller than the pickets and less of a public health and safety risk.

Given the expected negligible impact to public safety, any management practices will be triggered via the aforementioned monitoring strategies and the Subsidence Management TARP included in the Extraction Plan.

Triggering of a potential requirement for a public safety response will be based on the following management strategy:

- If subsidence measured indicates potentially increased impact at the foreshore or to sensitive features (navigational markers, seagrass beds) DPIE, RR and appropriate stakeholders will be notified;
- DC will investigate the area of potential increase for any change in public safety risk;
- DC will inform relevant parties that may be further impacted in relation to public safety. This may include landholders, infrastructure owners, TfNSW, LMCC, CC Council and DPIE;
- where required, DC will immediately implement public safety controls to control imminent risk (i.e. identification, barriers and signage, security, all of which are available at the mine site); and
- DC will develop long term safety controls and remediation with relevant parties in accordance with the Rehabilitation Management Plan.

6 Reporting

6.1 Regular Reporting

On receipt of any monitoring reports, results will be reviewed to confirm compliance with the relevant criteria. This will ensure corrective action is taken where results or trends indicate a non-compliance or risk of future non-compliance. On acceptance of these results by DC, reports will be published on the DC website within 7 days where required.

6.2 Annual Review

Monitoring results will be presented in the Annual Review, and include:

- a summary of results for the previous calendar year;
- a comparison against limits/criteria;
- a comparison of the impacts with those predicted in the Environmental Assessment; and
- present an analysis of the potential cause(s) of any significant discrepancies between measured and predicted levels.

The Annual Review will be provided to the relevant authorities and a copy will be placed on the DC website.

6.3 Incident or Non-Compliance Notifications and Reporting

If there has been a public safety incident as a direct result of CVC operations, DC must immediately notify DPIE and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name) and set out the location and nature of the incident.

Within seven days of becoming aware of a non-compliance, the Delta Coal must notify DPIE of the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name), set out the condition of the consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance. A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

The investigation into the incident/non-compliance will consider any activities, plant operations or other factors that may have caused or contributed. The investigation will consider any activities or other factors that may have generated the non-compliance.

The report will:

- describe the date, time and nature of the exceedance / incident;
- identify the cause (or likely cause) of the exceedance / incident;
- describe what action has been taken to date; and
- describe the proposed actions to address the exceedance / incident

DC will implement the recommendations of the investigation in order to minimise the potential for any similar future incident or non-compliance. Additional details of the incident reporting process are provided in the DC Environmental Management Strategy.

7 Stakeholder Management, Response and Training

7.1 Complaint Protocol

DC has a 24-hour telephone hotline (1800 115 277) through which members of the public can lodge complaints, concerns, or to raise issues associated with the operation. This service aims to promptly and effectively address community concerns and environmental matters.

All complaints are recorded and responded to and if, for some reason, no action is taken then the reason why is recorded. The information recorded in the complaint register includes:

- date and time the complaint was lodged;
- personal details provided by the complainant;
- nature of the complaint;
- action taken or, if no action was taken, the reason why; and
- follow up contact with the complainant.

7.2 Independent Review

As detailed in Condition 2, Schedule 5 of SSD-5465, an Independent Review can be requested by a landowner who "*considers the development to be exceeding the relevant criteria in Schedule 3".*

If the Secretary is satisfied that an independent review is warranted, then within 2 months of the Secretary's decision the Applicant shall:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Secretary, to:
- *consult with the landowner to determine his/her concerns;*
- *conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and*
- *if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and*

(b) give the Secretary and landowner a copy of the independent review.

7.3 Dispute Resolution

If any disputes are not adequately addressed by the complaints handling process then they will be handled by the Environment Compliance Coordinator. If the response of CVC is not considered to satisfactorily address the concern of the complainant, a meeting may be convened with the complainant, Mine Manager together with the Environment Compliance Coordinator to determine any further options to reduce potential impacts.

Any actions agreed from the meeting will be implemented by CVC. After implementation of the proposed actions the complainant will be contacted and advice sought as to the satisfaction or otherwise with the measures taken.

If no agreed outcome is determined or the complainant is still not satisfied by the action taken, then an Independent Review may be requested by the complainant. If determined to be warranted by the Secretary, an independent review will be undertaken in accordance with the process identified in Schedule 5 of SSD-5465.

7.4 Training, Awareness and Competence

Training is an essential component of the implementation phase of this PSMP. Any person or position that has a role or responsibility under this document will be provided with a copy of the document and be advised verbally regarding their requirements by the Environmental Compliance Coordinator.

As the document owner, the Environment Compliance Coordinator or delegate is the contact point for any person that does not understand this document or their specific requirements and will provide guidance and training to any person that requires additional training regarding this management plan.

8 Audit and Review

8.1 Review and Improvement

This document shall be reviewed, and if necessary revised, within 3 months of the following:

- the submission of an Annual Review;
- the submission of an incident report;
- the submission of an independent environmental audit; and
- following any modification to the development consent.

As outlined in **Section 6.2**, the Annual Review will include a review of the PSMP. Improvements identified during reviews or audits will be incorporated into the PSMP.

8.2 Auditing

Where required, audits shall be carried out by personnel who have the necessary qualifications and experience to make an objective assessment of the issues. The extent of the audit, although pre-determined, may be extended if a potentially serious deviation from this document is detected.

DC has an external independent Environmental Audit every three years. Due to the timing and relatively small geometry of the miniwall panels, a review of the finalised document will not be required as mining will have been completed within a year from authoring.

9 Records and Document Control

9.1 Records

Generally, the Environment and Community Coordinator will maintain all Environmental Management System records which are not of a confidential nature. Records that will be maintained include:

- monitoring data;
- environmental inspections and auditing results;
- environmental incident reports;
- the complaints register; and
- licences and permits.

All records will be stored so that they are legible, readily retrievable and protected against damage, deterioration and loss. Records will be maintained for a minimum of 4 years or as otherwise required under any legislation, licence, lease, permit or approval.

9.2 Document Control

This document and all others associated with the Environmental Management System shall be maintained in a document control system. Any proposed change to this document will be via the Approvals Coordinator or Environmental Compliance Coordinator. Details on document revisions are provided in **Table 3**.

Table 3: Document Revision Details

Review Date	Next Review Date	Revision No	Document Owner	Page
19/03/2021	19/03/2023	1	Approvals Coordinator	Page 12 of 26

Version	Date	Details of Revision	Company	Reviewed by/ Authorised by
0	19/12/2020 18/01/2021 19/03/2021	Draft Prepared using the 2020 S4 PSMP as a base document including proposed S5 and NMA pillar extraction workings. Review following SSD5465 Modification 3 approval. Update from DPIE consultation	Delta Coal	Chris Armit

10 Roles and Responsibilities

All employees and contractors at CVC are responsible for environmental management. However, various positions in the organisation have roles, responsibilities and authorities for managing environmental aspects, action plans, programs and controls.

Roles and responsibilities specific to completing the requirements of this PSMP are identified in **Table 4**.

Table 4: Public Safety Management Roles and Responsibilities

Role	Responsibilities
Operations Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the Public Safety Management Plan
Technical Services Manager	• Oversee the implementation of the BFMP for applicable areas
Mine Surveyor	• Co-ordinate subsidence monitoring, through the use of bathymetric surveys & conventional surveys along foreshore • Review subsidence monitoring results against Subsidence Management TARP triggers • Inform the Environmental Compliance Coordinator and Mine Manager of results and outcomes of monitoring reviews
Approvals Coordinator	• Write the PSMP in consultation with relevant government agencies and stakeholders • Undertake reviews of this document • Undertake or coordinate the required audits of this document • Develop management actions in consultation with regulatory agencies as/if required from the monitoring results

Environmental Compliance Coordinator	• Develop management actions in consultation with regulatory agencies as/if required from the monitoring results
	• Respond to any potential or actual non-compliance and report these as required to regulatory bodies and other stakeholders
	• Notify the relevant government agencies and other affected parties should exceedances in impact thresholds potentially be reached
	• Regularly audit the public safety equipment made available at the mine site
	• Ensure complaint handling and response is undertaken, including determination of sources and potential remedial action to avoid recurrence
	• Review, and if necessary, revise this document:
	  ○ In the event of any exceedance in impact thresholds;
	  ○ Following any modification to the development consent.

11 References

Documents referenced in the preparation of the PSMP are detailed in **Table 5.**

Table 5: References and Associated Documents

Reference type	Document
Australian Standards	AS/NZS ISO 14001:2004, Environmental management systems – Requirements with guidance for use AS/NZS ISO 14004:2004, Environmental management systems – General guidelines on principles, systems and support techniques
Legislation and Regulations	Development Consent SSD-5465 (as modified) Environment Protection Licence (EPL) 1770
Delta Coal documents	EMS Environmental Management Strategy
LakeCoal documents	MSEC 2019, S2 and S3 Panel, prepared for Lake Coal- Chain Valley Colliery
External documents	Strata Ground Control Consulting 2019, S4 Panel: Geotechnical Environment, Subsidence Estimates and Impacts, prepared for Delta Coal Chain Valley Colliery ANZECC 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

12 Definitions

CVC Chain Valley Colliery

DA Development approval

DC Delta Coal

DP&E Department of Planning & Environment (former)

DPIE Department of Planning, Industry and Environment

DPI Fisheries Department of Primary Industries – Fisheries NSW

EMS Environment Management System

EPA NSW Environment Protection Authority

EPL Environmental Protection License

EP&A Act *Environmental Planning and Assessment Act 1979*

LMCC Lake Macquarie City Council

MC Mannering Colliery

POEO Act *Protection of the Environment Operations Act 1997*

OEH Office of Environment and Heritage

ROM Run-of-mine

Planning Secretary Secretary of the Department of Planning, Industry and Environment, or nominee

SSD-5465 Development Consent SSD-5465 (for the Chain Valley Colliery Mining Extension 1 Project)

Appendix 1: Consultation

TfNSW Consultation

From: Lynda Hourigan **On Behalf Of** Navigation Advice North
Sent: Monday, 1 February 2021 1:18 PM
To: Kumar Kuruppu <Kumar.Kuruppu2@transport.nsw.gov.au>; Navigation Advice North <navigationadvicenorth@rms.nsw.gov.au>
Cc: Mike Baldwin <Mike.Baldwin@transport.nsw.gov.au>; Brett Boehm <Brett.Boehm@transport.nsw.gov.au>; Chris Austen <Chris.Austen@transport.nsw.gov.au>; Peter Browne <Peter.Browne@transport.nsw.gov.au>; Nicole Waller <Nicole.Waller@transport.nsw.gov.au>; Lun Yeung <lun.yeung@transport.nsw.gov.au>; Sonia Mckay <Sonia.McKay@transport.nsw.gov.au>; Nathan Koch <Nathan.Koch@transport.nsw.gov.au>
Subject: RE: Major Projects – Proponent Request for Advice - Chain Valley Extension Project- SSD-5465 - CVC Built Features Management Plan (SSD-5465-PA-38) (Central Coast,Lake Macquarie City)

Hello Kumar

Thank you for your email requesting TfNSW Maritime's comment on the CVC Built Features Management Plan below.

Transport for NSW (TfNSW) Maritime is responsible for the ongoing maintenance of safe navigation throughout NSW under the Marine Safety Act 1998. As such, proposals like this are reviewed to ensure that any disruption to navigation for vessels is minimised as much as is practical.

The project documentation provided has been assessed as having minimal impact on the safety of navigation to vessels operating in this area and Maritime has no objections to the proposed works.

TfNSW Maritime advises the following matters need to be considered and addressed when preparing the REF and / or the Scope of Works for the Chain Valley Extension Project:

1. Any works impacting on navigation during the construction phase must seek TfNSW Maritime support 21 days prior to works commencing. A full scope of works including dates is to be provided to *navigationadvicenorth@rms.nsw.gov.au.*
2. All associated work boats to comply with the relevant NSW Marine Legislation for survey, registration and safety equipment, and comply with the Marine Safety (Domestic Commercial Vessels) National Law Act 2012.
3. Vessels must exhibit lights and shapes in accordance with International Regulations for Preventing Collisions at Sea.
4. *"That If the subsidence was >500mm or the pylon ends up with more than 5° of lean on it, then there would need to be action taken."* and NSW Maritime is to be notified immediately.
5. For pelican rock NLM045, please confirm if this is an additional 155mm vertical subsidence to the 130mm already predicted for the mining of Miniwall S2-S4. NSW Maritime is seeking confirmation that the vertical subsidence is still within the limits allowing the project to go ahead without any action needed to be taken on NLM045.
6. NSW Maritime acknowledges that the 4mm/m tilt on NLM045 is less than 0.25 degrees so this is not an issue and using this same criteria for NLM062 the 20mm movement and 0 tilt is also acceptable.
7. NSW Maritime notes that NLM063 and NLM064 are both buoys so the tide has more impact on the Aid to Navigation height than the mining with the effect on the chain length and scope being almost undetectable. Therefore the subsidence values for these are also acceptable.

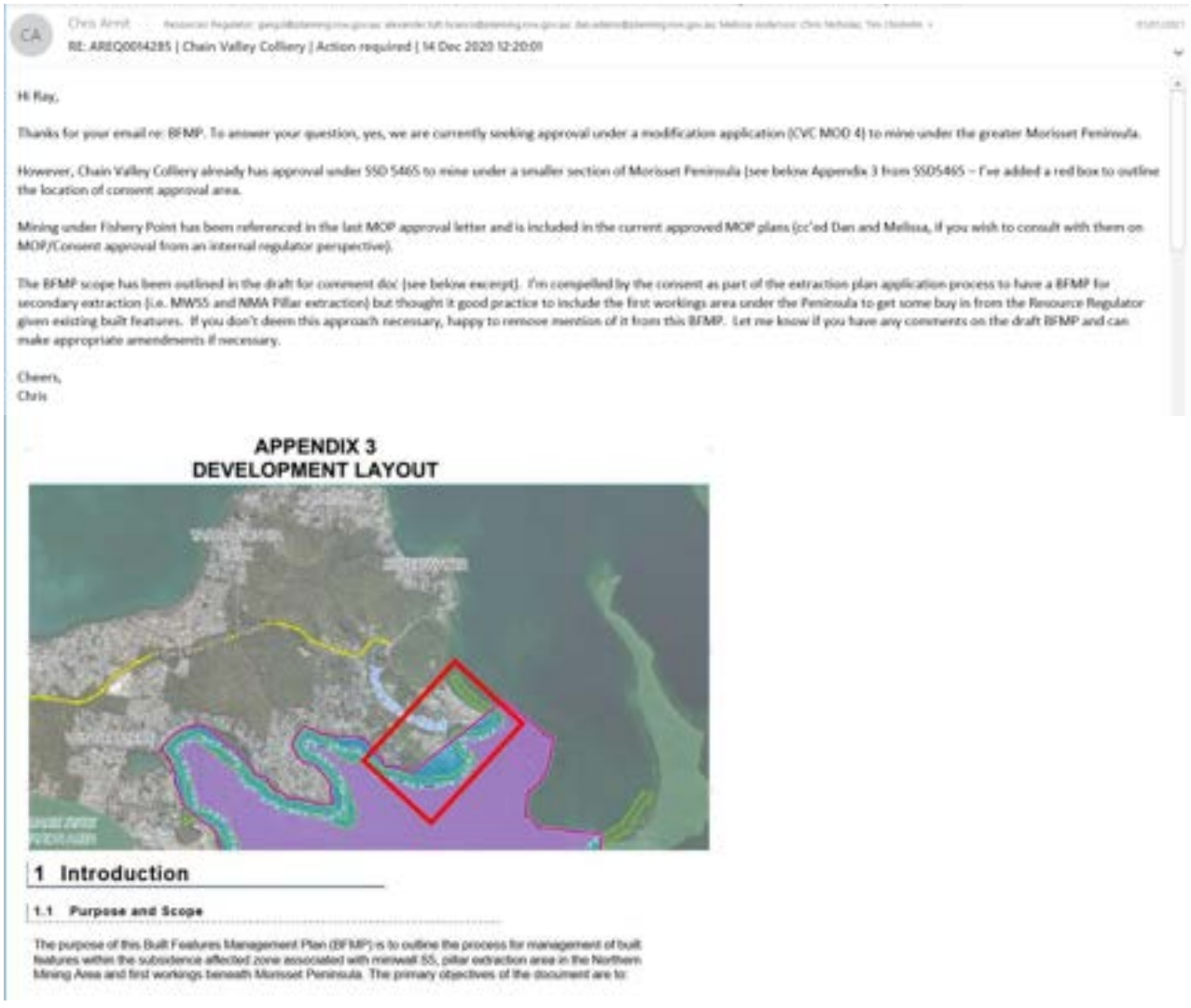
Subsequently, NSW Maritime advises that "There is no action required for these 4 navigation aids for the predicted subsidence and tilts and no further action required unless the subsidence and tilt exceed the values that have previously stipulated"

For more information, please direct all correspondence to *navigationadvicenorth@rms.nsw.gov.au*.

Kind regards

Lynda Hourigan
Project Officer North Maritime Greater Sydney **Transport for NSW M** 0409 483 676 PO Box 426 BALLINA NSW 2478

Resource Regulator Consultation



RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Hi Ray,

Thanks for your email re: BFMP. To answer your question, yes, we are currently seeking approval under a modification application (CVC MOD 4) to mine under the greater Morisset Peninsula.

However, Chain Valley Colliery already has approval under SSD 5465 to mine under a smaller section of Morisset Peninsula (see below Appendix 3 from SSD5465 – I've added a red box to outline the location of consent approval area.

Mining under Fishery Point has been referenced in the last MOP approval letter and is included in the current approved MOP plans (cc'ed Dan and Melissa, if you wish to consult with them on MOP/Consent approval from an internal regulator perspective).

The BFMP scope has been outlined in the draft for comment doc (see below excerpt). I'm compelled by the consent as part of the extraction plan application process to have a BFMP for secondary extraction (i.e. MW55 and NMA Pillar extraction) but thought it good practice to include the first workings area under the Peninsula to get some buy in from the Resource Regulator given existing built features. If you don't deem this approach necessary, happy to remove mention of it from this BFMP. Let me know if you have any comments on the draft BFMP and can make appropriate amendments if necessary.

Cheers,
Chris

APPENDIX 3
DEVELOPMENT LAYOUT

1 Introduction

1.1 Purpose and Scope

The purpose of this Built Features Management Plan (BFMP) is to outline the process for management of built features within the subsidence affected zone associated with mine wall 55, pillar extraction area in the Northern Mining Area and first workings beneath Morisset Peninsula. The primary objectives of the document are to:



RE: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

From: Resources Regulator
Sent: Monday, 21 December 2020 1:47 PM
To: Chris Arndt
Cc:
Subject: AREQ0014285 | Chain Valley Colliery | Action required | 14 Dec 2020 12:20:01

Dear Chris,

Further to your submission of a Built Features Management Plan (BFMP), dated 17 December 2020, to the Resources Regulator (RR) I require some clarification.

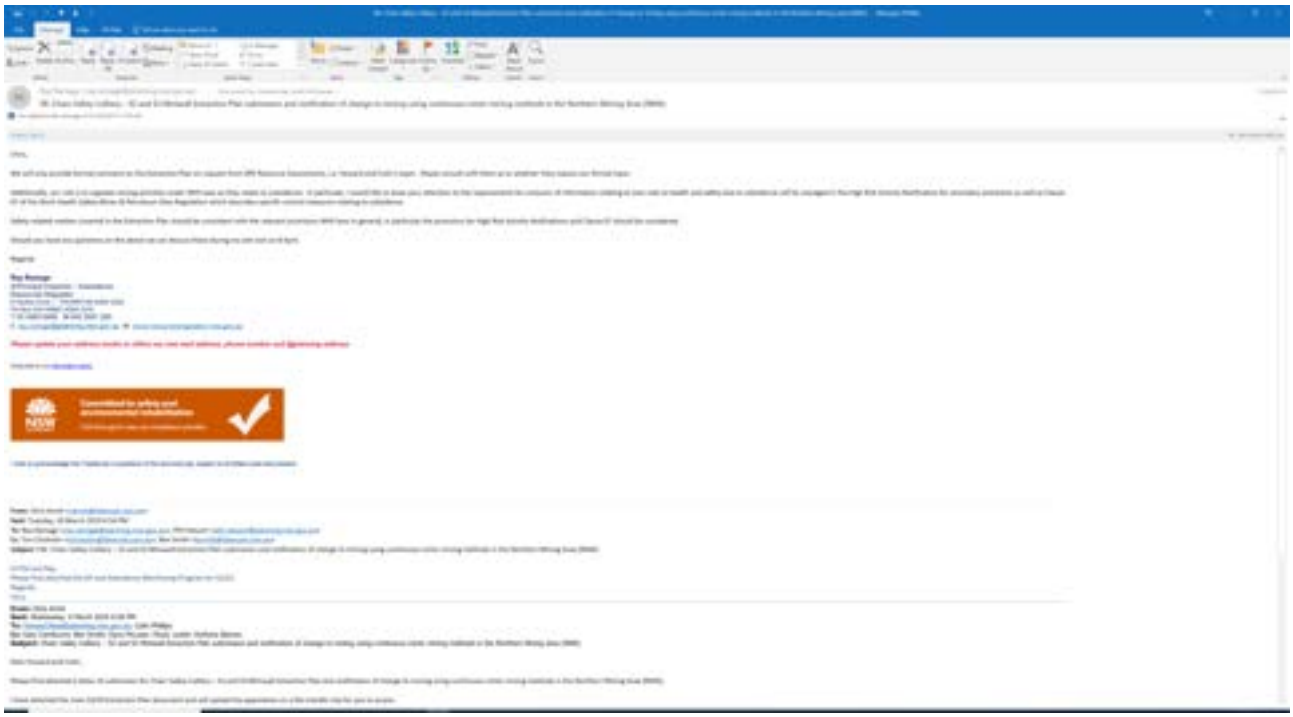
I understand that the BFMP has been submitted to RR for the purposes of consultation as required under Schedule 4, Condition 7(g) of SSD-5465.

The BFMP makes reference to Miniwall 55, first workings under Morrisett Peninsula and the Northern Mining Area. It is also understood that the mine operator is currently seeking planning approval for mining in the Northern Mining Area including the suburbs of Brightwaters, Mirrabooka and Sunshine.

It is not clear to me whether Northern Mining Area subject of the BFMP has current planning approval and therefore it is not possible to provide comment in relation to that area. Can you please clarify the extents to which the BFMP applies and the status all relevant planning approvals.

Regards,

Ray Ramage
Senior Mine Safety Officer Subsidence
Subsidence Engineering | Resources Regulator
M 0422 551 293





DPIE Consultation

Planning, Industry & Environment

Chris Armit
Approvals Coordinator
Chain Valley Colliery

Off Construction Rd (Off Ruttleys Rd)
MANNERING PARK, NSW, 2259

05/03/2021

Dear Mr Armit

Chain Valley Colliery
Extraction Plan – Miniwall S5 and Northern Pillar Area

I refer to the Extraction Plan dated January 2021 for Miniwall S5 and the Northern Pillar Area (NPA) at the Chain Valley Colliery, submitted in accordance with condition 7 of Schedule 4 of the Chain Valley Extension Project development consent (SSD 5465).

The Department has reviewed the Extraction Plan and identified several clarifications and minor matters that must be addressed by way of improvements to various parts of the Extraction Plan and its sub-plans (see Attachment A). The Department is satisfied that these matters can be addressed in a timely manner and would not materially change the ability of Delta Coal to effectively manage subsidence impacts.

In summary, the revised Extraction Plan should:

- include the detailed plans of existing and proposed first and second workings that clearly indicate the High Water Mark Subsidence Barrier (Plan 2) and show that all areas of proposed extraction are outside of the Seagrass Protection Barrier;
- where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls;
- include detailed performance indicators and contingencies for Threatened Species or Endangered Populations, as required by Table 6 of the conditions of consent;
- include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP;
- include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments; and
- align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions.

The attached comments on the Extraction Plan and its sub-plans must be addressed to the satisfaction of the Secretary prior to the Department granting its final approval of the Extraction Plan. As noted above, the Department believes that they can be readily addressed in a timely manner. It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review.

If you require any more information, please contact James McDonough on 9585 6313.

Yours sincerely

DPIE Request for Information Letter - Response Summary Table

DPIE Review	Response
where necessary refer to the proposed extraction of Miniwall S5 and the NPA, not previously extracted miniwalls	Document updated for legacy miniwall naming (see tracked changes)

include timeframes for the implementation of contingency measures set out in the Subsidence Management TARP	Incident and non-compliance reporting timeframes included. Timeframes of contingency measures implementation added to the Subsidence Management TARP
include evidence of further consultation, including specific details of the comments received from agencies and the actions taken in response to those comments	See updates in section 2.5 Table 1 and Appendix 1 which includes specific stakeholder comment details and communications.
align with the current consolidated conditions of consents, including alignment with the timing of document reviews and revisions	Consent references updated to changes in SSD5465 Modification 3 numbering and conditions.
It would be appreciated if Delta Coal provides an electronic copy of the revised document, with tracked changes, allowing for a more expedient review	A Microsoft Word document has been provided with tracked changes included at the start of the document change process. Plan 2 amendment and Subsidence Management TARP were not able to be tracked changed as they were drafted in software without the tracked changes option.

Appendix 2: Development Consent Summary

Chain Valley Colliery Development Consent SSD-5465 Summary

This PSMP has been prepared in accordance to Schedule 3, Condition 21 of SSD-5465, which states the requirements of the PSMP and what it must address. **Table A2** outlines the requirements of the PSMP and where this document addresses these requirements.

Table A2: Requirements from Chain Valley Colliery Development consent SSD-5465

Condition No.	Requirement	Relevant section of this document
	Schedule 2 Administrative Conditions	
18	***Updating and Staging Strategies, Plans or Programs*** *The Applicant must regularly review the strategies, plans and programs required under this consent and ensure that these documents are updated to incorporate measures to improve the environmental performance of the development and reflect current best practice in the mining industry. To facilitate these updates, the Applicant may at any time submit revised strategies, plans or programs for the approval of the Secretary.* *With the agreement of the Secretary, the Applicant may also submit any strategy, plan or program required by this consent on a staged basis. With the agreement of the Secretary, the Applicant may prepare a revision or stage of any strategy, plan or program required under this consent without undertaking consultation with all parties nominated under the applicable condition in this consent.* *Notes:* • *While any strategy, plan or program may be submitted on a staged basis, the Applicant must ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.* • *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*	**Section 8**
22.	***Evidence of Consultation*** *Where conditions of this consent require consultation with an identified party, the Applicant must:* *(a) consult with the relevant party prior to submitting the subject document;* *(b) provide details of the consultation undertaken including:* *i. the outcome of that consultation, matters resolved and unresolved; and* *ii. details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.*	**Section 1.3 and Appendix 1**
28	***Compliance*** *The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply with, the conditions of this consent relevant to activities they carry out in respect of the development.*	**Appendix 1**

	Schedule 4 Specific Environmental Conditions	
4	***Performance Measures- Built Features*** *The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 7 to the satisfaction of the Planning Secretary.*  *Notes:* • *The Applicant will be required to define more detailed performance indicators for each of these performance measures in Built Features Management Plans or a Public Safety Management Plan (see Condition 7 below).* • *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Planning Secretary will be the final arbiter.* • *The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of this development consent.* • *Requirements regarding safety or serviceability do not preclude preventative actions or mitigation being taken prior to or during mining in order to achieve or maintain these outcomes.* • *Requirements under this condition may be met by measures undertaken in accordance with the Coal Mine Subsidence Compensation Act 2017.*	**This document**
7	***Extraction Plan*** *(j) include a Public Safety Management Plan, which has been prepared in consultation with RR, to ensure public safety;* *The Applicant shall implement the approved management plan as approved from time to time by the Secretary.*	**This document**
8	*The Applicant must ensure that the management plans required under conditions 7(g)-(j) above include: (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this consent; and (b) a detailed description of the measures that would be implemented to remediate predicted impacts*	**Section 4 and 6**
	Schedule 6 – Environmental Management, Reporting and Auditing	
6	***Reporting and Auditing*** **Incident Notification** The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name) and set out the location and nature of the incident.	**Section 6.3**
7	**Non-Compliance Notification** Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance. ***Note**: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.*	**Section 6.3**

Appendix 3: Approval Letter

Appendix 12 Rehabilitation Management Plan

Environmental Management System
Delta Coal
Rehabilitation Management Plan

Reviewers	Lachlan McWha (Delta Coal – Environmental Compliance & Approvals Coordinator)
Authorised by:	Pieter Van Rooyen (Delta Coal – Technical Services Manager)
Date:	15/01/2024

Rehabilitation Management Plan Summary Table

Name of Mine /s	Chain Valley Colliery and Mannering Colliery
Name of Mine Operator	Great Southern Energy Pty Ltd (trading as Delta Coal)
Rehabilitation Management Plan Commencement Date	20 October 2022
Rehabilitation Management Version and Revision Dates	1 (20 October 2022)
Name of Mining Authorisation / Authorisation holder(s)	**Great Southern Energy Pty Ltd** Mining Leases: • ML1051 (7 July 2022 – renewal requested) • ML1052 (7 July 2022 – renewal requested) • ML1308 (4 May 2022 – renewal requested) • ML1781 (3 July 2031) • ML1782 (29 July 2026) • ML1783 (28 June 2028) • ML1784 (7 March 2023) • ML1785 (13 October 2043) • CCL706 (29 April 2022 – renewal requested) • CCL707 (30 December 2023) Surface Leases: • MPL1349 (5 October 2028) • MPL1400 (6 November 2031) • MPL337 (30 January 2037) • MPL1389 (14 May 2031) • CCL706 (29 April 2022 – renewal requested) • ML1781 – Surface Portion (3 July 2031) • ML1782 – Surface Portion (29 July 2026) Exploration Licenses and Authorisations: • EL8428 (7 December 2025) • A383 (21 September 2025)
Name and Contact Details of the Environmental Representative	Lachlan McWha (Environmental Compliance and Approvals Coordinator) Phone: 02 4358 0800, Email: lmcwha@deltacoal.com.au
Name and Contact Details of the Mine Manager	Joshua Cornfield (Mine Manager) Phone: 02 4358 0800, Email: Jcornfield@deltacoal.com.au
Nominated Contatct Person (Mining Act 1992)	Pieter van Rooyen (Technical Services Manager Phone: 02 4358 0800; Email: PvanRooyen@deltacoal.com.au
Current Version and Date	**15/01/2024 (V2).**

Note:
Mining Authorisation abbreviations:
CCL – Consolidated Coal Lease
ML - Mining Lease
MPL – Mining Purposes Lease

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1 Introduction

1.1 History of Operations

1.1.1 Chain Valley Colliery

Chain Valley Colliery (CVC) is an underground coal mine (colliery) situated in the Newcastle coalfields of New South Wales, at the southern end of Lake Macquarie (see **Figure 1.3.1.1**). Chain Valley Colliery is located directly adjacent to the Vales Point Power Station. **Table 1-1** outlines the key mining and ownership milestones over the site's 60-year history. Under Development Consent SSD-5465 the site is permitted to operate until 31 December 2027.

Table 1-1: Chain Valley Colliery History of Operations

Year	Key Mining and Ownership Milestones
1960	J&A Brown and Abermain Seaham Collieries Ltd commence site clearing, drift/shaft sinking
1962/1963	Coal Production for Wallarah seam / First coal delivery to Vales Point Power Station Mining methods commenced – Bord and Pillar first workings, partial and full secondary extraction
1963-1994	Ownership - J&A Brown and Abermain Seaham Collieries Ltd, Coal & Allied.
1980s	Peak employment of 380 people
1994	Wallarah Coal Joint Venture (WCJV)
1997	Wallarah Seam workings discontinued
1994 - 2002	WCJV – owned by Ingwe Coal, Billiton and BHP Billiton
2002 - 2006	WCJV – 80% LakeCoal Pty Ltd (Excel Coal Pty Ltd) and Sojitz Corporation
2006	Fassifern Seam workings commenced
2006 - 2009	Peabody owned 100% LakeCoal
2008	Great Northern Seam workings discontinued
2009	LDO, AMCI own LakeCoal
2011	20% Sojitz share of WCJV acquired by LDO through Fassi Coal Pty Ltd Commencement of Miniwall Mining Method
2016	RWE NSW Pty Ltd acquired percentage in Joint Venture
2018	Fassi Coal Pty Ltd and Lake Coal Pty Ltd placed into Administration.
2019	Great Southern Energy Pty Ltd acquired Chain Valley Colliery assets and leases from LakeCoal and became the operator
Present	First workings and Miniwall Mining Method in Fassifern Seam

In 2020, Delta Coal decommissioned and demolished its former mine cottages located adjacent Lake Macquarie. The rehabilitation objectives for the footprint of the cottages is to be open grasslands. The project is within

growth media development phase from Q4 2020 to Q4 2023. Additionally, derelict infrastructure at CVC including the former ROM Coal bin and belt winder house were demolished in 2020.

1.1.2 Mannering Colliery

Mannering Colliery (MC) underground coal mine located directly adjacent to CVC, and is shown on **Figure 1.3.1.1**. **Table 1-2** outlines the key mining and ownership milestones over the site's 60-year history. Under Project Approval MP06_0311, Mannering Colliery is permitted to mine and handle coal until 31 December 2027.

Table 1-2: Mannering Colliery History of Operations

Year	Key Mining and Ownership Milestones
1960	Commencement of operations as Wyee State Coal Mine
1961	Commence Coal Production in Great Northern and Fassifern seams / First coal delivery to Vales Point Power Station Mining methods commenced – Bord and Pillar first workings, partial and full secondary extraction
1999	Great Northern Seam workings discontinued
2002	Mining operations ceased. Centennial Coal company purchased from PowerCoal Pty Ltd
2005	Mine renamed Mannering Colliery, recommenced production in Fassifern Seam
2012	Underground mining operations ceased
2013	LakeCoal Pty Ltd became the operator
2014	Development Consent Approval to develop tunnel link between Chain Valley Colliery and Mannering Colliery
2017	Underground Link Road between CVC and MC enables coal mined from Chain Valley Colliery to be conveyed to Mannering Colliery
2017 – Present	Underground coal conveyance and surface coal handling activities to Vales Point Power Station
2018	Fassi Coal Pty Ltd and Lake Coal Pty Ltd placed into Administration.
2019	Great Southern Energy Pty Ltd acquired Mannering Colliery assets and subleases from Centennial and became the operator
2020	MC continues to be used as an underground link to transfer coal from CVC to MC surface, coal crushing and handling and product coal transfer to Vales Point Power Station. Rotary Breaker was removed and primary crusher installed underground to reduce noise impacts. Other noise mitigation projects completed.

As the pit-top facilities at Mannering Colliery remain in use, there has been no decommissioning or rehabilitation projects at the site.

1.2 Current Development Consents, Leases and Licenses

The consents relevant to the Delta Coal operations are identified in **Table 1-3**, under both SSD-5465 and MP 06_0311 operations are permitted to continue to 31 December 2027. Delta Coal is currently preparing an

application to consolidate the two consents and extend the permitted life of operations to 31 December 2029. Both SSD-5465 and MP06_0311 require an RMP be prepared, however, under MP06_0311 it is noted that the Mining Operations Plan (MOP) which will become the RMP after amendment to the Mining Act will satisfy the requirement for an RMP. Prior to amendment to schedule 8A of the Mining Regulation 2016 the approved MOP for the site covered both CVC and MC operations and rehabilitation.

All Delta Coal lease holdings are registered under Chain Valley Colliery, the leases are shown on **Figure 1-3**, all leases within the holding are listed in **Table 1-4**. On 1 July 2022, Delta Coal registered all mining leases, mining purposes leases and consolidated coal leases to be treated as one under schedule 8A clause 3(1) of the Mining Regulation 2016.

Delta Coal holds two Environmental Protection Licences (EPLs) for Chain Valley Colliery and Mannering Colliery, issued by the Environment Protection Authority (EPA) under the Protection of the Environment Operations Act 1997 identified in **Table 1-5.** A copy of the current EPL's are publicly available on the NSW EPA licensing website and Delta Coal Website (www.deltacoal.com.au).

Delta Coal holds two water licences for Chain Valley Colliery and Mannering Colliery, which permit extraction of groundwater for mine dewatering identified in **Table 1-6**.

Table 1-3: Consent Details

Approval	Issued / Modified Date	Approval Authority	Project
SSD-5465	Originally issued 23/12/2013 MOD 1 Issued 27/11/2014 MOD 2 Issued 16/12/2015 MOD 3 Issued 26/06/2020 MOD 4 Issued 05/08/2021	Minister for Planning under Environmental Planning and Assessment Act 1979	Chain Valley Colliery – Extension Project MOD 1 for linkage to Mannering Colliery MOD 2 increased to 2.1Mtpa production and reorientation of Miniwall panels in Northern Mining Domain MOD 3 increase of ROM coal to 2.1Mtpa to Mannering Colliery. Mining area and Mining method to include Bord and Pillar MOD 4 approves mining in the Northern Mining Area extension covered by ML1785 and allows an increased employee limit at CVC.
MP 06_0311	Original Issued 12/3/2008 MOD 1 Issued 25/10/2012 MOD 2 Issued 27/11/2014 MOD 3 Issued 3/12/2015 MOD 4 Issue 4/8/2016 MOD 5 Issued 26/06/2020	Minister for Planning under Environmental Planning and Assessment Act 1979	Mannering Colliery – Continuation of Mining Project. MOD 1 for extension of the approved Project Site. MOD 2 for linkage to Chain Valley Colliery MOD 3 increase coal handling from Chain Valley to 1.3 Mtpa. Extension of Approval to 2022 MOD 4 recommission rotary breaker MOD 5, handle 2.1Mtpa and decommission rotary breaker

Table 1-4: Leases

Current Mining tenement	Holder	Grant date / Renewal date	Lease expiry date	Applicability
CCL 706	Great Southern Energy	24 January 1990	29 April 2022 (renewal requested)	Incorporates historical workings within the Fassifern, Wallarah and Great Northern Seams which are, and would continue to be utilised for passive operational activities.
CCL 707	Great Southern Energy	3 July 1989	30 Dec 2023	Incorporates historical workings within the Fassifern, Wallarah and Great Northern seams which are, and would continue to be, utilised for passive operational activities and the Summerland Point ventilation shaft site.
EL8428	Great Southern Energy	7 Dec 2015	7 Dec 2025	Future mine exploration area.
A383	Great Southern Energy	31 May 2021	21 September 2025	Surface exploration license for ML1781 area.
ML 1051	Great Southern Energy	7 July 1941	7 July 2022 (renewal requested)	Part of the area approved under SSD-5465.
ML 1052	Great Southern Energy	7 July 1941	7 July 2022 (renewal requested)	Part of the area approved under SSD-5465.
ML 1308	Great Southern Energy	4 May 1965	4 May 2022 (renewal requested)	Mining lease for the mine drift entries.
ML 1781	Great Southern Energy	22 April 2022	3 July 2031	Potential future mining area, incorporates historical workings.
ML 1782	Great Southern Energy	24 January 2022	29 July 2026	Partial transfer of previous sub leased area of CCL 721 from Centennial Coal to GSE. Incorporates previous Mannering Colliery workings.
ML 1783	Great Southern Energy	22 April 2022	28 June 2028	Partial transfer of 30.7 hectares from previous subleased area of CCL 722 from Centennial Coal to GSE.
ML 1784	Great Southern Energy	6 July 2021	7 March 2033	Partial transfer of previous subleased area of ML 1370 from Centennial Coal to GSE.

Current Mining tenement	Holder	Grant date / Renewal date	Lease expiry date	Applicability
ML 1785	Great Southern Energy	28 April 2021	13 Oct 2022	Partial transfer of previous subleased area of ML 1632 from Centennial Coal to GSE. Incorporates current Fassifern workings in the Northern Mining Area.
MPL 337	Great Southern Energy	30 January 2016	30 January 2037	Mining purposes lease for a portion of the electricity cable on the bed of Chain Valley Bay connecting the pit top switchyard to the ventilation shaft site at Summerland Point.
MPL 1349	Great Southern Energy	5 Oct 1967	5 Oct 2028	Mining purposes lease for the Chain Valley pit top area.
MPL 1389	Great Southern Energy	14 May 1970	14 May 2031	Mining purposes lease for a portion of the electricity cable on the bed of Chain Valley Bay connecting the pit top switchyard to the ventilation shaft site at Summerland Point.
MPL 1400	Great Southern Energy	6 Nov 1970	6 Nov 2031	Mining purposes lease for a portion of the electricity cable on the bed of Chain Valley Bay connecting the pit top switchyard to the ventilation fan at Summerland Point.

Table 1-5: Environmental Protection Licences

Premises	EPL Number	Date of Issue	Issued to
Mannering Colliery	191	06/04/2000	Great Southern Energy Pty Ltd
Chain Valley Colliery	1770	10/11/2000	Great Southern Energy Pty Ltd

Table 1-6: Water Licences

Site	Water Licence Number	Extraction Volume	Additional Information
Mannering Colliery	WAL40461	450 ML/year	Work Approval 20AL217059
Chain Valley Colliery	WAL41508	4443 ML/year	Work Approval 20MW065025

1.3 Land Ownership and Land Use

The CVC development consent and MC project approval boundaries lie within two separate local government areas (LGAs), namely the City of Lake Macquarie LGA and Central Coast LGA shown in **Figure 1-1**

The Chain Valley and Mannering pit top surface operational areas are on land owned by Sunset Power International Pty Ltd (trading as Delta Electricity) and form part of the Vales Point Power Station (VPPS) buffer zone. The land is occupied under compensation agreements with Delta Electricity. In addition to the two pit top areas there are two remote surface sites associated with the Chain Valley Colliery Holding, the main ventilation fan site for CVC (at Summerland Point and situated on land owned by Delta Coal) and a downcast shaft site for

Mannering (adjacent to the Vales Point Ash Dam and situated on land owned by Sunset Energy). Land ownership details of the surface facilities sites are shown on **Figure 1-2** and listed in **Table 1-7**.

The CVC lease holdings are shown in **Figure 1-3** and local vegetation communities are shown on **Figure 1-4**.

The Chain Valley and Mannering Colliery pit top areas have been used as mining infrastructure areas for the last 60 years. The pit top facilities are situated within Zone SP2 (Infrastructure – Electricity generating works). The Chain Valley ventilation fan site is listed as predominately Zone C3 – Environmental Management with a portion of the land within Zone C2 – Environmental Conservation. Zoning of the aforementioned lands under the Central Coast Council Local Environmental Plan 2022 is shown on Figure 1-5. Current land-uses surrounding the sites and above the old and proposed workings include; natural waterways, infrastructure, public recreation, National Parks and nature reserves and low density residential.

Local topography is shown on **Figure 1-6** at 2m contours and sites registered under the Aboriginal Heritage Information Management System (AHIMS) are shown on **Figure 1-7**.

Table 1-7: Land Ownership

Lot	Deposited Plan	Owner	Description
A	379918	Sunset Energy	Chain Valley pit top facilities area
B	379918	Sunset Energy	Chain Valley pit top facilities area
C	349733	Sunset Energy	Chain Valley pit top facilities area
A	187570	Sunset Energy	Chain Valley pit top facilities area
1B	339441	Sunset Energy	Chain Valley pit top facilities area
1	226133	Great Southern Energy	Chain Valley ventilation shaft and fans site
1	379203	Sunset Energy	Mannering downcast shaft site
102	1170291	Sunset Energy	Mannering surface facilities site

1.3.1 Land Ownership and Land use Figures

Figure 1-1: Chain valley Colliery and Mannering Colliery Locality

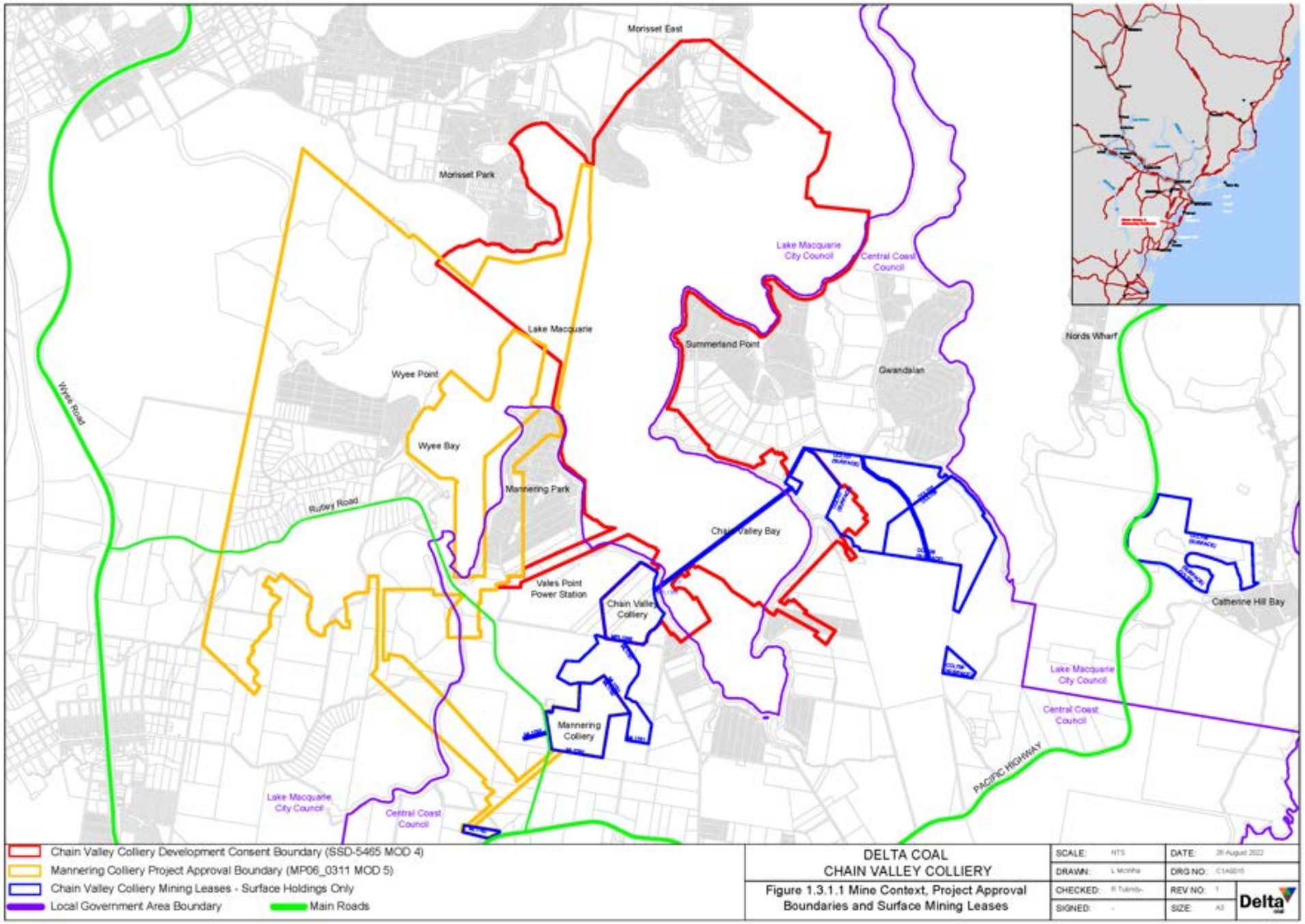


Figure 1-2: CVC and MC Land Ownership

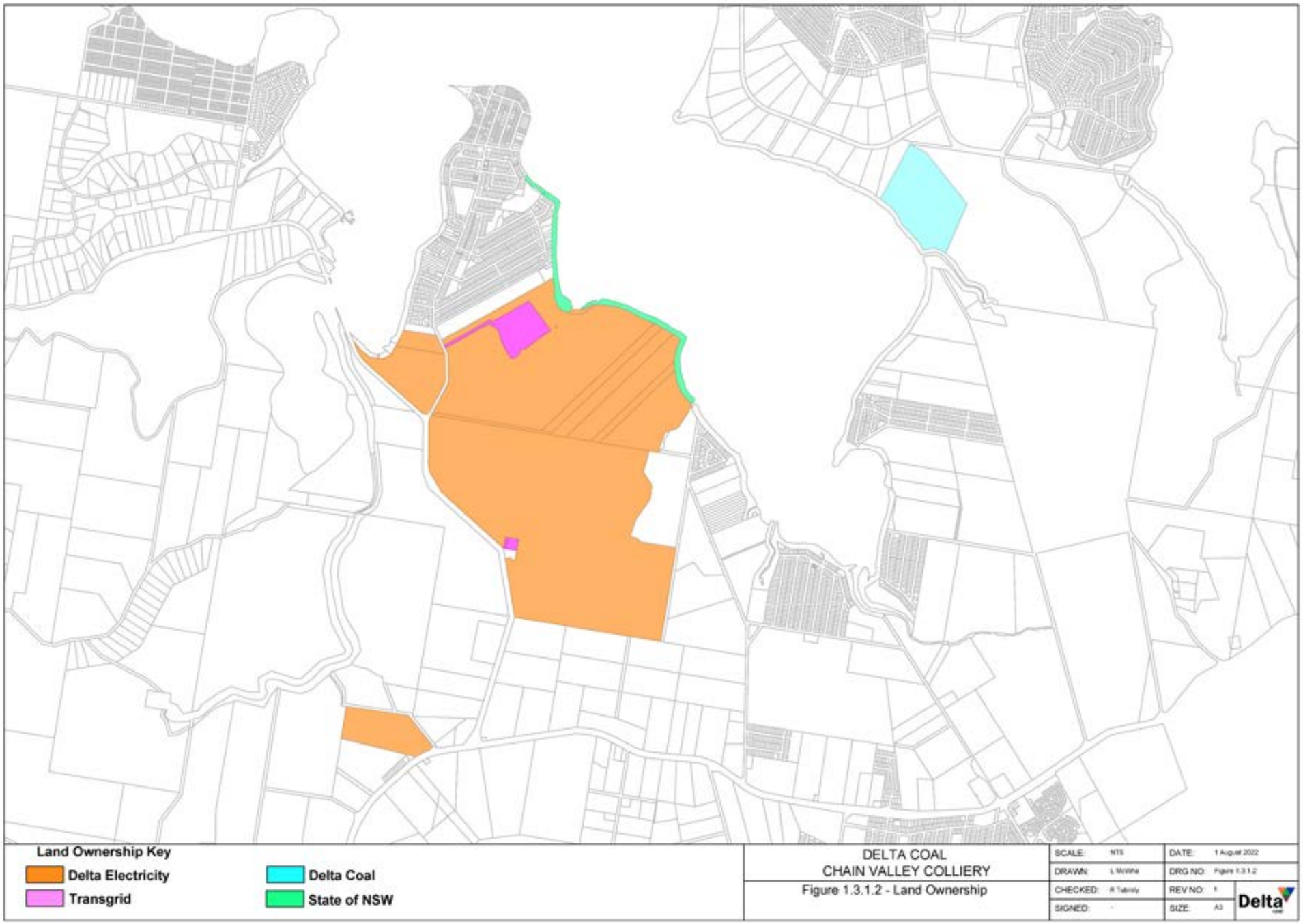


Figure 1-3: Chain Valley Colliery Mining Tenements

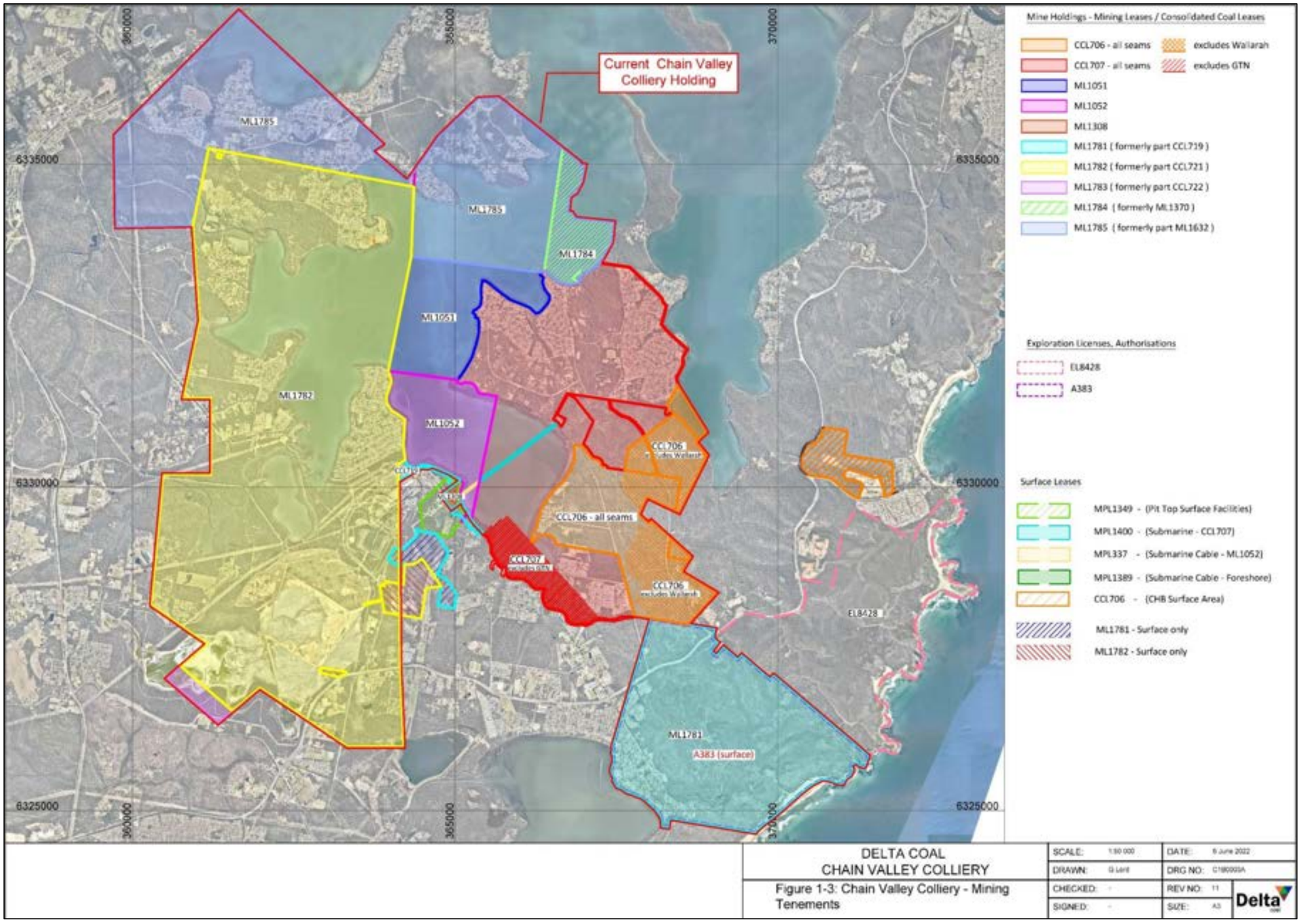


Figure 1-4: Vegetation Boundaries and Natural Features

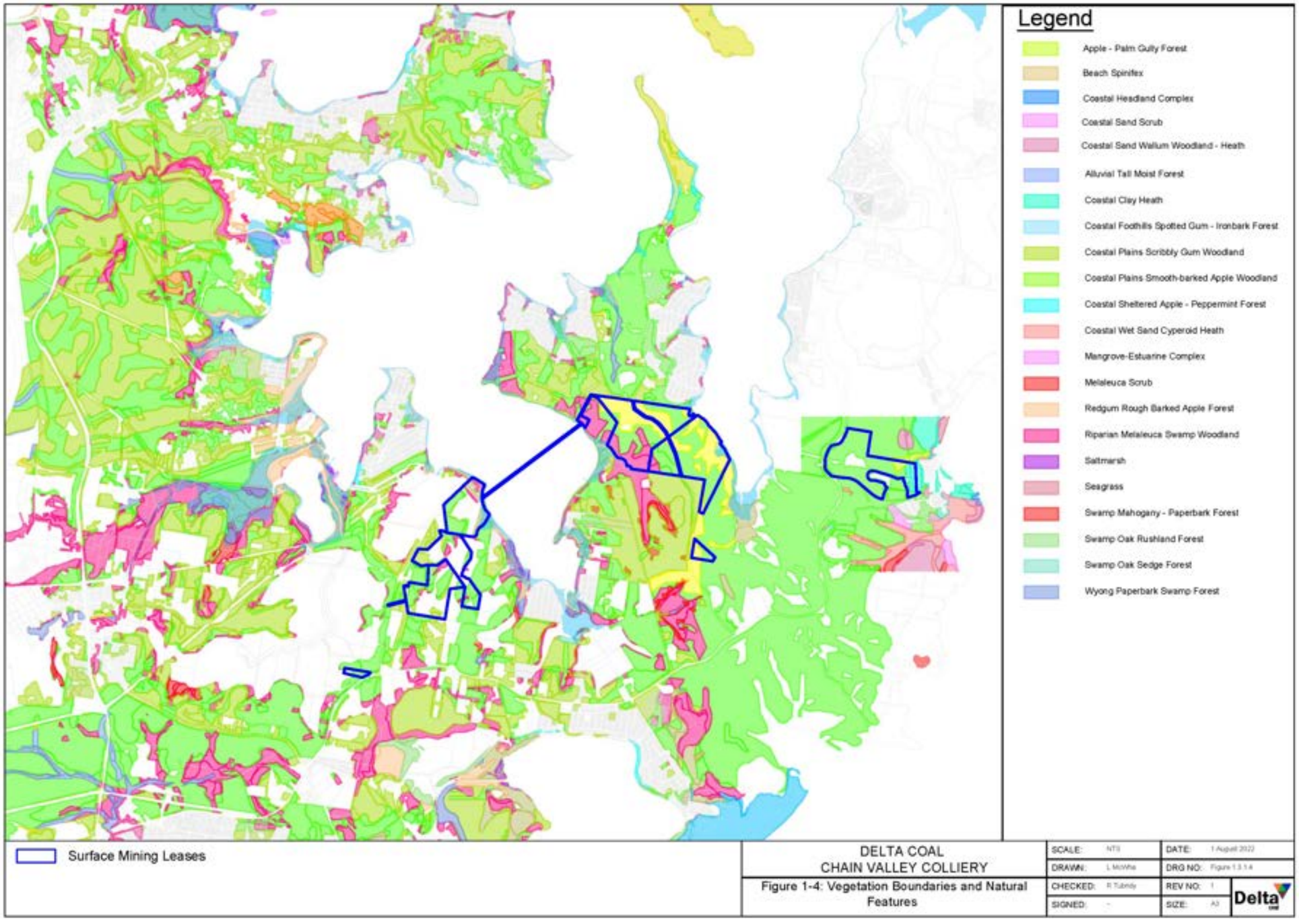


Figure 1-5: Council Zoning Areas and Land Uses

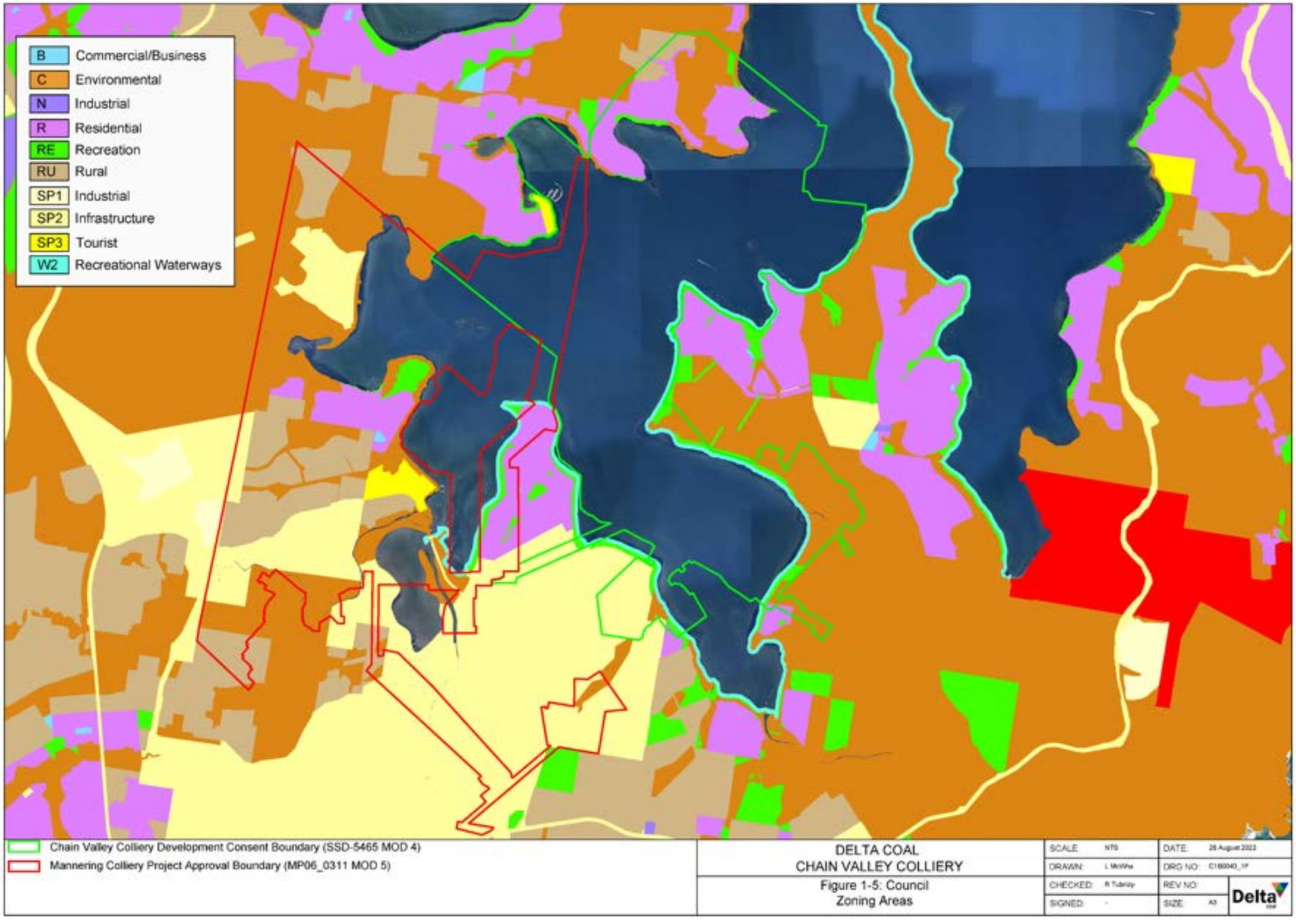


Figure 1-6: Surface Contours

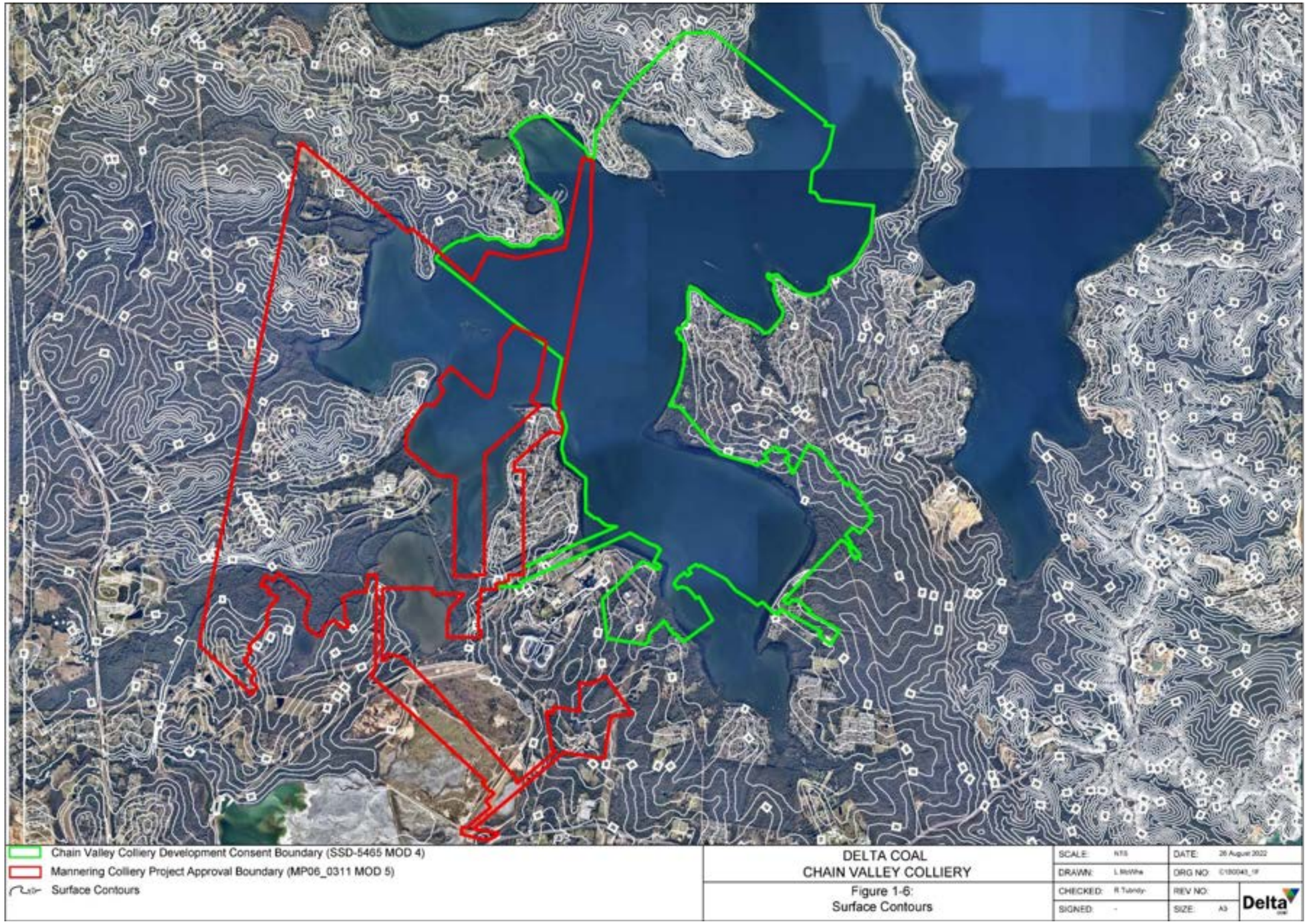
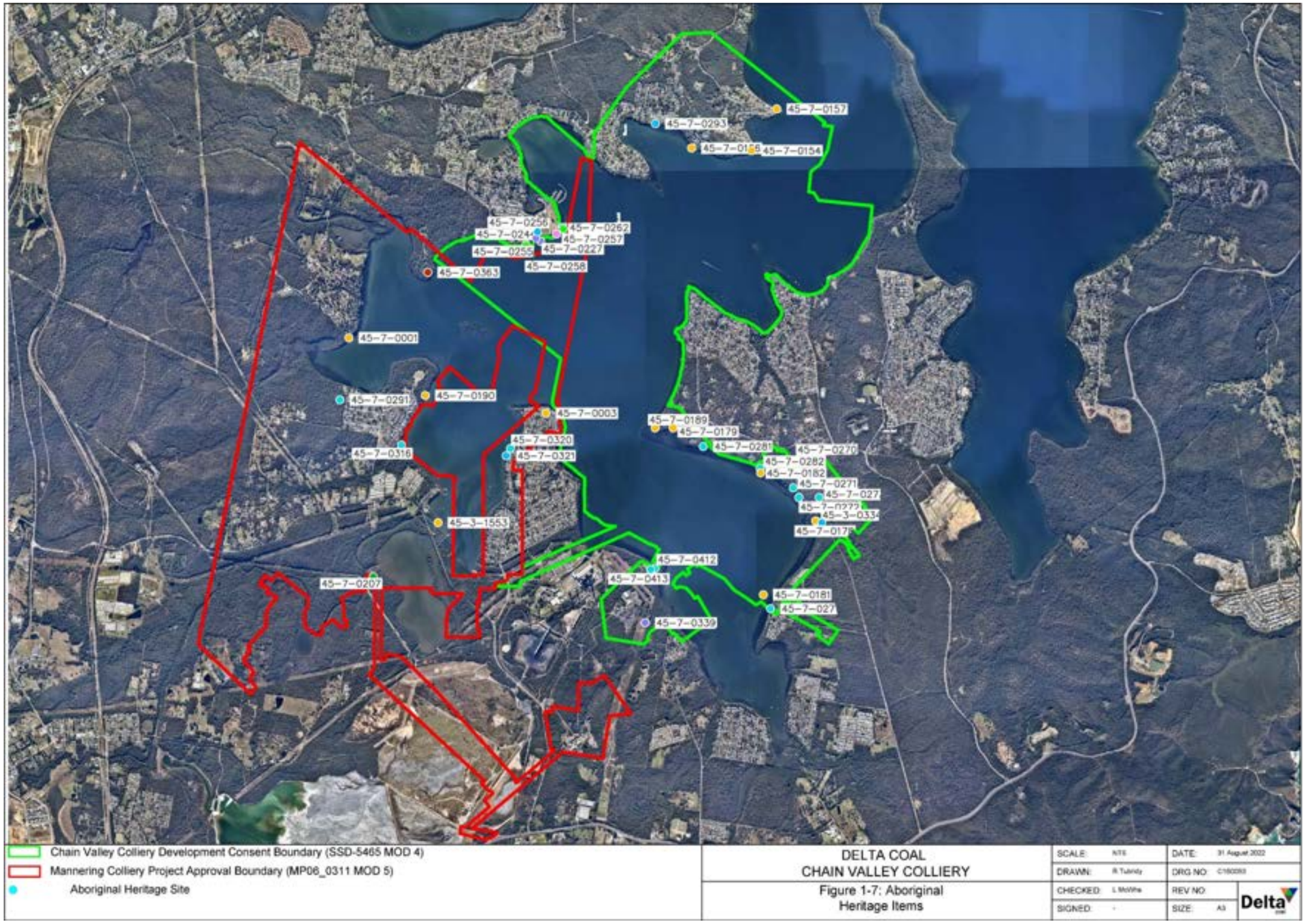


Figure 1-7: Aboriginal Heritage Information Management System (AHIMS) recorded Aboriginal sites



2 Final Land Use

2.1 Regulatory Requirements for Rehabilitation

Regulatory requirements relating specifically to the rehabilitation of the CVC and MC mine sites are identified in **Table 2-1**.

Table 2-1 - Regulatory Requirements for Rehabilitation

<table>
<tr><th>Regulatory Document</th><th>Condition</th><th>Site / Domain</th><th>Description of Requirement</th><th>Relevant section of RMP</th></tr>
<tr><td>Development Consent SSD-5465 (MOD 4)</td><td>Schedule 3, Condition 25</td><td>Chain Valley Colliery</td><td>Rehabilitation Objectives

The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. This rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the EIS, and comply with the objectives in Table 5.

Table 5: Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th></tr>
<tr><td>Mine Site (as a whole)</td><td>Safe, stable and non-polluting.

Final land use compatible with surrounding land uses.</td></tr>
<tr><td>Surface Infrastructure</td><td>To be decommissioned and removed, unless the RR agrees otherwise.</td></tr>
<tr><td>Portals and ventilation shafts</td><td>To be decommissioned and made safe and stable.

Retain habitat for threatened species (e.g. bats), where practicable.</td></tr>
<tr><td>Other land affected by the development</td><td>Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of:

Local native plan species (unless the RR agrees otherwise);and

A landform consistent with the surrounding environment.</td></tr>
<tr><td>Built features damaged by mining operations</td><td>Repair to pre-mining condition or equivalent unless:

The owner agrees otherwise; or

The damage is fully restored, repaired or compensated under the Coal Mine Subsidence Compensation Act 2017.</td></tr>
<tr><td>Community</td><td>Ensure public safety

Minimise the adverse socio-economic effects associated with mine closure.,</td></tr>
<tr><td colspan="2">Note:</td></tr>
</table></td><td>Section 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 6.2.2</td></tr>
</table>

Regulatory Document	Condition	Site / Domain	Description of Requirement	Relevant section of RMP
			These rehabilitation objectives apply to all subsidence impacts and environmental consequences caused by underground mining taking place after the granting of project approval MP 10_0161, and to all development surface infrastructure that is part of the development, whether constructed prior to or following the date of this consent. Rehabilitation of subsidence impacts and environmental consequences cased by mining which took place prior to the date of project approval (MP 10_0161) may be subject to the requirements of other approvals (eg under a mining lease or a Subsidence Management Plan approval).	
Development Consent SSD-5465 (MOD 4)	Schedule 3, Condition 26	Chain Valley Colliery	Progressive Rehabilitation The Applicant must carry out the rehabilitation of the site progressively, that is, as soon as reasonably practicable following disturbance.	Section 6.1
Development Consent SSD-5465 (MOD 4)	Schedule 3, Condition 27	Chain Valley Colliery	Rehabilitation Management Plan The applicant must prepare a Rehabilitation Management Plan for the development, in accordance with the conditions imposed on the mining lease(s) associated with the development under the *Mining Act 1992*. This Plan must: be prepared in consultation with BCD, DPIE Water, CC Council, LMCC and the CCC; be submitted to the RR within 12 months of the date of approval of this development consent be prepared in accordance with any relevant RR guideline and be consistent with the rehabilitation objectives in the EIS and in Table 5; describe how the performance of the rehabilitation would be monitored and assessed against the objectives in Table 5; describe the process whereby additional measures would be identified and implemented to ensure the rehabilitation objectives are achieved; provide for detailed mine closure planning, including measures to minimise socio-economic effects due to mine closure, to be conducted prior to the site being placed on care and maintenance; and be integrated with the other management plans required under this consent. Note: The rehabilitation Management Plan should address all land impacted by the development whether prior to, or following, the date of this consent.	Section 4.2 Section 4.2 Section 2.1 Section 4.1 Section 10 Section 10
Development Consent SSD-5465 (MOD 4)	Statement of Commitments	Chain Valley Colliery	Rehabilitation and Mine Closure Rehabilitation will be undertaken in accordance with the Colliery's RMP and the MOP in force at the time. Detailed management and monitoring proposals for final	Section 10.1

<table>
<tr><th>Regulatory Document</th><th>Condition</th><th>Site / Domain</th><th>Description of Requirement</th><th>Relevant section of RMP</th></tr>
<tr><td></td><td></td><td></td><td>rehabilitation will be included within a Mine Closure Plan to be prepared at least two years prior to cessation of mining activities.</td><td></td></tr>
<tr><td>Environmental Impact Statement – Mining Extension 1</td><td>Chapter 20.1</td><td>Chain Valley Colliery</td><td>Approach to Rehabilitation

LakeCoal (former operator of CVC, now Great Southern Energy Pty Ltd) will undertake a progressive approach to rehabilitation of the mine.

A detailed mine closure plan will be prepared at least two years prior to cessation of mining activities at the colliery.

LakeCoal (former operator of CVC, now Great Southern Energy Pty Ltd) proposes to revegetate the site to a near native ecosystem compatible with the surrounding vegetation communities.</td><td>Section 6.1

Section 4.1

Section 4.1.4</td></tr>
<tr><td>Project Approval MP 06_0311 (MOD 5)</td><td>Schedule 3, Condition 13</td><td>Mannering Colliery</td><td>Rehabilitation

The Applicant must rehabilitate the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. Rehabilitation must be generally consistent with the proposed rehabilitation described in the EA and the Statement of Commitments, and comply with the objectives in Table 2.

Table 2: Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th></tr>
<tr><td>Mine Site (as a whole)</td><td>Safe, stable and non-polluting.

Final land use compatible with surrounding land uses.</td></tr>
<tr><td>Surface Infrastructure</td><td>To be decommissioned and removed, unless the RR agrees otherwise.</td></tr>
<tr><td>Portals and ventilation shafts</td><td>To be decommissioned and made safe and stable.

Retain habitat for threatened species (e.g. bats), where practicable.</td></tr>
<tr><td>Other land affected by the development</td><td>Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of:

Local native plan species (unless the RR agrees otherwise);and

A landform consistent with the surrounding environment.</td></tr>
<tr><td>Built features damaged by mining operations</td><td>Repair to pre-mining condition or equivalent unless:

The owner agrees otherwise; or</td></tr>
</table></td><td>Section 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 6.2.2</td></tr>
</table>

Regulatory Document	Condition	Site / Domain	Description of Requirement	Relevant section of RMP
			The damage is fully restored, repaired or compensated under the Mine Subsidence Compensation Act 1961. Community: Ensure public safety	
Project Approval MP 06_0311 (MOD 5)	Schedule 3, Condition 13A	Mannering Colliery	The Applicant must carry out all surface disturbing activities in a manner that, as far as practicable, minimises potential for dust emissions and must carry out rehabilitation of disturbed areas progressively, that is, as soon as reasonably practicable following disturbance.	Section 6.2.3.2
Project Approval MP 06_0311 (MOD 5)	Schedule 3, Condition 13A	Mannering Colliery	Rehabilitation Management Plan The Applicant must prepare a Rehabilitation Management Plan for the site in accordance with the conditions imposed on the mining lease(s) associated with the development under the Mining Act 1992. This plan must: (a) be submitted within 3 months of approval of Modification 2 to the RR prior to carrying out any disturbing activities of the development, unless otherwise agreed by the Planning Secretary; (b) be prepared in accordance with RR guidelines and in consultation with the Department, BCD, EPA, DPIE Water, affected councils and the mine's CCC; (c) incorporate and be consistent with the rehabilitation objectives in the EA, Statement of Commitments and Table 2 above; (d) integrate and build on, to the maximum extent practicable, the other management plans required under this consent; and (e) address all aspects of mine closure and rehabilitation, including post-mining land use domains, rehabilitation objectives, completion criteria and rehabilitation monitoring and management. Note: The approved Mining Operations Plan (which will become the REMP once the Mining Act Amendments have commenced) required as a condition of the Mining Lease(s) issued in relation to this development, will satisfy the requirements of this condition for a Rehabilitation Plan.	Former RMP submitted Section 2.1 Section 2.1 Throughout this RMP Sections 4.1, 5, 6, 8
Project Approval MP 06_0311 (MOD 5)	Statement of Commitments - Rehabilitation	Mannering Colliery	Rehabilitation will be undertaken in accordance with the Colliery's Rehabilitation Management Plan, which will be updated to include any changes as a result of any modification. The Rehabilitation Management Plan will be amended to reflect any modification and will include integrated rehabilitation and environmental management.	Section 11
Mannering Colliery Environmental	Section 7.11 – Final Land Use	Mannering Colliery	A Mine Closure Plan will be prepared for Mannering Colliery five years in advance of mine closure. This will detail the specific rehabilitation activities required to be	Section 9.2

Regulatory Document	Condition	Site / Domain	Description of Requirement	Relevant section of RMP
Assessment March 2007			undertaken to achieve the agreed final land use for the site in consultation with relevant stakeholders.	
Mannering Colliery Environmental Assessment March 2007	Section 7.11 – Final Land Use	Mannering Colliery	At mine closure, the Mannering Surface facilities will be decommissioned and the site will be rehabilitated using endemic native plant species in consultation with Delta Electricity and any requirements for closure which pertain to the buffer land for Vales Point Power Station. The dams and water management structures on-site will be retained where possible to provide natural habitat and a water source for fauna in the area. Sufficient vehicular access will also be maintained so that these dams can be accessed for firefighting, inspection and maintenance purposes as relevant.	Section 2.3

The above commitments and requirements are in determined in general accordance with the following key legislation, policy and guidelines relating to rehabilitation of Delta Coal operations:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Mining Act 1992 and Mining Regulation 2016*;
- *Biosecurity Act 2015* and Biosecurity Regulation 2017;
- *Local Land Services Act 2013*,
- *National Parks and Wildlife Act 1974*;
- *Biodiversity Conservation Act 2016*; and
- *Rural Fires Act 1997*.

2.2 Final Land Use Options Assessment

Both Development Consent SSD-5465 (CVC) and Project Approval MP06_0311 (MC) stipulate the required final land use of the sites and as such an options assessment is not applicable.

2.3 Final Land Use Statement

The post mining land uses for the Mannering and Chain Valley Colliery pit top facilities and ancillary infrastructure sites are identified in the *Mannering Colliery Continuation of Mining Environmental Assessment* (Hansen Bailey 2007) and the *Chain Valley Colliery – Mining Extension Project Environmental Impact Statement* (EMM 2013) respectively. Although both post mining land uses are largely consistent, they are differentiated below for clarity.

The principal post mining land use goal for the MC pit top area is to return the land to vegetated buffer zone for the VPPS. It was noted, however, that the dams and water management structures on site are to be retained where possible to provide natural habitat and a water source for fauna in the area, and that sufficient vehicle access will also be maintained so that these dams can be accessed for future fire-fighting, inspection and maintenance purposes, as relevant.

The above is the current landowner's (Sunset Energy's) preferred final land use, achievement of this final land use would involve demolition and removal of all MC infrastructure followed by revegetation with endemic native plant species consistent with surrounding bushland. Should Sunset Energy wish to utilise any or all of the infrastructure, they will be retained subject to the approval of DPIE and other relevant authorities.

The proposed post mining land use as identified within the EIS for the CVC pit top areas is largely consistent with that of MC. It is proposed to revegetate the surface facilities areas to a near-native ecosystem compatible with the surrounding vegetation communities. As the goal is to return the areas of disturbance to a native plant community (or communities) aligned with the surrounding bushland, no introduced species (e.g., *Melaleuca armillaris*, *Pinus radiata* and non-endemic eucalypts) would be used in the revegetation program. Rather, the focus of the works would be the use of locally occurring species plant preferentially grown from locally sourced seeds. CVC is on land owned by Delta Electricity who will, therefore, be a key stakeholder in determining the vegetation selection and landform of the area.

Further to the above, some areas will be revegetated to grassland where this is consistent with the final land use and surrounds. This applies to the areas within existing high voltage power line easements, where the existing grassland vegetation communities are actively managed to ensure they have no impact to the transmission of electricity for the state. Accordingly, a grassland community is both consistent with other areas within the easement and considerate of future management requirements (as the high voltage power lines will remain following mine closure). One other small area of grassland is proposed at the MC downcast shaft site, which is consistent with grassed areas surrounding the site. During the development of a Mine Closure Plan, Delta Coal will consult with Ausgrid on any preferred measures/landforms regarding the relinquishment of the easement area.

2.4 Final Land Use and Mining Domains

2.4.1 Final Land Use Domains

In accordance with the site rehabilitation requirements, majority of both CVC pit top and MC pit top will be native ecosystem with the retention of some water management structures, as shown on **Plan 1** in **Section 5**. Native ecosystems will be developed to match adjacent vegetation communities being:

- Mannering pit top - Broad-Leaved Scribbly Gum Open Forest;
- Mannering downcast shaft - Managed exotic grassland;
- Chain Valley pit top - Coastal Open Woodland and managed grassland (within existing high voltage power line easements); and
- Chain Valley upcast shaft - Swamp Sclerophyll Forest.
- Catherine Hill Bay – native woodland / heathland

2.4.2 Mining Domains

2.4.2.1 Infrastructure Area

This domain includes the:

- Main operational area at CVC (administration, stores, storage areas, workshop, drifts, switchyard, car parking, operations offices, bathhouse etc.);
- Main operational area at Mannering (administration, fans, stores, storage areas, workshop, drifts, switchyard, car parking, operations offices, bathhouse etc.);
- Mannering downcast shaft site (located adjacent to VPPS ash dam;
- CVC upcast shaft and ventilation fan site (located at Summerland Point); and
- CVC downcast shaft (located in the north eastern section of the main pit top facilities)

The CVC pit top is gently sloping to the east with no significant changes in surface elevations. Retaining walls are utilised only beneath the winder rope for the man and materials drift. The CVC ventilation shaft site at Summerland Point slopes gently toward the south west, toward Lake Macquarie, with clean water diversion drains in place on the upslope side of the site which direct water around the ventilation fan site compound.

The infrastructure domain at the MC pit top is benched down from the south eastern border with retaining walls (3.5 to 4 m high) separating the carpark from the main operational area, and also separating the main operational area from the coal handling area. The unpaved storage yard is used as a lay down area for equipment and an explosives magazine (not currently utilised). Overall, the domain area falls from south to north and cross contour to the northwest flowing to containment sumps and ponds.

The downcast shaft site is remote to the MC pit top and is located within the boundaries of VPPS ash dam area. The shaft site is relatively small with surrounding areas all managed by Delta Electricity.

2.4.2.2 Other – Coal Stockpile

the coal stockpile area includes associated coal handing facilities within the CVC pit top and the coal stockpile area at the Mannering Colliery pit top.

At the MC the coal stockpile emplacement area has a nominal capacity of approximately 25,000 tonnes and is used to store ROM coal when the VPPS is unable to accept the coal or during extended maintenance periods. The coal pad is a constructed area up to 3.5 m higher than the surrounding areas, with high banks on the western and southern boundaries, which can be used as backfill for other areas during closure.

This area has drainage including concrete drains and sumps, which ultimately report to the Pond B water control system.

CVC has a substantially larger coal stockpile area, which has a capacity of approximately 150,000 tonnes however, in 2020 Delta Coal demolished redundant infrastructure at CVC including the conveyor winder house, ROM coal and final product bins, with the stockpile area currently not in operation. Surface water is drained from the coal handling and stockpile area into the sediment dams directly to the east of the stockpile location. Delta Coal may reinstate coal handling equipment at CVC if/as required.

2.4.2.3 Water Management Area

The water management area at the Chain Valley pit top area includes dams 1 to 13 which have a combined storage capacity of 18,381 kL and discharges via a gravity fed discharge (Point 1 under EPL 1770) and a spillway for high flows (Point 27 under EPL 1770). Both surface and groundwater are transferred to the sediment dam system, which enables retention and settlement of fines prior to water being discharged offsite. Flows into the dams occur via pumping (groundwater from the underground workings), gravity flow through subsurface drains and surface flows from dirty water drains.

At the Mannering pit top the water management area includes:

- Dirty water management control system (including Pond B, Pond 1, Pond 2, Pond 3); and
- Former firefighting supply dam (Dam 4).

The Pond B pollution control system, comprising four pollution control ponds (B, 1, 2,and 3) manages runoff from the pit top. The retention and settlement of storm water takes place within these ponds before water is discharged offsite via Point 1 under EPL 191.

3 Rehabilitation Risk Assessment

Delta Coal undertook a rehabilitation risk assessment on 11 August 2022, with an objective to assess and document potential risk associated with the end of life and progressive rehabilitation of Chain Valley Colliery, Mannering Colliery and Catherine Hill Bay. Prior to conducting the risk assessment, risks to rehabilitation were considered in broader operational risk assessments.

A summary of the proposed controls for risks identified in the most recent rehabilitation risk assessment are presented in **Table 3-1**. A copy of the rehabilitation Risk assessment is presented in **Appendix 2.**

Table 3-1: Risk Assessment Summary

Proposed Control	Section Addressed in RMP
• Hazardous Materials Assessment of pit top infrastructure at decommissioning	Section 6.2.2.5
• Site services scanning prior to decommissioning	Section 6.2.2.2
• Include in RMP - Establish quality assurance for rehabilitation	Section 7
• Compliance database maintained	Section 6.2.1.15
• Review roles and responsibilities of RMP	Section 10.1
• Engage appropriate specialists/knowledge	Section 4.1.3, 4.1.4 and 4.1.5
• Stakeholder Engagement in Mine Closure Plan. Criteria and obligations developed in consultation with stakeholders i.e. Land Owner – Delta Electricity.	Section 4.2
• Community consultation strategy in Mine Closure Plan.	Section 4.1
• Expected outcomes of rehabilitation included in Rehabilitation Management Plan	Section 4.1
• Outline expected outcomes of easement bisecting CVC pit-top dams in consultation with AusGrid.	Section 2.3
• Environmental Monitoring programs throughout remediation phases	Section 6.2
• Detail standard business hours within the Remediation Management Plan.	Section 6.2
• Address access and site security requirements in Rehabilitation Management Plan	Section 6.2.2.1
• Areas of disturbance and landform establishment works to be demarcated on site prior to decommissioning	Section 6.2.2.2 and 6.2.3.2
• Development of a topsoil securement strategy in mine closure plan.	Section 6.2.1.1
• Development of a flora seed/stock securement strategy in mine closure plan.	Section 6.2.1.2
• Infrastructure survey for threatened species prior to demolition	Section 6.2.2.2
• Include in RMP: prior to mine closure stage, undertake in-situ assessment for beneficial re-use (ENM/VENM Order) and waste classification of soils to be removed to achieve final land-form.	Section 6.2.1.1
• Water management to be addressed in RMP	Section 6.2.1.10 and 6.2.3.1
• Develop strategy for management of reject material remaining at MC.	Section 6.2.1.9
• Include carbonaceous material management in RMP	Section 6.2.2.4

• RMP to detail final water management structures	Section 5 and 6.2.3.1
• Include in RMP resourcing for maintenance (roles and responsibilities).	Section 10.1

4 Rehabilitation Objectives and Rehabilitation Completion Criteria

The approved rehabilitation objectives statement is provided in Section 4.1 (below).

4.1 Rehabilitation Objectives and Rehabilitation Completion Criteria

As outlined in the Mine Closure and Rehabilitation section of the SSD5465 Statement of Commitments a detailed management and monitoring proposals for final rehabilitation will be included within a Mine Closure Plan to be prepared at least two years prior to cessation of mining activities. The plan will be comprehensive and not only consider such issues as the physical rehabilitation of the Colliery site and the decommissioning and removal of plant but also community engagement and socio-economic issues. It is not expected that such a plan would be required until approximately 2027, however this date would be dependant on future approvals and access to resources and reserves.


NSW GOVERNMENT
NSW Resources Regulator
ROBJ0001297
APPROVED REHABILITATION OBJECTIVES STATEMENT
Chain Valley Colliery
MONDAY 20 NOVEMBER 2023

APPROVED REHABILITATION OBJECTIVES STATEMENT
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Summary

DETAIL	APPROVAL
Reference	ROBJ0001297
Date of approval	Monday 20 November 2023
Mine	Chain Valley Colliery
Contact	Lachlan Peter McWha

Important note

The Regulator may make the information in your application and any supporting information (including this approval) available for inspection by members of the public, including by publication on its website or by displaying the information at any of its offices. If you consider any part of your application to be confidential, please communicate this to the Regulator via the message function on this application within the Portal.

3

APPROVED REHABILITATION OBJECTIVES STATEMENT
ROBJ0001297 | Chain Valley Colliery

NSW Resources Regulator

Rehabilitation Objectives

The following rehabilitation objectives have been approved.

FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Native Ecosystem	Infrastructure Area		A1	Bushfire	Accumulation of combustible materials removed or diluted such that the site does not present a combustion risk. Roadways required for bushfire management will be retained if required. Bushfire risk management included in mine closure plan including consultation with RFS.
Native Ecosystem	Infrastructure Area		A1	Ecological rehabilitation	Ecological Rehabilitation Objective 2: The vegetation composition of the rehabilitation contains species that are commensurate with native vegetation communities found in the area, comprising: Chain Valley Colliery Pit-Top & Ventilation Compound: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland Chain Valley Colliery Upcast Shaft: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_Derived Native Grasses) Chain Valey Colliery, Former Mine Cottages: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_Derived Native Grassland Mannering Colliery Pit-Top: PCT 1642 - Scribbly gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland Possum Gulley, Catherine Hill Bay: PCT 1619 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
Native Ecosystem	Infrastructure Area		A1	Ecological rehabilitation	Ecological Rehabilitation Objective 3: Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable.
Native Ecosystem	Infrastructure Area		A1	Ecological rehabilitation	Ecological rehabilitation objective 1: The native vegetation composition of the rehabilitation contains species that are commensurate with native vegetation communities found in the area of: Chain Valley Colliery Pit-Top & Ventilation Compound: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland Chain Valley Colliery Upcast Shaft: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia

APPROVED REHABILITATION OBJECTIVES STATEMENT

ROBJ0001297 | Chain Valley Colliery

NSW Resources Regulator

FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
					heathy woodland of southern Central Coast_Derived Native Grasses) Chain Valey Colliery, Former Mine Cottages: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_Derived Native Grassland Mannering Colliery Pit-Top: PCT 1642 - Scribbly gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland Possum Gulley, Catherine Hill Bay: PCT 1619 - Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
Native Ecosystem	Infrastructure Area		A1	Groundwater	Groundwater quality is similar to or better than pre-disturbance water quality.
Native Ecosystem	Infrastructure Area		A1	Groundwater	Impacts to groundwater regime are similar to the pre-mining environment.
Native Ecosystem	Infrastructure Area		A1	Land contamination	There is no residual soil contamination on site that is incompatible with the final land use or that poses a threat of environmental harm. There is no residual contamination on site that can impact, or, migrate within, groundwater.
Native Ecosystem	Infrastructure Area		A1	Landform stability	The final landform is stable for the long-term and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public and native fauna.
Native Ecosystem	Infrastructure Area		A1	Management of waste and process materials	No residual waste materials to be left on-site.
Native Ecosystem	Infrastructure Area		A1	Removal of infrastructure	All infrastructure that is not required for the final land use is to be removed and the land left safe and free of hazardous materials.
Native Ecosystem	Infrastructure Area		A1	Removal of infrastructure	Decommissioning of portals and shafts to relevant standards
Native Ecosystem	Infrastructure Area		A1	Retention of infrastructure	Identified Aboriginal heritage items remain undisturbed during site rehabilitation

APPROVED REHABILITATION OBJECTIVES STATEMENT

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NSW Resources Regulator

FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Native Ecosystem	Infrastructure Area		A1	Retention of infrastructure	Relevant approvals are in place for the management of threatened species habitat (i.e microbats in portals/shafts) as part of the decomissioning and sealing of mine entrances. Retained infrastructure is safe and does not present a hazard to the community.
Native Ecosystem	Infrastructure Area		A1	Surface water	Runoff water quality from mine site meets the requirements of the relevant development consent(s) / Environment Protection Licence and does not present a risk of environmental harm.
Native Ecosystem	Water Management Area		A3	Bushfire	Accumulation of combustible materials removed or diluted such that the site does not present a combustion risk. Roadways required for bushfire management will be retained if required. Bushfire risk management included in mine closure plan including consultation with RFS. Such that the site does not present an unacceptable bushfire risk to local infrastructure and communities.
Native Ecosystem	Water Management Area		A3	Ecological rehabilitation	Ecological Rehabilitation Objective 2: The vegetation composition of the rehabilitation contains species that are commensurate with native vegetation communities found in the area, comprising: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland
Native Ecosystem	Water Management Area		A3	Ecological rehabilitation	Ecological Rehabilitation Objective 3: Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable.
Native Ecosystem	Water Management Area		A3	Ecological rehabilitation	Ecological Rehabilitation Objective 1: The native vegetation composition of the rehabilitation contains species that are commensurate with native vegetation communities found in the area of Coastal Open Woodland (PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland).
Native Ecosystem	Water Management Area		A3	Groundwater	Groundwater quality is similar to or better than pre-disturbance water quality.

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FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Native Ecosystem	Water Management Area		A3	Groundwater	Impacts to groundwater regime are similar to the pre-mining environment.
Native Ecosystem	Water Management Area		A3	Land contamination	There is no residual soil contamination on site that is incompatible with the final land use or that poses a threat of environmental harm.
Native Ecosystem	Water Management Area		A3	Landform stability	The final landform is stable for the long-term and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public and native fauna.
Native Ecosystem	Water Management Area		A3	Removal of infrastructure	All infrastructure that is not required for the final land use is to be removed and the land left safe and free of hazardous materials.
Native Ecosystem	Water Management Area		A3	Surface water	Runoff water quality from mine site meets the requirements of the relevant development consent(s) / Environment Protection Licence and does not present a risk of environmental harm.
Water Management Areas	Water Management Area		F3	Bushfire	Embankments of retained water structures assessed for combustible metarial. Accumulations of combustible materials removed.
Water Management Areas	Water Management Area		F3	Ecological rehabilitation	Identified water management structures to be retained to provide natural habitat and a water source for fauna in the area.
Water Management Areas	Water Management Area		F3	Groundwater	Groundwater quality is similar to or better than pre-disturbance water quality.
Water Management Areas	Water Management Area		F3	Groundwater	Impacts to groundwater regime are similar to the pre-mining environment.
Water Management Areas	Water Management Area		F3	Land contamination	There is no residual sediment contamination on site that is incompatible with the final land use or that poses a threat of environmental harm.

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FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Water Management Areas	Water Management Area		F3	Landform stability	The final landform is stable for the long-term and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public and native fauna.
Water Management Areas	Water Management Area		F3	Removal of infrastructure	All infrastructure that is not required for the final land use is to be removed and the land left safe and free of hazardous materials.
Water Management Areas	Water Management Area		F3	Surface water	Water quality within retained surface water ponds is suitable as a water sauce for fauna in the area as well as water reserve for bushfire fighting. Meets applicable Development Consent / Environmental Protection Limits.
Water Management Areas	Water Management Area		F3	Water approvals	Water management structures retained are appropriately licensed and ensure that sufficient license shares are held in the water source(s) to account for water take.
Infrastructure	Infrastructure Area		I1	Bushfire	The risk of bushfire and impacts to the community, environment and infrastructure has been addressed as part of rehabilitation.
Infrastructure	Infrastructure Area		I1	Land contamination	There is no residual sediment contamination on site that is incompatible with the final land use or that poses a threat of environmental harm.
Infrastructure	Infrastructure Area		I1	Landform stability	The final landform is stable for the long-term and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public and native fauna.
Infrastructure	Infrastructure Area		I1	Removal of infrastructure	Decommissioning of portals and shafts to relevant standards
Infrastructure	Infrastructure Area		I1	Retention of infrastructure	All infrastructure that is to remain as part of the final land use is safe, does not pose any hazard to the community. All infrastructure that is to remain as part of the final land use benefits from the relevant approvals (e.g. development consent and/or licence/lease/binding agreement, etc.)
Infrastructure	Infrastructure Area		I1	Surface water	Runoff water quality from mine site meets the requirements of the relevant development consent(s) / Environment Protection Licence and does not present a risk of environmental harm.

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FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Infrastructure	Water Management Area		I3	Bushfire	Accumulation of combustible materials removed or diluted such that the site does not present a combustion risk. Roadways required for bushfire management will be retained if required. Bushfire risk management included in mine closure plan including consultation with RFS. Such that the site does not present an unacceptable bushfire risk to local/retained infrastructure and communities.
Infrastructure	Water Management Area		I3	Ecological rehabilitation	Ecological Rehabilitation Objective 2: The vegetation composition of the rehabilitation contains species that are commensurate with native vegetation communities found in the area, comprising: PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_Derived Native Grasses)
Infrastructure	Water Management Area		I3	Ecological rehabilitation	Ecological Rehabilitation Objective 3: Levels of ecosystem function have been established that demonstrate the rehabilitation is self-sustainable.
Infrastructure	Water Management Area		I3	Ecological rehabilitation	Ecological Rehabilitation Objective 1: The native vegetation composition of the rehabilitation contains species that are commensurate with PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_Derived Native Grassland.
Infrastructure	Water Management Area		I3	Groundwater	Groundwater quality is similar to or better than pre-disturbance water quality.
Infrastructure	Water Management Area		I3	Groundwater	Impacts to groundwater regime are similar to the pre-mining environment.
Infrastructure	Water Management Area		I3	Land contamination	There is no residual soil contamination on site that is incompatible with the final land use or that poses a threat of environmental harm.
Infrastructure	Water Management Area		I3	Landform stability	The final landform is stable for the long-term and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public and native fauna.

APPROVED REHABILITATION OBJECTIVES STATEMENT

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FINAL LAND USE DOMAIN	MINING DOMAIN	SPECIFY OTHER DOMAIN	SPATIAL REF	REHABILITATION OBJECTIVE CATEGORY	REHABILITATION OBJECTIVES
Infrastructure	Water Management Area		I3	Removal of infrastructure	All infrastructure that is not required for the final land use is to be removed and the land left safe and free of hazardous materials.
Infrastructure	Water Management Area		I3	Retention of infrastructure	All infrastructure that is to remain as part of the final land use is safe, does not pose any hazard to the community. All infrastructure that is to remain as part of the final land use benefits from the relevant approvals (e.g. development consent and/or licence/lease/binding agreement, etc.)
Infrastructure	Water Management Area		I3	Retention of infrastructure	Identified Aboriginal heritage items remain undisturbed during site rehabilitation
Infrastructure	Water Management Area		I3	Surface water	Runoff water quality from mine site meets the requirements of the relevant development consent(s) / Environment Protection Licence and does not present a risk of environmental harm.

4.2 Rehabilitation Objectives and Rehabilitation Completion Criteria – Stakeholder Consultation

A key component for the development of the RMP is consultation. Previous versions of the RMP and MOP were prepared in consultation with a number of stakeholders, including Central Coast Council (CC Council), Lake Macquarie City Council (LMCC), NSW Department of Primary Industries – Fisheries (DPI-Fisheries), Biodiversity Conservation Division (BCD) Department of Planning, Infrastructure and Environment-Water (DPIE-Water), Delta Electricity and the Community Consultative Committee (CCC).

The rehabilitation strategy for the site remains unchanged from previously approved versions of RMP and MOP. Consultation undertaken with stakeholders as part of the approval processes of the MOP and RMP is presented in **Table 4-1**.

Table 4-1: Summary of Stakeholder Consultation

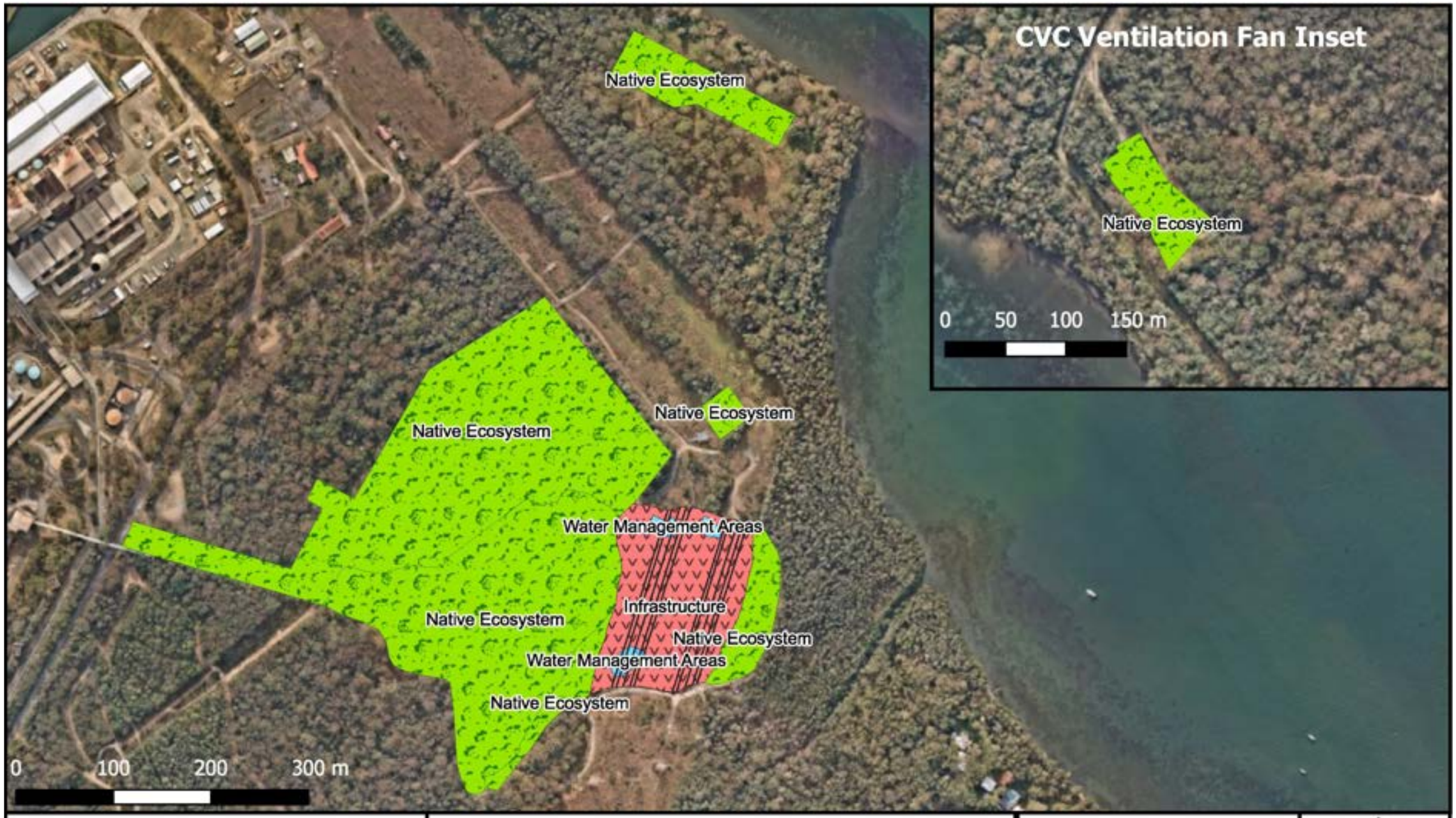
Relevant plan	Stakeholder	Date	Comments	Response/Action
RMP – Rehabilitation Objectives	RR	November 2023	Rehabilitation objectives Approved	Update RMP to reflect approved rehabilitation objectives.
RMP (2022)	RR	September 2022	RMP does not require RR approval.	Nil.
CVC RMP (2021)	DPIE-Resource Assessments	March 2020 December 2020	• Request for information (RFI) provided on 5 March 2020. • Extraction Plan approval (March 2021) which included approval of the Rehabilitation Management Plan (Appendix 1).	• Tracked changed document provided on planning portal for updated consent references and mining panel numbering
CVC RMP (2021)	RR	December 2020	• No comments	• Nil required
CVC RMP (2021)	BCD	December 2020	• No comments	• Nil required
CVC RMP (2021)	LMCC	December 2020	• No comments	• Nil required
CVC RMP (2021)	CC Council	December 2020	• No comments	• Nil required
CVC RMP (2021)	CCC	December 2020	• No comments	• Nil required
CVC and MC MOP (2021)	DPIE	July 2020	• No comments	• Nil required
CVC and MC MOP (2021)	EPA	July 2020	• No comments	• Nil required
CVC and MC MOP (2021)	CC Council	May 2020 (quarterly meeting)	• No comments	• Nil required
CVC and MC MOP (2021)	Lake Macquarie City Council	May 2020 (quarterly meeting)	• No comments	• Nil required

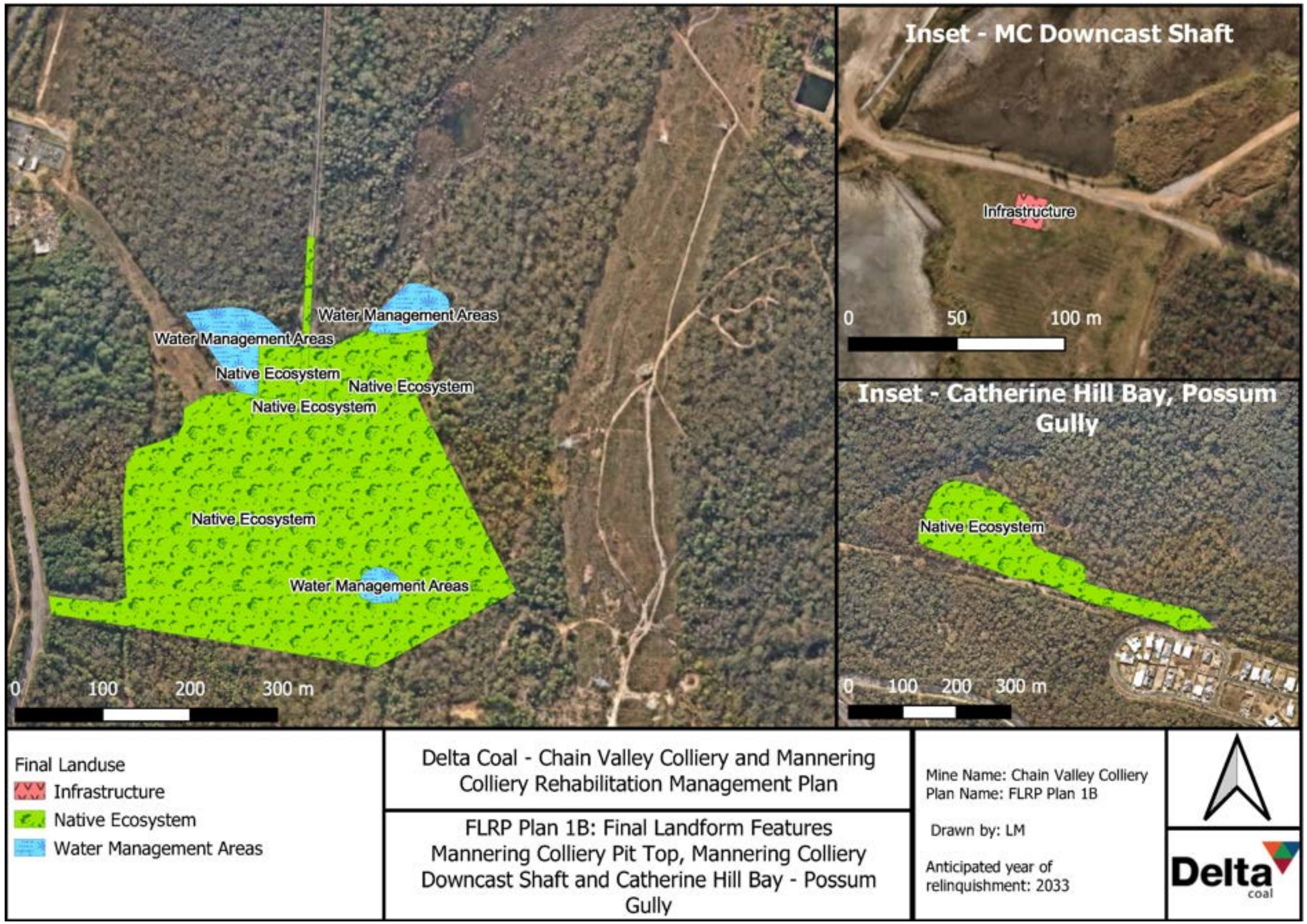
Relevant plan	Stakeholder	Date	Comments	Response/Action
CVC and MC MOP (2021)	CCC	May 2020 and July 2020	• No comments	• Nil required
CVC and MC MOP (2021)	BCD	July 2020	• No comments	• Nil required

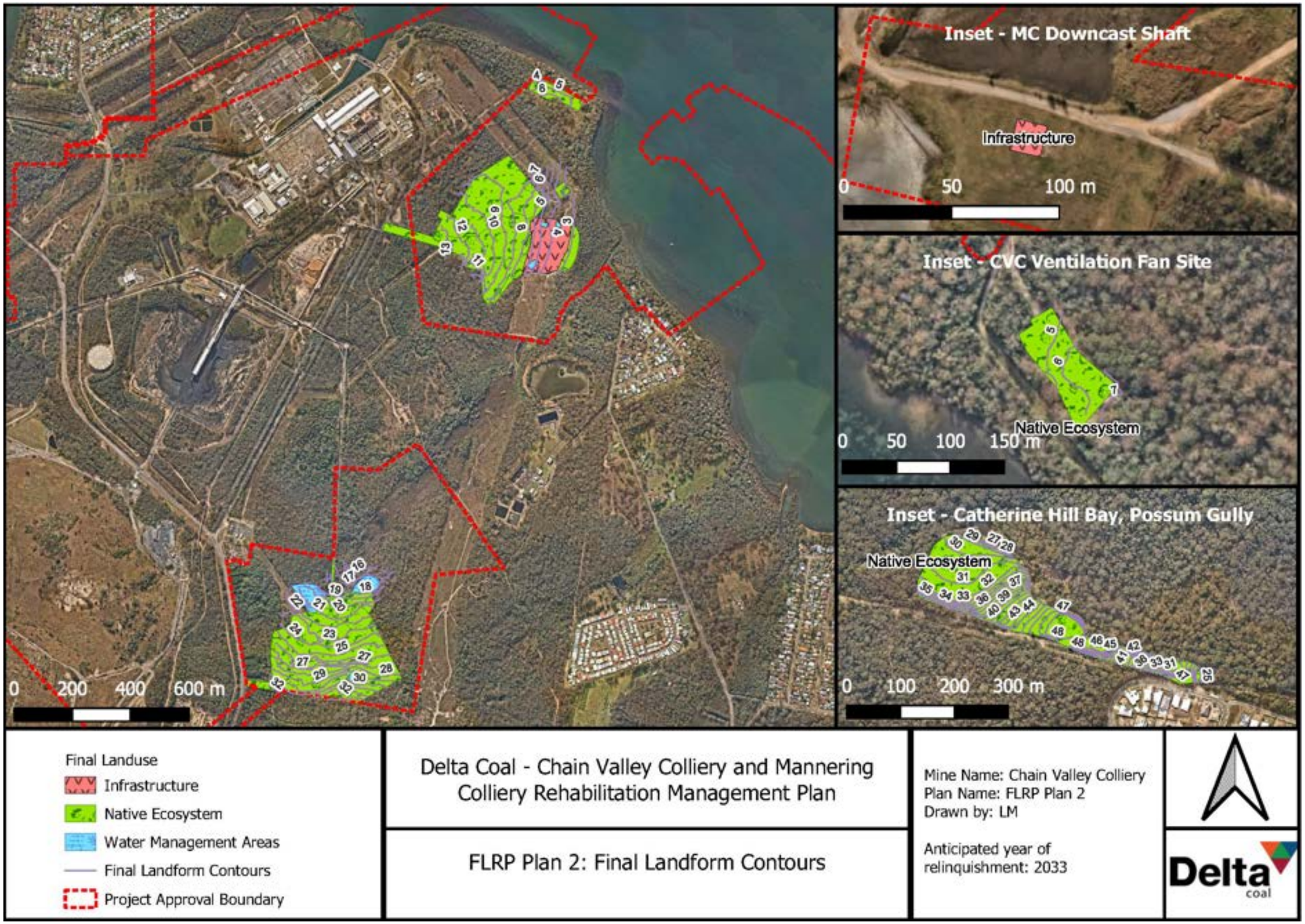
5 Final Landform and Rehabilitation Plan

The final landform and rehabilitation plan spatially defines the proposed final land use and final landform at the completion of rehabilitation and is presented as two plans:

- FLRP Plan 1A: Final Landform Features – Chain Valley Colliery Pit Top and Ventilation Fan Site
- FLRP Plan 1B: Final Landform Features – Mannering Colliery Pit Top, Downcast Shaft and Catherine Hill Bay
- FLRP Plan 2: Final Landform Contours


CVC Ventilation Fan Inset
Native Ecosystem
0 50 100 150 m
Native Ecosystem
Native Ecosystem
Water Management Areas
Infrastructure
Native Ecosystem
Native Ecosystem
Water Management Areas
Native Ecosystem
0 100 200 300 m
Final Landform Features
Final Landuse
Infrastructure
Native Ecosystem
Water Management Areas
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
FLRP Plan 1A: Final Landform Features Chain Valley Colliery Pit Top and Ventilation Fan Site
Mine Name: Chain Valley Colliery
Plan Name: FLRP Plan 1A
Drawn by: LM
Anticipated year of relinquishment: 2033


Inset - MC Downcast Shaft
Infrastructure
0
50
100 m
Inset - Catherine Hill Bay, Possum Gully
Native Ecosystem
0
100
200
300 m
Water Management Areas
Native Ecosystem
Water Management Areas
Native Ecosystem
Native Ecosystem
Native Ecosystem
Water Management Areas
0
100
200
300 m
Final Landuse
Infrastructure
Native Ecosystem
Water Management Areas
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
FLRP Plan 1B: Final Landform Features Mannering Colliery Pit Top, Mannering Colliery Downcast Shaft and Catherine Hill Bay - Possum Gully
Mine Name: Chain Valley Colliery
Plan Name: FLRP Plan 1B
Drawn by: LM
Anticipated year of relinquishment: 2033
Delta coal


Inset - MC Downcast Shaft
Infrastructure
0 50 100 m
Inset - CVC Ventilation Fan Site
Native Ecosystem
0 50 100 150 m
Inset - Catherine Hill Bay, Possum Gully
Native Ecosystem
0 100 200 300 m
0 200 400 600 m
Final Landuse
Infrastructure
Native Ecosystem
Water Management Areas
Final Landform Contours
Project Approval Boundary
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
FLRP Plan 2: Final Landform Contours
Mine Name: Chain Valley Colliery
Plan Name: FLRP Plan 2
Drawn by: LM
Anticipated year of relinquishment: 2033

6 Rehabilitation Implementation

6.1 Life of Mine Rehabilitation Schedule

Areas of surface disturbance are limited to relatively small areas due to the inherent nature of underground mining and limited coal processing on-site. As no coal beneficiation occurs on-site and, as a result, no major sources of reject or tailings are generated, the areas of direct surface disturbance within the Chain Valley and Mannering are able to be maintained at a minimum. As a consequence, the opportunities for the rehabilitation of areas of disturbance have been limited, with the surface features remaining largely unchanged since the 1960s. Regardless of this, where achievable Delta Coal is committed to the progressive rehabilitation of it's sites examples of this include the demolition and ongoing rehabilitation of the former mine cottages in 2020, with surface coal handling structures also demolished during 2020.

There are two areas operated by Delta Coal which are currently under-going phased rehabilitation, being the Chain Valley Colliery former mining cottages and Catherine Hill Bay – Possum Gulley identified in **Table 6-1** and **Table 6-2** respectively. The life of mine rehabilitation schedule is presented in **Table 6-3**.

Rehabilitation timelines have been prepared in consideration of Delta Coals application to consolidate the CVC and MC consents and extend the life of mining operations to 2029 in alignment with the planned closure date of Vales Point Power Station.

Table 6-1: Chain Valley Colliery - Former Mining Cottages Area Rehabilitation

Rehabilitation Phase	Estimated Timing of Rehabilitation Phase
Chain Valley Colliery – Former Mining Cottages	
Decommissioning	Completed – Q3 2020
Landform Establishment	Completed – Q4 2020
Growth Media Development	Completed – Q4 2020
Ecosystem and Land Use Establishment Phase	Completed – Q4 2023
Ecosystem and Land Use Sustainability Phase	Q1 2024 to Q1 2026
Relinquishment	Part of larger lease to be relinquished at cessation of mining and successful rehabilitation. Ongoing management until relinquishment

Table 6-2: Catherine Hill Bay – Possum Gulley Area Rehabilitation

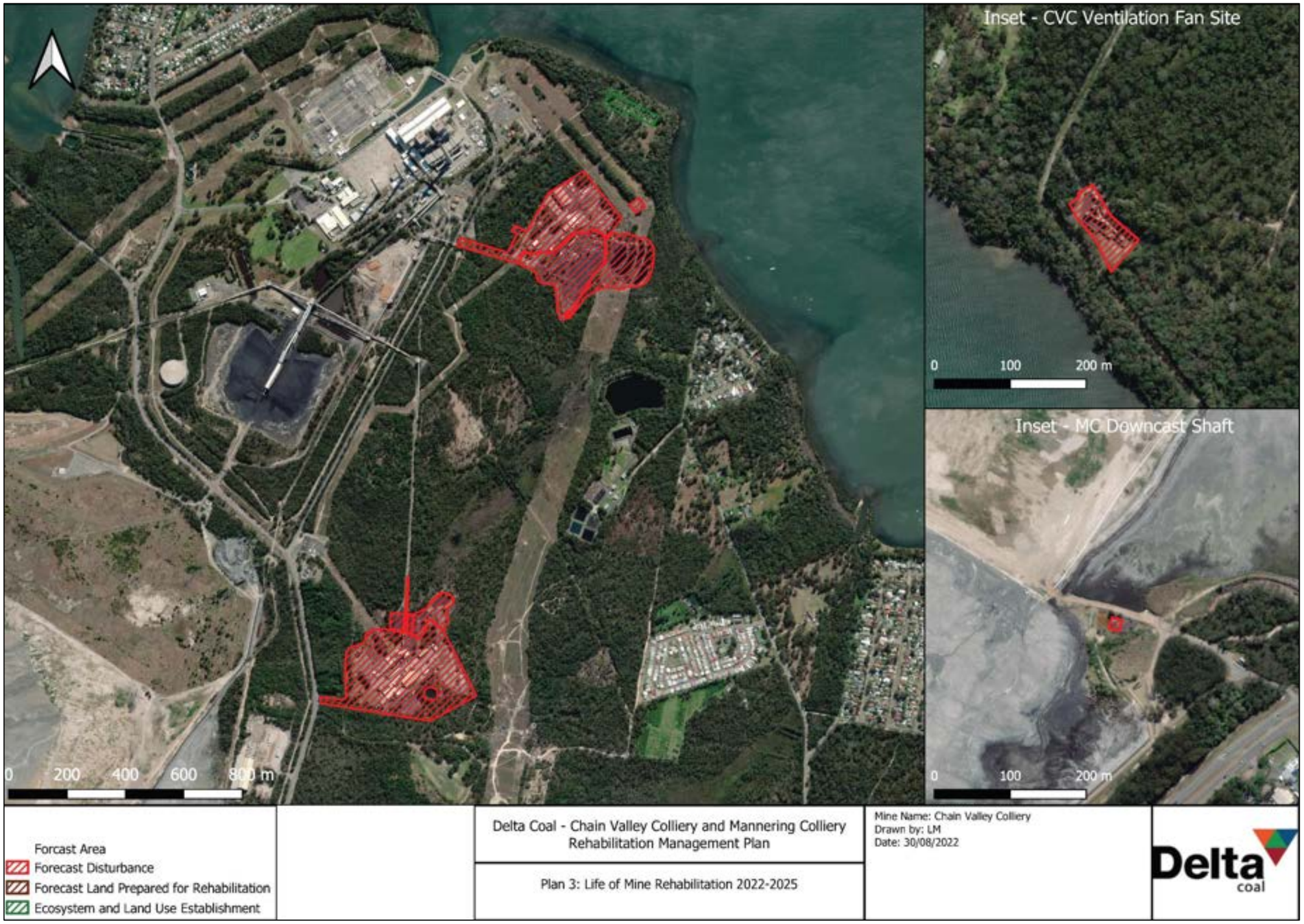
Rehabilitation Phase	Estimated Timing of Rehabilitation Phase
Catherine Hill Bay – Possum Gulley Area	
Decommissioning	Completed
Landform Establishment	Current – Q1 2024
Growth Media Development	Q2 2023 - Q3 2023
Ecosystem and Land Use Establishment Phase	Q2 2023 - Q3 2023
Ecosystem and Land Use Sustainability Phase	Q3 2023 - Q1 2024

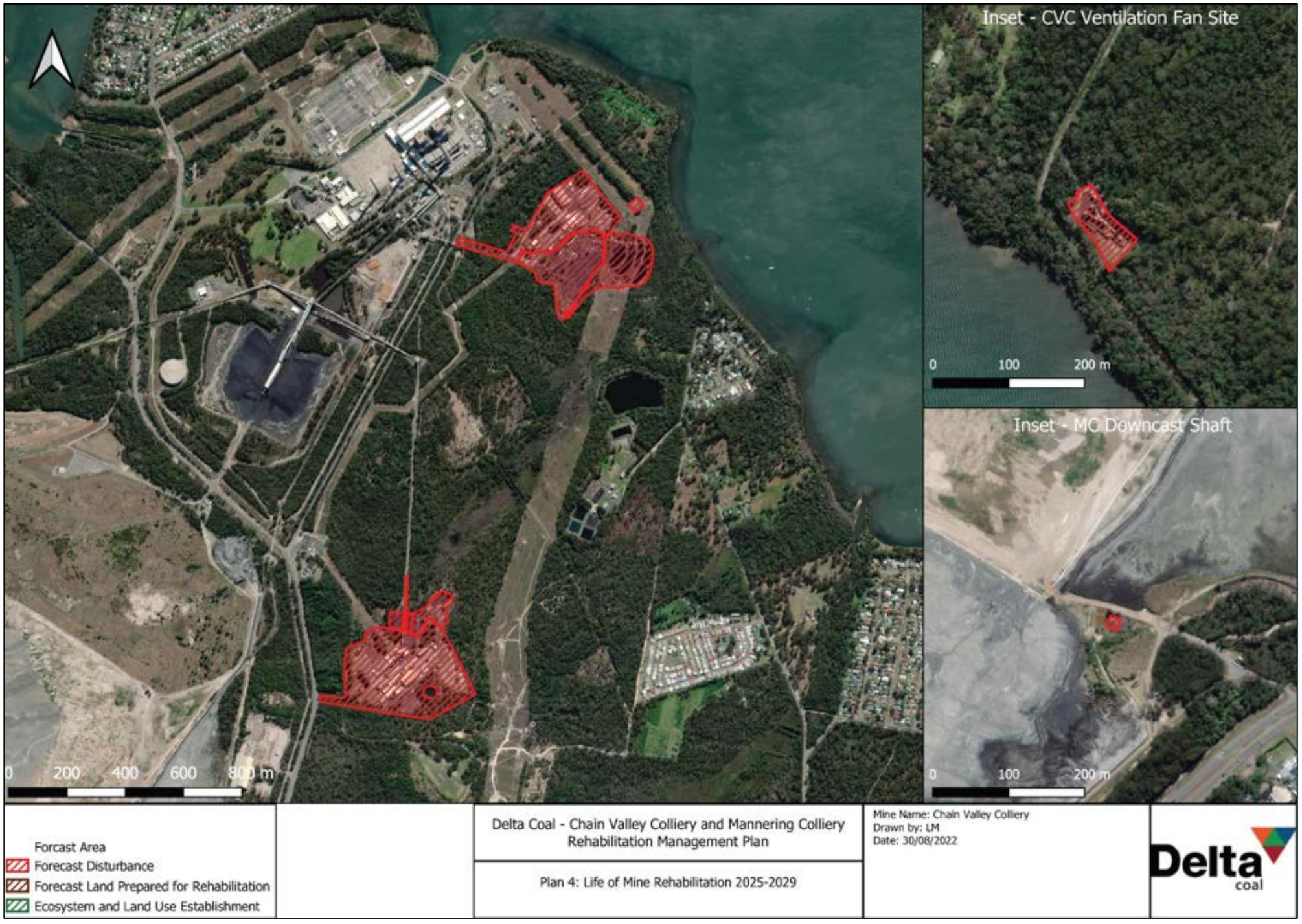
Relinquishment	Date to be confirmed with National Parks and Wildlife Services and Resources Regulator

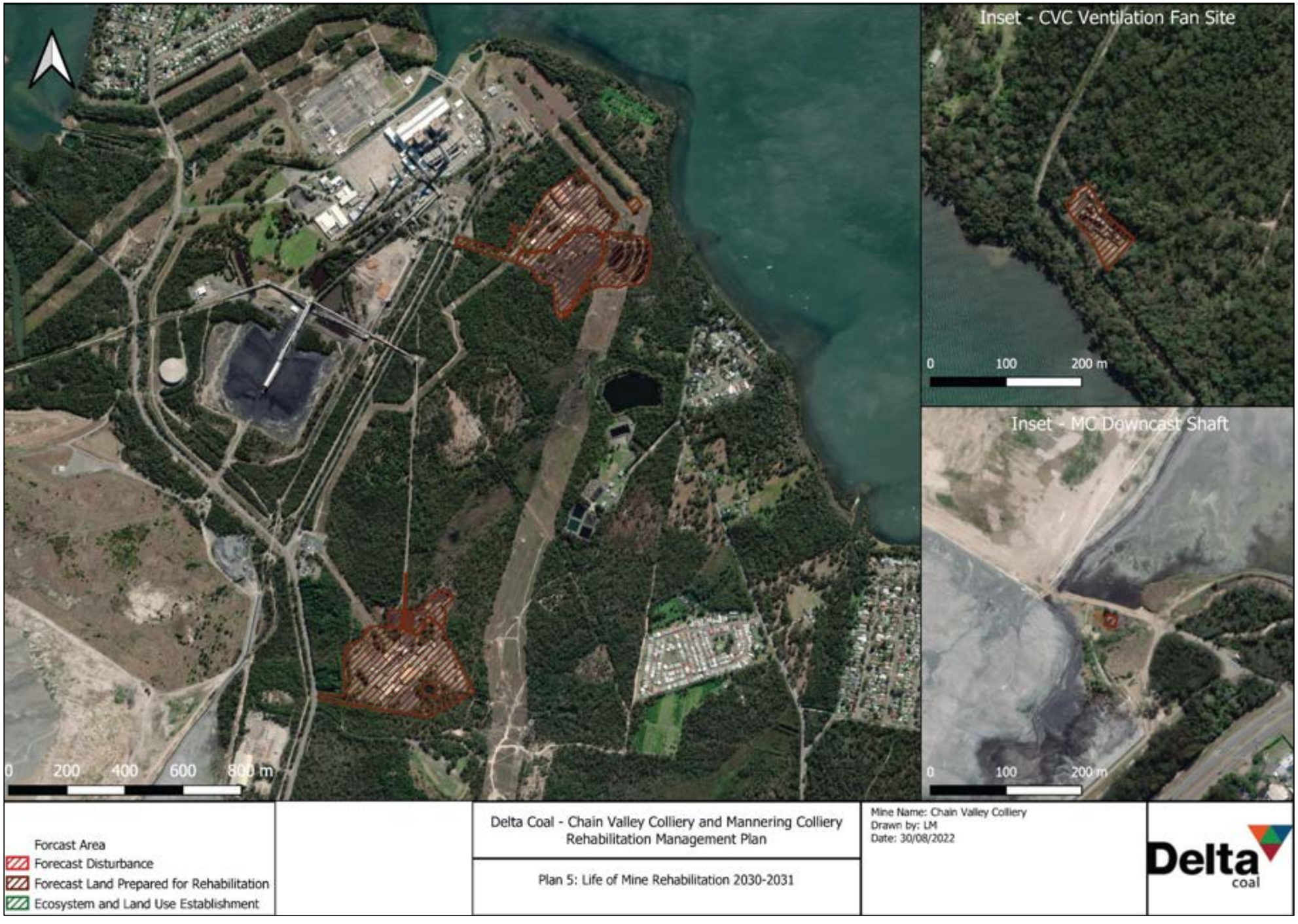
The life of mine rehabilitation schedule has been developed based on assumed approval of the Delta Coal Consent Consolidation, extending permitted operations from 31 December 2027 to 31 December 2029, in line with the current scheduled closure date of the adjacent Vales Point Power Station.

Table 6-3: Life of Mine – Rehabilitation Schedule.

Rehabilitation Phase	Estimated Timing of Phase Completion
CVC Pit top, MC Pit Top, CVC Ventilation Shaft, MC Downcast Shaft	
Decommissioning	Q4 2029 – Q4 2030
Landform Establishment	Q4 2030 – Q2 2031
Growth Media Development	Q2 2031 – Q4 2031
Ecosystem and Land Use Establishment Phase	Q4 2031 – Q1 2032
Ecosystem and Land Use Sustainability Phase	Q1 2032 – Q1 2033
Relinquishment	Q1 2033 – Q3 2033


Inset - CVC Ventilation Fan Site
0
100
200 m
Inset - MC Downcast Shaft
0
100
200 m
0
200
400
600
800 m
Forcast Area
Forecast Disturbance
Forecast Land Prepared for Rehabilitation
Ecosystem and Land Use Establishment
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
Plan 3: Life of Mine Rehabilitation 2022-2025
Mine Name: Chain Valley Colliery
Drawn by: LM
Date: 30/08/2022


Inset - CVC Ventilation Fan Site
0
100
200 m
Inset - MC Downcast Shaft
0
100
200 m
0
200
400
600
800 m
Forcast Area
Forecast Disturbance
Forecast Land Prepared for Rehabilitation
Ecosystem and Land Use Establishment
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
Plan 4: Life of Mine Rehabilitation 2025-2029
Mine Name: Chain Valley Colliery
Drawn by: LM
Date: 30/08/2022


Inset - CVC Ventilation Fan Site
0 100 200 m
Inset - MC Downcast Shaft
0 100 200 m
0 200 400 600 800 m
Forcast Area
Forecast Disturbance
Forecast Land Prepared for Rehabilitation
Ecosystem and Land Use Establishment
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
Plan 5: Life of Mine Rehabilitation 2030-2031
Mine Name: Chain Valley Colliery
Drawn by: LM
Date: 30/08/2022


Inset - CVC Ventilation Fan Site
0 100 200 m
Inset - MC Downcast Shaft
0 100 200 m
0 200 400 600 800 m
Forcast Area
Forecast Disturbance
Forecast Land Prepared for Rehabilitation
Ecosystem and Land Use Establishment
Delta Coal - Chain Valley Colliery and Mannering Colliery Rehabilitation Management Plan
Plan 6: Life of Mine Rehabilitation 2031-2033
Mine Name: Chain Valley Colliery
Drawn by: LM
Date: 30/08/2022

6.2 Phases of Rehabilitation and General Methodologies

Environmental monitoring and management will be undertaken in accordance with the sites Development Consents, Environmental Protection Licenses and approved environmental management plans throughout the phases of rehabilitation.

All rehabilitation and decommissioning works which have the potential to create noise/light disturbance to local receivers (including truck movements) will be undertaken during standard operating hours (7 am – 5 pm).

6.2.1 Active Mining Phase

6.2.1.1 Soils and Materials

The pit top area and Summerland Point ventilation shaft site are located on lands comprising the Doyalson and Wyong soil landscapes. Doyalson soils are strongly acidic with low fertility and slight to high erodibility. Wyong soils are strongly acidic, poorly drained, impermeable, and saline with very low fertility.

The NSW Acid Sulfate Soil Risk Maps for the Lake Macquarie area shows that acid sulfate soils are likely to occur at a depth of 1 to 2m along the foreshore of Lake Macquarie adjacent to the pit top area and the Summerland Point ventilation shaft. The acid sulfate soil risk warrants consideration during the development of the detailed mine closure plan.

Due to the disturbed nature of the pit top areas there is potential for poorly structured soils or soils with high clay content to be present. Either condition is likely to hamper growth of new plantings by reducing opportunities for root growth and establishment. Where poor conditions are evident or identified under a soil sampling program, unsuitable soil profiles will be supplemented with virgin excavated natural material (VENM), growth medium ameliorants or suitable top soil to be imported to site.

Due to the age of the sites and soil management practices adopted historically, only limited amounts of previously stripped and stored topsoil are available for the rehabilitation of the pit top areas. Prior to mine closure and in the development of a detailed Mine Closure Plan, a topsoil securement strategy will be developed, detailing topsoil requirements for the site and including an in-situ assessment for beneficial re-use of Virgin Excavated Natural Materials/ Excavated Natural Materials as well as classifying soils against the NSW EPA Waste Classification Guidelines for off-site disposal.

6.2.1.2 Flora

Whilst threatened flora species are known to occur within the region, none have been recorded on site. It is noted that existing vegetation communities which adjoins the Chain Valley and Mannering infrastructure areas are primarily as follows.

- Mannering pit top - Broad-Leaved Scribbly Gum Open Forest;
- Mannering downcast shaft - Managed exotic grassland;
- Chain Valley pit top - Coastal Open Woodland and managed exotic grassland (within existing high voltage power line easements); and
- Chain Valley upcast shaft - Swamp Sclerophyll Forest.

From the above both the swamp oak forest and swamp sclerophyll forest are listed as Endangered Ecological Communities under the *Biodiversity Conservation Act 2016*.

Sunset Energy, as owner of the land, have indicated that the preferred final land use option for the Mannering and Chain Valley infrastructure areas is to provide an additional buffer zone for VPPS by the demolition and removal of all infrastructure followed by the establishment of vegetation consistent with surrounding bushland.

In the development of a detailed Mine Closure Plan for the site, a seed/stock securement strategy will be developed to ensure appropriate resources are available for the regeneration of vegetation communities at the site.

Due to the prior disturbance of the pit top facilities, past conditions have been conducive to the spread of weeds. To control weed populations, weed management is undertaken in accordance with the weed control programs

outlined in the Land Management Plan for Mannering and within the Biodiversity Management Plan for Chain Valley. These works are undertaken by suitably qualified contractors who spray weeds or undertake other treatment measures in the correct window periods.

The primary focus of weed management activities is the control or elimination of those weeds listed under the Biosecurity Act, 2015. Declared noxious plants are those that have a detrimental effect, or cause serious economic loss to agriculture or harm to the environment and have the likelihood of spreading from their present location(s) to other areas. As identified in the Delta Coal Weed Management Plan, MC Land Management and CVC Biodiversity Management Plans weed control, has and will continue to focus on Lantana, Blackberry, Crofton Weed, Pampas Grass, Bitou Bush, Coolatai, Fireweed, Bamboo and Scotch Thistle.

Seagrass monitoring is undertaken, by a suitably qualified ecologist in Lake Macquarie, as per the Seagrass Management Plan to determine seagrass health, diversity and density and potential impact from mine subsidence on the seagrasses located within the project area. **B**athymetric surveys are undertaken which assists with measuring subsidence limit compliance.

6.2.1.3 Fauna

Previous environmental assessments and field surveys have identified the following in the vicinity of the surface facilities areas:

- Through database searches - 28 terrestrial or wetland fauna species listed under the *Environmental Protection and Biodiversity Conservation Act 1999* and/or the *Threatened Species Conservation Act 1995*, comprising:
- *Environmental Protection and Biodiversity Conservation Act 1999*: 14 species (three endangered species and eleven vulnerable species); and
- *Threatened Species Conservation Act 1995*: 17 species (seven endangered species, ten vulnerable species) and one endangered population, with 3 species listed under both pieces of legislation.

The likelihood of the listed species occurring in the pit top areas and surrounding areas was assessed on the basis of their distribution patterns, habitat preferences, and past records, with the following species assessed as having a moderate to high potential to occur in or around the surface facilities areas:

Amphibians:

- *Crinia tinnula,* Wallum Froglet

Birds

- *Anthochaera phrygia*, Regent Honeyeater
- *Calyptorhynchus lathami*, Glossy Black-cockatoo
- *Lathamus discolour*, Swift Parrot
- *Ninox connivens,* Barking Owl
- *Ninox strenua,* Powerful Owl
- *Pandion haliaetus,* Osprey
- *Tyto novaehollandiae,* Masked Owl
- *Tyto tenebricosa,* Sooty Owl

Mammals

- *Falsistrellus tasmaniensis,* Eastern False Pipistrelle
- *Miniopterus australis*, Little Bentwing-bat
- *Miniopterus schreibersii oceanensis*, Eastern Bentwing-bat
- *Mormopterus norfolkensis,* Eastern Freetail-bat

- *Petaurus norfolcensis,* Squirrel Glider
- *Pteropus poliocephalus,* Greyheaded Flying-fox

All of the above listed species could potentially visit or use the pit top areas due primarily to the range of vegetation communities within and contiguous with the pit top area, including the Lake Macquarie State Conservation Area, and the high mobility of most species listed. Field surveys in 1997 and 2012 have identified the Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying Fox (*Pteropus poliocephalus*) and the Osprey (*Pandion haliaetus*) within or adjacent to the surface facilities sites.

Pest species are monitored during biodiversity surveys (annual) and environmental walkover inspections of the pit-top areas, with management controls implemented as required/recommended.

Benthic communities monitoring is undertaken, by a suitably qualified ecologist in Lake Macquarie, as per the Benthic Communities Management Plan to determine benthic communities health, diversity and density and potential impact from mine subsidence on the benthic communities located within the project area. Bathymetric surveys are undertaken which assists with measuring subsidence limit compliance.

6.2.1.4 Rock/overburden Emplacement

The surface facilities and surrounds predominantly comprise in-situ materials, i.e. not emplaced overburden or rock. No capping of combustible content is forecast in the mine rehabilitation, with the preference to manage combustible content by removal and subsequent blending of material impractical to remove to below combustible limits.

To achieve the proposed final landforms the following required soil volumes have been calculated Chain Valley Colliery, Mannering Colliery and the Chain Valley Colliery Ventilation Fan Site:

Table 6-4: Cut/Fill Volumes to Achieve Final Landform

Site	Cut/Fill Volume to Achieve Final Landform
Chain Valley Colliery Pit-top	4,800 m^3 of material to be cut from current landform to achieve final landform contours. 17,146 m^3 material required to level dams (excluding D11, D13, D5) **Shortfall of 12,346 m^3** of suitable fill material required to achieve final land form.
Chain Valley Colliery Ventilation Fan Site	**Shortfall of 1,630 m^3** of suitable fill material required to achieve final landform.
Mannering Colliery Pit-top	21,000 m^3 material to be cut from current landform to achieve final landform contours. 2,750 m^3 material required to level ponds (excluding Pond B). **Excess of 18,250 m^3** of material in achieving final landform.
Mannering Colliery Downcast Shaft	Nil.

Given that an excess volume of 18,250 m^3 of material is anticipated to be generated in achieving the final landform at Mannering Colliery, this material should be segregated based on soil composition and waste classification. Consideration should be given to assessment of the excess soil material for the purposes of beneficial re-use under and an Excavated Natural Material (ENM) or Virgin Excavated Natural Material (VENM) classification, where achievable. Should excess material from Mannering Colliery landform establishment meet the requirements of VENM or ENM, this would allow some of the material to be transported between the source and a receiving site, allowing the excess material be utilised in landform establishment at Chain Valley Colliery provided that it is deemed suitable during assessment.

6.2.1.5 Waste Management

Both Chain Valley Colliery and Mannering Colliery have a total waste management contractor engaged for both operations. This is to allow for the efficient management and reporting of waste, and also greater recycling through the sorting of waste brought to the surface from underground. The recyclable material is separated out of the general waste into allocated bins for paper, steel and timber.

Purpose built oil drainage bins are placed in the Oil Storage Sheds and the wash down bay for the collection of waste oil. Waste oil is removed from site by the Waste Management Contractor as per the waste tracking guidelines.

Waste material from the Coal Handling Plant refuse bin is classified as general waste and transported to the appropriate waste facility by the waste contractor.

There is no known soil contamination at the site, should soil contamination be identified on-site during operation or in a site contamination assessment it will be assessed by suitably qualified individuals and managed under a Remedial Action Plan (RAP).

6.2.1.6 Geology and Geochemistry

Coal processing wastes are not produced as coal extracted does not require washing or additional treatment, and all ROM coal production equates to product coal. Some waste materials (timber, plastic, steel, concrete and rock) is recovered from the site magnets and screens which is transferred to a waste facility. The surface facilities areas and surrounds are predominantly in-situ, and are not on emplaced overburden/interburden and hence there are no significant issues created by geochemistry of wastes.

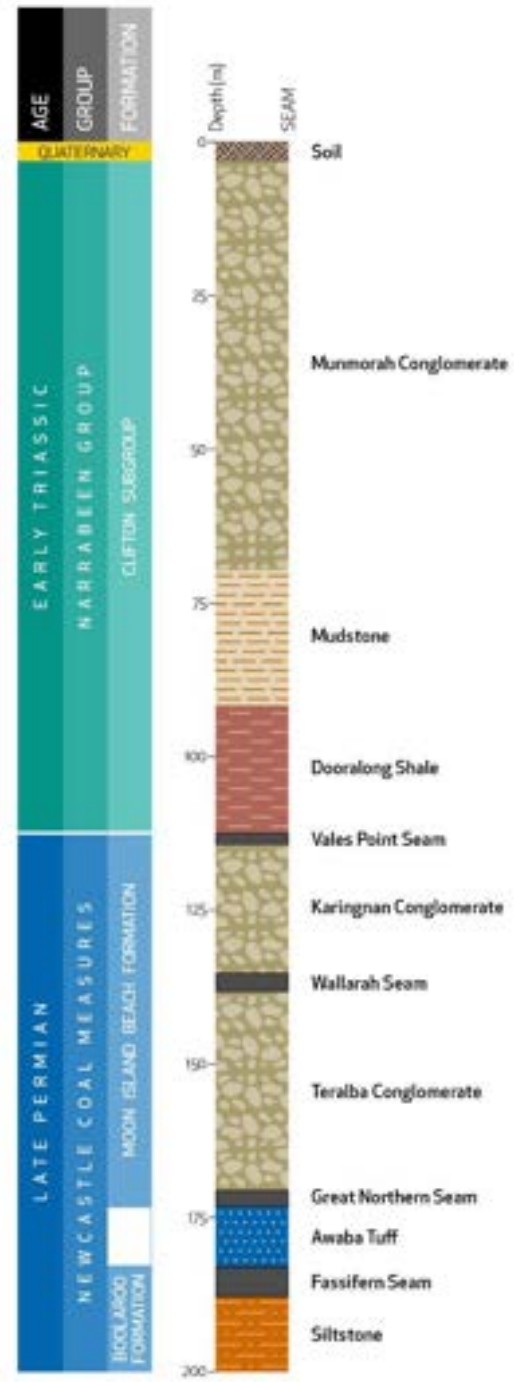
Current approved mining operations are located within the Fassifern Seam, which is part of the Boolaroo Formation within the Newcastle Coal Measures. Overlying the Fassifern Seam are the Great Northern, Wallarah and Vales Point seams (and their associated conglomerates and tuffs), which are part of the Moon Island Beach Formation within the Newcastle Coal Measures. Historically, mining has occurred within one or more of the Wallarah, Great Northern and Fassifern seams at the various mines throughout the Lake Macquarie region.

Previous workings within the Wallarah, Great Northern and Fassifern seams in conjunction with exploration boreholes and geophysical surveys in the area provide a solid base of data regarding regional and local structural features, which have been considered as part of the future mine design.

The coal resource within the Fassifern Seam has a low sulphur content, which makes it suitable for both export and domestic power generation markets. Within the approved mining area, the Fassifern Seam lies at depth of around 150 to 210 metres (based on known and inferred contour data). The Fassifern Seam is approximately 4.5 to 5.5 metres thick, with the immediate roof and floor comprising a tuffaceous claystone of varying hardness. Mining involves the extraction of a 3.5m section of coal (approximate) beneath the A and B plies. The A and B plies, which comprise approximately 1.0 to 1.2 metres of inferior coal, are left on the roof (Seedsman 2011) dependant on mining conditions. Up to approximately 0.8 m coaly shale is left in the floor. The general geology within the Chain Valley Colliery area is shown on Figure 6-1: General Stratigraphic Column within Colliery Holding Area. There are no recognised aquifers within the stratigraphic sequence, except for the coal seams themselves.

Water quality monitoring will continue in accordance with the Water Management Plan and EPL requirements, which will identify any water quality issues associated with potential leachate from unexpected geochemistry of the coal materials on-site.

Figure 6-1: General Stratigraphic Column within Colliery Holding Area



6.2.1.7 Material Prone to Spontaneous Combustion

The incidence of underground spontaneous combustion is addressed within the site-specific Spontaneous Combustion Principal Hazard management plan (PMHMP - Spontaneous Combustion). Underground controls to mitigate risk of spontaneous combustion include:

- The mine has no known recorded in-situ spontaneous combustion events in its 50+ year history at Chain Valley Colliery.
- Spontaneous combustion is considered at the mine design, mine development, mine maintenance and mine closure phases.

- Trigger Action Response Plans (TARPs) have been developed to identify and manage any deviation from normal operating conditions with respect to indicators of spontaneous combustion.
- The mine monitors gases using a multipoint tube bundle gas analysis system.
- Methods to suppress heating from spontaneous combustion include ventilation structure changes (sealing/appliance regulation) and introduction of appropriate, inertising gases (nitrogen / exhaust gases) and materials (fly ash etc.).
- Regular underground inspections are conducted by Mining Officials.

The R70 self-heating rate value recorded for a sample from the middle of the Fassifern Seam is 3.03 ^{o}C/h. This rates the coal as having medium intrinsic spontaneous combustion reactivity for New South Wales conditions.

Within the mine closure stage, the underground workings will be sealed in accordance with current standards thus mitigating the potential of spontaneous combustion underground.

It is noted that he mine design for areas under land are in a manner that results in <20mm (negligible) subsidence, reducing the risk of oxygen ingress to mine workings.

Coal stockpiling is kept to a minimum and is managed in such a way as to limit risk of combustion. Surface incidence of spontaneous combustion is considered a minimal risk given seam characteristics and limited stockpiling activities undertaken.

There are some combustible materials throughout the site (predominantly within dam embankments) which, while not prone to spontaneous combustion, still pose a combustion risk when exposed to external heat sources such as bushfires.

Following cessation of mining:

- All remaining saleable coal material will be recovered.
- An assessment of combustion risk over surface areas within all domains, specifically focusing on Coal Stockpile Areas at CVC and MC will be undertaken and recommended actions will be implemented.
- Any accumulation of combustible materials will be removed or diluted to prevent combustion risk.

6.2.1.8 Material Prone to Generate Acid Mine Drainage

The surface facilities areas and surrounds predominantly comprise in-situ materials, i.e. not emplaced overburden/interburden, with no reject emplacement areas. Additionally, mine workings are below sea-level and sealing of the shafts and portals is proposed to be constructed at sea level (0 m AHD), mitigating risk of acid mine drainage from historic workings. No geochemical issues have been identified, with water monitoring undertaken in accordance with both EPL 191 and EPL 1770 indicating no acid mine drainage at the monitoring points. Water quality monitoring will continue until relinquishment in accordance with the site Water Management Plans and EPL requirements, which will identify any water quality issues arising from coal materials or other materials on the Chain Valley and Mannering sites.

6.2.1.9 Ore Beneficiation Waste Management (reject and tailings disposal)

Under current operations, Mannering Colliery processes the ROM coal produced from the Chain Valley Colliery holding. Mannering Colliery has a Coal Handling and Preparation Plant which can crush and size the ROM coal but no washing of coal takes place. There are no tailings emplacement areas designated on site. Any minor fine coal accumulations are collected in sediment traps and drains and are returned to the product coal stockpile after dewatering.

Currently, a negligible amount of waste from the processing plant in the form of rock, timber, steel and plastic from the Mannering CHP is managed by the waste management contractor. The waste is removed from site to a licensed waste management facility for recycling or landfill.

6.2.1.10 Erosion and Sediment Control

Erosion and sediment control is managed within the overall water management system for each pit top in accordance with the respective Water Management Plans. The Water Management Plans incorporate an Erosion and Sediment Control Plan.

Water quality monitoring and reporting is undertaken in accordance with Chain Valley and Mannering EPLs and Water Management Plan requirements to ensure water discharges comply with the total suspended solids; limit as defined in the EPLs, currently 50 mg/L

The removal of large areas of sealed surfaces and buildings at mine closure could result in increased sediment load in the runoff during the early stages of the rehabilitation program. Conversely, the removal of the majority of the coal stockpiles, the associated reduction in the batter heights and the removal of historically compacted surfaces will result in increased infiltration rates during the first few months of the rehabilitation program and reduce the amount of runoff reporting to the sediment dams. Control of erosion is important during the landform construction and revegetation program, with the principal objective prior to an adequate cover of vegetation is established achieved being to prevent erosion.

There are 10 basic principles that will be followed to ensure effective soil and water management during the decommissioning phase. These are to:

- Plan for erosion and sediment control with project design and well in advance of earthworks;
- Minimise the area of soil exposure;
- Conserve available topsoil - introduce topsoil or suitable growth medium where required;
- Control water flow;
- Divert clean runoff away from disturbed areas;
- Minimise slope gradient and length;
- Minimise water runoff velocities;
- Trap sediments and pollutants;
- Revegetate disturbed areas as soon as possible; and
- Maintain and monitor erosion controls to ensure the quality of water released is acceptable.

6.2.1.11 Ongoing Management of Biological Resources for Use in Rehabilitation

Limited biological resources are currently available to the site due to the sites history and historic lack of topsoil preservation during the development of the sites (Circa 1960's). As such, it is understood that there will be a requirement for the site to import suitable top soil and soil ameliorants to achieve the desired final land form with a suitable composition for the proposed vegetation communities.

Preparation for ecosystem establishment (such as the collection of seed stock from nearby native vegetation communities) will be able to commence once a decision for mine closure has been made. Seed stock of local native vegetation species may include:

- Dominant tree species: *Eucalyptus haemastoma, Corymbia gummifera, Eucalyptus capitellata,*

Casuarina glauca and Angophora costata. Other tree species include *Eucalyptus robusta, Eucalyptus oblonga, Melaleuca sieberi, Melaleuca quinquenervia, Eucalyptus teretcornis* and *Banksia serrata*.

- Understory species (shrubs): *Acacia longifolia, Acacia suaveolens, Acacia terminalis, Hakea bakeriana, Hakea dactyloides, Gompholobium latifolium, Banksia spinulosa var. collina, Isopogon anemonifolius* and *Lambertia formosa*.
- Understory species (herbs): *Patersonia sericea, Hibbertia vestita, Dampiera stricta, Lepidosperma laterale, Stylidium graminifolium, Entolasia stricta, Themeda australis, Anisopogon avenaceus* and *Lomandra obliqua*.

6.2.1.12 Mine Subsidence

Mine workings planned under land is limited to a negligible amount (considered less than 20mm) of subsidence. The mine regularly conducts subsidence monitoring to confirm the extent of actual subsidence.

All approved secondary extraction is has occurred or is planned to occur beneath Lake Macquarie outside of the seagrass protection barrier and high water subsidence protection barrier.

There are negligible environmental impacts expected due to mine subsidence. There will be no risk to public safety due to the planned subsidence.

6.2.1.13 Management of Potential Cultural and Heritage Issues

Aboriginal heritage site survey work for the both the Chain Valley and Mannering pit top areas, as well as proposed mining areas has been undertaken during 2012, 2013 and 2020 with registered Aboriginal stakeholder groups invited to attend and participate.

The location of known Aboriginal sites (AHIMS sites) within Chain Valley Colliery Lease Holding, are shown on **Figure 1-7**. The risk of impacting on Aboriginal heritage sites is minimal as:

- The areas of the existing Mannering and Chain Valley surface facilities have been heavily disturbed in the past and, in the case of Chain Valley, fencing has been installed around the only identified site. There are no known heritage sites present in or around the Mannering pit top area;
- The site induction details the importance and significance of the Aboriginal heritage and that no clearing is permitted without a permit;
- All monitoring of Aboriginal heritage sites, including those overlying areas of underground workings, is undertaken in accordance with an approved Heritage Management Plan, which has been developed in consultation with Aboriginal groups;
- There are no proposed surface disturbance activities outside of the current approved development footprints; and
- The heritage sites within the areas where underground workings are proposed within the term of this MOP are to be first workings only and a maximum of 20mm vertical subsidence.

As identified within the Heritage Management Plans there are three Aboriginal heritage sites located within the Chain Valley surface facilities site, one of which is adjacent to the sediment dams and two within the footprint of the former mine cottages. It is not anticipated that these sites would be impacted during operation or closure activities.

Searches over the pit top facilities and within the local area, including proposed mining areas, for items of non-indigenous cultural heritage have also been undertaken. While a number of items were identified within the lease holding, none of these items are present over areas where the surface facilities exist, and accordingly would not be impacted by the future decommissioning activities. The closest listed items were the “Eatons Bulk Store Building” at 464 Ruttleys Road and the “Wyee Coal Conveyor to Vales Point”.

Due to the age and type of construction of the surface infrastructure facilities, no buildings represent significant heritage value. Consequently, the provisions of the *NSW Heritage Act 1977* do not apply.

Aboriginal heritage will continue to be managed in accordance with the approved Heritage Management Plans. The Heritage Management Plans applicable to the pit top areas detail procedures, resources, responsibilities

and reporting requirements in the event that a heritage item is encountered. These management plans would be applied during decommissioning and demolition of the site.

6.2.1.14 Exploration Activities

As described within the rehabilitation objectives for the decommissioning phase (Section 4.1.1), all portals, ventilation shafts and exploration boreholes are to be sealed, decommissioned and made safe and stable.

6.2.1.15 Compliance

Delta Coal has developed and will maintain an environmental compliance database for all obligations in regard to environmental commitments / responsibilities. The environmental compliance database is run through 'LawLex' an SAI Global product.

6.2.2 Decommissioning

6.2.2.1 Site Security

The existing site security will be maintained during the decommissioning phase of site rehabilitation.

Public safety is primarily a concern around the surface facilities at the pit top areas, ventilation shaft site and downcast shaft site.

The safety of the public around the ventilation shaft site and downcast shaft site is afforded by:

- restricting access;
- the presence of a security fence and signage around the perimeter of the compounds, with locked access gates; and
- security monitoring.

In relation to the pit top areas, there is only one (sealed) access road into each of the areas, with both accesses having a set of lockable gates present which can be closed should the need arise to stop access to the site during the decommissioning phase. These gates may be closed and locked at times of no expected traffic.

Site security also incorporates external fencing, sign posting, lighting, back to base monitoring, regular patrols and static guards as required. Public access will be monitored and managed during the decommissioning phase of the mine through the standard incident reporting process, which would include reporting of unauthorised access.

A visitor login system on-site ensures that all employees, contractors and authorised visiting members of the public are able to be accounted for when on-site.

6.2.2.2 Infrastructure to be Removed and Demolished

All mining related infrastructure, with the exception of items specifically requested by landowners to remain and approved for retention by the relevant authorities, will ultimately be removed or made safe for the post-mining land use at mine closure. The infrastructure items and hardstand surfaces within the various domains are listed within **Table 6-5**.

Prior to undertaking decommissioning works, sensitive areas such as native vegetation are to be identified and demarcated to prevent incidental damage to native vegetation communities.

During mine closure the following actions will be taken with respect to the buildings and structures associated with the mining, preparation and transport of the coal:

- Any plant, structures, buildings or conveyors would be preferentially sold and/or relocated for reuse at another mining operation;
- A survey for potential threatened fauna will be undertaken of structures prior to demolition;
- The remaining coal bins, surface conveyor plant, buildings and built structures will be demolished or removed. All demolition is to occur in accordance with AS 2601-2001: The Demolition of Structures (or its latest version);

- All underground services will be located by a certified underground services locator;
- Concrete pads and footings will be either completely removed (RR preference) or removed to a minimum 1m below surface levels and disposed of in an appropriate place or recycled, and following removal will be covered with at least 300mm of growth medium;
- Roadways not required for access to the mine site or other areas for purposes such as bushfire management will be rehabilitated;
- Asphalt hardstand will be removed;
- Mining related power lines within the domains will be removed;
- Mining related surface services will be removed; and
- All services, including buried services will be safely disconnected and have any stored energies dissipated. Buried services will either be removed or if there is limited risk associated with the pipelines/cables remaining in-situ and that these old services do not inhibit post mining land uses and removal would have unacceptable risks to community, heritage, safety and environment they will be capped and de-energised and remain buried beneath the final rehabilitation landform surface.

These proposed actions could be subject to change during the mine closure process depending on requests by the landowner for infrastructure to be left in accordance with alternative future land use options. Additionally, it is noted that while services will be disconnected to the majority of the site during decommissioning activities, services may remain connected to a portion of the site for beneficial use during the later rehabilitation phases (such as watering tube stock) and subsequently be disconnected following ecosystem establishment.

Table 6-5: Domain Infrastructure Register and Key Demolition/Removal Activities

Domain Code	Domain Area	Assets Items	Key Demolition and Removal Activities
A1	26.41 ha	**Chain Valley pit top:** • Men and materials drift • Conveyor drift • Workshop and store • Control room • Bunded storage areas and sumps • Air compressors (and containing shed). • Operations office • Bathhouse • Carpark • Aerated wastewater treatment system and septic systems • Training office • Administration office • Potable water tanks • Old haulage shed • Haulage room and switch room • Switch yard/Sub-station • Tube bundle monitoring room • Cable belt switch room • Conveyors and gantries • Diesel storage containers • Weighbridge and associated sheds • Hardstand area • Chemical storage sheds • Cable shed	General demolition/removal of structures Sealing, Backfilling and capping of drifts and shafts. Backfilling of tunnels and excavations Management of potentially contaminated soil. Management of combustible material. Disconnection from AusGrid 11kV supply Disconnection from Central Coast Council water supply Disconnection of telecommunications services

Domain Code	Domain Area	Assets Items	Key Demolition and Removal Activities
		• Oil water separator • Upcast shaft site and main ventilation fans • Ventilation fan switchroom • Fencing • Downcast shaft **Chain Valley Ventilation fan site:** • Fencing • Mine ventilation fans, upcast shaft and electrical management infrastructure **Mannering pit top:** • Main office block • Bath house, inclusive of report room and lamp cabin • Tube bundle monitoring room • Engineers offices • Cable shed • Workshop, inclusive of store and fire station • Men and materials drift • Number 1 winder room (men and materials) • Conveyor drift • Number 2 winder room (conveyor) • Coal crushing facility (including rotary breaker) • General conveyor and gantries • 1000t final product bin • Overhead stack out gantry • Reclaim tunnel and conveyor • Drainage structures • Material storage areas • Substation and switch room • Storage sheds • Diesel workshop • Stonedust storage shed • Diesel storage shed • Pollution control sumps • Sewage pump station, vents and pipeline • Oil water separator and underground storage tank • Water tanks • Unpaved hardstand • Mine ventilation fans and upcast shaft • Powerpoles and overhead lines • Concrete hardstand • Paved bitumen carpark and roads • Perimeter Security Fencing	

Domain Code	Domain Area	Assets Items	Key Demolition and Removal Activities
		• Various surface and underground services include electricity, potable water and telecommunications	
K1	0.003 ha	**Mannering downcast shaft site:** • Downcast shaft • Fencing	Sealing, Backfilling and capping of shaft. General demolition.
K3	3.17 ha	Chain Valley Water Management Area (within the high voltage transmission line easement); • Sediment dams • Drainage structures • Fencing	All dams/ponds and associated drainage structures to be backfilled, re-profiled or removed.
A8	7.06 ha	Mannering coal stockpile area; • Coal stockpile area Note: the associated coal handling infrastructure at Mannering (e.g. bin, conveyors, gantry and reclaim tunnel) is incorporated into the 1A domain. Chain Valley coal stockpile area; • Coal stockpile area • CPP facilities and switch room • 250 tonne product bin • 1000 tonne product bin • Weighbridge • Concrete sumps and subsurface drainage	Recovery and disposal of coal material from stockpile. Management of combustible material. Disconnection of services General demolition/removal of structures. Management of potentially contaminated soil.
A3	2.41 ha	Chain Valley pit top area; • Sediment dams • Drainage structures Mannering water management: • Pond 1, Pond 2, Pond 3	Removal of drainage and monitoring infrastructure All dams/ponds to be backfilled.
F3	1.3 ha	Chain Valley water management: • Dam 3 • Dam 11 • Dam 13 Mannering water management: • Pond A. • Pond B • Former Firefighting Supply Dam.	Dams to be retained for ecological functions and water supply following mine closure Modification and use of dams/ponds as appropriate for use as sediment dams during rehabilitation. Firefighting Supply Dam to be retained without modification.

6.2.2.3 Buildings, Structures and fixed plant to be Retained

All mining related infrastructure, with the exception of items specifically requested by landowners to remain and approved for retention by the relevant authorities, will ultimately be removed or made safe for the post-mining land use at mine closure.

Dams 3, 11 and 13 at CVC and Pond A and B at MC (Domain F3) are to be retained for ecological functions (water supply). The Former Firefighting Supply Dam at MC is to be retained without modification.

6.2.2.4 Management of Carbonaceous / Contaminated Material

The following will be undertaken in order to manage carbonaceous material at the cessation of mining:

- All remaining saleable coal material will be recovered.
- An assessment of combustion risk over surface areas within all domains, specifically focusing on Coal Stockpile Areas at CVC and MC will be undertaken and specific controls implemented based on the report findings.

A Preliminary Site Investigation (Contaminated Land) has been completed for the Mannering pit top area, which identified areas of potential contamination based on desktop review. While a Preliminary Site Investigation has not yet been undertaken for the Chain Valley pit top area, given the similarity of the operations, it is likely these findings would be similar.

At the cessation of mining a detailed site investigation for contaminated land will be undertaken across all domains. Contaminated land remediation would be undertaken based on the findings of the report and guided under a remedial action plan and in accordance with the Contaminated Land Management Act 1997.

6.2.2.5 Hazardous Materials Management

Hydrocarbons

- All remaining hydrocarbons and dangerous goods will be removed from site and disposed/recycled by a licensed waste contractor
- All remaining equipment will be sold for re-use or disposed of by a licensed waste contractor

Asbestos

Hazardous materials audits of the Mannering pit top were undertaken in 2012 by URS and in 2020 by EHO Consulting. Asbestos was identified as present in most of the buildings, as would be expected due to the age of the Colliery. A register of these hazardous materials was created and is available within the report completed by EHO Consulting titled “Hazardous Materials Survey and Register – Mannering Colliery” (dated March 2020).

Similar reports and findings were also prepared for the Chain Valley pit top in 2007 and later re-inspected and updated reports and registers developed in 2012 by AECOM. The most recent inspection was undertaken in 2020 by EHO Consulting. Asbestos was identified as present in most of the buildings, as would be expected due to the age of the Colliery. A register of these hazardous materials was created and is available within the report completed by EHO Consulting titled “Hazardous Materials Survey and Register – Chain Valley Colliery” (dated March 2020).

Asbestos risks associated with mine closure will need to be considered following the determination of exactly which, if any, buildings and infrastructure are to remain. Appropriate disposal of asbestos material will be required and clearance certificates obtained from licenced asbestos demolition contractors. Prior to demolition of any infrastructure any asbestos containing materials will be removed with all work will be undertaken to conform to SafeWork NSW Guidelines and approval requirements.

6.2.2.6 Underground Infrastructure

Following the cessation of mining, sealing of the mine entries would be undertaken.

The shaft and drift entries will be sealed as per the DRG guidelines, "MDG 6001: Guidelines for the Permanent Filling and Capping of Surface Entries to Coal Seams (February 2012)", and any boreholes will be sealed as per the "EDG01: Borehole Sealing Requirements on Land: Coal Exploration (April 2012)" or the latest versions.

Prior to the sealing of underground workings being undertaken, sealing plans will be prepared in consultation with, and approved by appropriate regulatory authorities.

Dewatering of the mine will cease, it is noted that since the mine entries are located above sea-level there is no 'fill and spill' potential for groundwater considered at the site. The Groundwater Management Plan for the site will be reviewed at the mine closure phase to ensure that it remains applicable and addresses risks associated to ceasing mine de-watering.

6.2.3 Landform Establishment

6.2.3.1 Water Management Infrastructure

Final contouring of the land will remove terraced areas and provide drainage consistent with the general fall of the land to the north and east. The design of run-off and sediment controls will be incorporated in the final surface planning. General contour design is shown on **Plan 2**.

To ensure effective erosion control during removal of structures, contouring and revegetation of the site, the following practices are to be adopted:

- Surface runoff is to be directed to existing sediment ponds. Excess water stored in these ponds may be used as irrigation for establishing vegetation or discharged subject to its satisfaction of EPL limits;
- Runoff from areas under development would be directed away from revegetated areas where possible;
- Drainage patterns are to be designed to direct flows through erosion and sediment control structures and so keep the sediment as close as possible to the source;
- Sediment control structures are to be maintained and kept in place until rehabilitation of the relevant catchment area is completed (see further detail below).

The primary mechanism for erosion control will be the retention of the current drainage system and sediment dams during the initial stages of the rehabilitation program. Once the primary earthworks and initial revegetation works are completed, including the removal of the hardstand areas, bitumen, concrete and the bulk of the coal stockpiles, a program of dam rationalisation will be undertaken.

Where appropriate, the former dams will be used as receptacles for excavated or crushed inert material. Once these are filled, the wall and batter materials will be used to cap the dams. These surfaces will then be stabilised using a cover crop comprising fast growing sterile species and the seed of longer-lived native species.

At this stage it is intended to fill and cap, or otherwise remove, all dams that are not within Domain F3 as shown on **Plan 1A and Plan 1B**. A suitable growth medium would be established over decommissioned dams, while at the same time establishing contours which will enable surface flows to enter the natural drainage lines adjacent to the site. It is expected that at the completion of the rehabilitation process, some of the sediment dams would be retained for ecological purposes.

During the detailed closure planning phase, further consideration will, however, need to be to the potential retention and/or construction of small dams or ponds which could either continue to provide habitat or allow fauna to relocate to these areas when the main sediment dams are rehabilitated during closure. At this stage, and as shown on **Plan 1A and 1B**, it is proposed to retain all dams within Domain F3 in the final landform.

6.2.3.2 Final Landform Construction: General Requirements

landform establishment is the process involved in achieving stable landforms including slopes, erosion controls and drainage lines, with integrated landscape features, which are compatible with the surrounding landform, whilst ensuring that the areas of native vegetation established link with surrounding vegetation communities. Prior to landform construction, vegetation communities identified to remain in the rehabilitation process will be

demarcated to prevent incidental damage.

Following decommission, final landforms will be developed that are safe, stable, permanent and compatible with subsequent land use as determined through consultation with stakeholders, including landowners and the relevant Government departments.

Landforms to be established during the mine closure and rehabilitation will be contoured to match the surrounding topography and to control and direct runoff to sediment basins and natural existing drainage lines. No significant changes to the pre-mining landform will result from the contouring of the land following the removal of all surface infrastructure.

Final contouring of the land will remove terraced areas and provide drainage consistent with the general fall of the land to the north and east. The design of run-off and sediment controls will be incorporated in the final surface planning. General contour design is shown on **Plan 2**.

Calculated cut and fill volumes, inclusive of backfilling water management infrastructure are presented in **Table 6-4.**

Delta Coal will carry out all surface disturbing activities in a manner that, as far as practicable, minimises potential for dust emissions and will carry out rehabilitation of disturbed areas progressively, that is, as soon as reasonably practicable following disturbance. Throughout the rehabilitation program the Air Quality and Greenhouse Gas Management Plan will be in place to mitigate air quality impacts including dust generation.

6.2.3.3 Final Landform Construction: Reject Emplacement Areas and Tailings Dams

As no coal beneficiation occurs on-site and, no major sources of reject or tailings are generated, with no reject emplacement areas or tailings dams within the colliery holdings.

6.2.3.4 Final Landform Construction: Final Voids, Highwalls and Low Walls

There are no voids, highwalls or low walls present.

6.2.3.5 Construction of Creek/River Diversion Works

No creek/river diversion works are considered to be required in rehabilitation of the site.

6.2.4 Growth Media Development

Delta Coal proposes to vegetate the majority of disturbed areas to either bushland or grass compatible with the future land uses. Accordingly, the establishment of the growth medium will be different for the areas proposed for revegetation to a bushland compared to those areas proposed for revegetation to a grassland.

Growth media development incorporates the processes involved to achieve a soil which is capable of supporting a sustainable plant community. It includes consideration of the chemical, physical and biological properties of the media and takes into account the necessity or desirability for specialist treatments such as the importation of appropriate virgin excavated natural material (VENM) or the application of soil ameliorants aligned to the revegetation of the disturbed areas.

Due to the age of the sites and prior soil management practices, only limited amounts of previously stripped and stored topsoil is available for the pit top areas. The development of growth medium will rely on re-spreading existing on-site material and/or the importing of suitable material. It is noted however, that there are a substantial number of recycled organics that have been successfully utilised in mine rehabilitation (Kelly 2006), including fly ash, a ready source of which is available from the nearby VPPS. Nevertheless, it is expected that the importation of topsoil or other growth medium material will be required to achieve the closure objectives.

As discussed in Section 9.1, during the term of this MOP, Delta Coal will undertake soil characterisation of the existing soil stockpiles and in-situ subsoils to determine the suitability of the material for use in final rehabilitation activities.

Weed management will be undertaken in accordance with the DC Weed Management Plan, MC Land Management and CVC Biodiversity Management Plans. It is anticipated that an initial spray control program will be undertaken prior to earth works in order to minimise the subsequent distribution of weed material. For rehabilitation areas, the early control of weeds will minimise competition and maximise early growth and

survival of desired species. This can be achieved by physical removal and mulching or by chemical control where appropriate.

As an outcome of community consultation, it is also proposed to remove the existing radiata pines (*Pinus radiata*) from the rehabilitation domains during the rehabilitation and weed control programs undertaken at mine closure.

6.2.5 Ecosystem and Land Use Establishment

The objective of the rehabilitation program for the pit top areas is to create a landform and vegetation assemblage consistent with those in the local area in order to enhance the buffer zone surrounding the VPPS and provide habitat for native fauna.

For those areas to be returned to bushland, Delta Coal aims to establish a native bushland ecosystem compatible with that of the surrounding vegetation communities, which includes targeting final vegetation communities comparable to the:

- Broad-Leaved Scribbly Gum Open Forest (for Mannering pit top);
- Coastal Open Woodland (for majority of Chain Valley pit top); and
- Swamp Sclerophyll Forest (for Chain Valley upcast shaft).

It should be noted that, for some areas, a grass cover will be established consistent with surrounding grass species (i.e. those areas of the Chain Valley site that are within existing high voltage power line easements and the Mannering downcast shaft site).

Preparation for ecosystem establishment would be able to commence once a decision for mine closure has been made, but prior to the completion of the detailed mine closure plan. This preparation would include undertaking longer lead time activities that will be nominated in the detailed mine closure plan but are already known, such as undertaking native seed collection and propagation of species specifically to be used in ecosystem establishment.

Following mine closure, vegetation will be progressively established as areas are made available following the decommissioning, landform establishment and growth medium development stages. This is to be achieved by establishing endemic tree, shrub and grass species.

6.2.6 Ecosystem and Land Use Development

This phase of development includes rehabilitation monitoring as described in Section 8, and the ongoing management of the rehabilitated areas as determined through the rehabilitation monitoring and may include one or more of the following activities, as appropriate.

- Weed and feral animal control;
- Erosion control and rectification works;
- Maintenance fertilizing;
- Re-seeding or replanting; and
- Improvements to site security.

6.3 Rehabilitation of Areas Affected by Subsidence

There is no anticipated rehabilitation of areas affected by subsidence required. See Section 6.2.2.12

7 Rehabilitation Quality Assurance Process

In consideration of Delta Coals application to extend the life of mining operations from 2027 to 2029, and due to the ongoing requirement to utilise surface facilities within the site's footprint throughout the life of mining, rehabilitation is not forecast to commence until 2029. Throughout this period, there is also no increased disturbance forecast within the sites surface footprint. A detailed rehabilitation quality assurance process will be developed and implemented when preparing a detailed Mine Closure Plan, prior to closure. The quality assurance process will be based on a plan-do-check-act process.

Validation methods of each stage of the rehabilitation works is proposed within **Table 4-1** to **Table 4-6**, in **Section 4**.

Records of mine closure activities will be kept to assist with the monitoring and assessment of rehabilitation success, including:

- Demolition activities;
- Removal and disposal (e.g. quantities, treatment, location) of demolition materials;
- Clearance certificate(s) for asbestos materials;
- Validation of contaminated material management (if required under a Remedial Action Plan);
- Landform establishment (e.g. materials, timing, drainage) and stability;
- Surface preparation (e.g. growth medium source, treatment and depth);
- Revegetation methods;
- Maintenance activities;
- Photographs; and
- Weather conditions.

8 Rehabilitation Monitoring Program

A site-specific Rehabilitation Monitoring Program and Baseline has been prepared by EMM Consulting on behalf of Delta Coal for the Chain Valley and Mannering Colliery sites. The Rehabilitation Monitoring Program is presented in **Appendix 1**.

8.1 Analogue Site Baseline Monitoring

The analogue/reference site(s) for use in the rehabilitation monitoring program (refer Section 8.1.2) was commenced in 2019. Delta Coal commenced a program establishing and monitoring analogue/reference sites, including:

- Development of analogue/reference sites for Mannering including site(s) within the following adjacent vegetation community:
    - Broad-Leaved Scribbly Gum Open Forest (for pit top).
    - Grass land (for downcast shaft).
- Development of analogue/reference sites for Chain Valley, including site(s) within the following adjacent vegetation communities:
    - Coastal Open Woodland (for pit top).
    - Swamp Sclerophyll Forest (for upcast shaft).
    - Grass land (for pit top area under high voltage power line).

Further details on the analogue sites and baselines are presented in **Appendix 1.**

8.2 Rehabilitation Establishment Monitoring

Vegetation monitoring activities will be undertaken periodically at a frequency commensurate with the progress of revegetation, i.e. more frequently following initial revegetation efforts and at a reduced frequency once vegetation is adequately established and natural regeneration is evident. For small scale rehabilitation projects prior to closure (example mine cottage area rehabilitation), visual inspections and photo monitoring will be undertaken quarterly in the first year and annual walkover inspections to determine if rehabilitation is progressing adequately.

The monitoring program for the areas undergoing revegetation to a native bushland, includes:

- a quantitative assessment of revegetation success based on landscape function analysis or other similar methodology proposed by specialist consultants;
- monitoring of analogue/reference sites outside the domain;
- assessment of weed species present and feral animal occurrence;
- taking photographs from series of fixed photo points which will enable a qualitative/visual analysis of changes in vegetation structure, condition and regeneration over the lifetime of the rehabilitation strategy; and
- general field observations including the identification of significant rehabilitation issues.

8.3 Measuring Performance Against Rehabilitation Objectives and Rehabilitation Completion Criteria

Once closure has commenced and broad scale rehabilitation for the sites has been conducted, annual rehabilitation monitoring will be undertaken to assess the overall rehabilitation success against the established rehabilitation objectives and completion criteria (refer Section 4.1) and other commitments made within this RMP.

9 Rehabilitation Research, Modelling and Trials

9.1 Current Rehabilitation Research, Modelling and Trials

The proposed final rehabilitation program will be based on extensive experience of rehabilitation in coastal areas undertaken previously by DC, in addition to that undertaken by Councils and mineral sand mining companies and research on mine rehabilitation in the Hunter Valley. Given this, and the limited amount of area disturbed, major rehabilitation trials or research programs are not expected to be necessary.

9.2 Future Rehabilitation Research, Modelling and Trials

Prior to development of a detailed mine closure plan (2-5 years from planned mine closure) Delta Coal will commence a program to investigate and maintain records relating to available soil material for use as growth media on-site, including:

- Soil characterisation of existing soil stockpiles on-site; and
- Subsoil characterisation over domain areas to determine suitability as growth medium.

10 Intervention and Adaptive Management

Should events occur that result in the Delta Coal Operatrion being placed into temporary closure or care and mainternance, a risk assessment will be triggered, with the resulting actions being included in a care and maintenance plan. The care and maintenance plan would be implemented until such a time that the Delta Coal Opperatrion resumes mining activities or a detailed mine closure plan is developed and approved.

Risks to rehabilitation and the management of those risks was addressed in the Risk Assessment undertaken as part of the preparation of this RMP (refer to Section 3). **Table 10-1** identifies the key threats to rehabilitation.

Table 10-1: Key Threats Relating to Rehabilitation

Key threat	Initial Risk Level (based on existing controls) (low, medium, high or critical)	Residual Risk Level (based on proposed controls) (low, medium, high or critical)	Where addressed in this document
Geology/geochemistry and Material prone to spontaneous combustion *Geochemistry of coal materials which may cause combustion risk (through spontaneous combustion or other ignition sources post mine closure – e.g. bushfire)*	Medium	Low	Section 6.2.1.7
Erosion and sediment control *Water quality impacts to local environment due to less than adequate erosion and sediment control during rehabilitation*	Medium	Low	Section 6.2.1.10
Soil type(s) and suitability (Growth Medium) *Insufficient growth medium material available to achieve final land use objectives.* *Soils / growth medium pH*	Medium	Low	Section 6.2.4
Flora and Fauna *Failure to establish suitable vegetation communities as per requirements*	Medium	Low	Section 6.2.1.2 Section 6.2.1.3 Section 6.2.5 Section 6.2.6
Surface water *Discharge from the site water management system resulting in contamination of water resources*	Medium	Medium	Section 6.2.3.1
Contaminated land and hydrocarbon management	Medium	Low	Section 6.2.2.4 Section 6.2.2.5

Key threat	Initial Risk Level (based on existing controls) (low, medium, high or critical)	Residual Risk Level (based on proposed controls) (low, medium, high or critical)	Where addressed in this document
Contamination remains following closure			
Bushfire *Significant impact to rehabilitation as a result of bushfire occurring prior to successful establishment of re-vegetation*	Medium	Low	Section 10

Table 10-2 presents the Rehabilitation Trigger Action Response Plan (TARP) for each of the rehabilitation threats identified in **Table 10-1.**

Table 10-2: Rehabilitation Trigger Action Response Plan (TARP)

Issue	Potential Hazard	Trigger	Action/Response	TARP Ref #
Geology/geochemistry and Material prone to spontaneous combustion	*Geochemistry of coal materials which may cause combustion risk (through spontaneous combustion or other ignition sources post mine closure – e.g. bushfire)*	Assessment of combustion risk (to be undertaken following cessation of mining) identifies materials on site which may pose a combustion risk.	Assessment of combustion risk to include recommendations for management of materials which may pose a combustion risk. Recommendations to be implemented.	1
Erosion and sediment control	*Water quality impacts to local environment due to less than adequate erosion and sediment control during rehabilitation*	Site inspection identifies that erosion and/or controls are not in accordance with completion criteria/ESCP.	Delta Coal personnel investigate to identify inadequate controls, and make recommendations to repair or upgrade site controls (specialist to be engaged as required) to ensure compliance with: • ESCP; • Completion criteria; • "Blue Book'. Recommendations to be implemented.	2
Soil type(s) and suitability (Growth Medium)	*Insufficient growth medium material available to achieve final land use objectives.* *Soils / growth medium pH*	Final soil characterisation (to occur following cessation of mining) identifies that growth medium on-site is not adequate to meet completion criteria.	Soil characterisation assessment to include management recommendations such as details of any soil amelioration requirements. Recommendations to be implemented.	3
Flora and Fauna	*Failure to establish suitable vegetation communities as per MOP*	Vegetation monitoring identifies that vegetation communities established do not meet completion criteria (e.g. not comparable to adjacent/analogue vegetation/final land use objectives).	Notify DPIE. Rehabilitation specialist to be engaged to identify reason for failed vegetation , and recommend actions to improve vegetation outcomes, which may include the following:	4

Issue	Potential Hazard	Trigger	Action/Response	TARP Ref #
			• Weed and feral animal control; • Erosion control works; • Maintenance fertilizing; • Re-seeding or replanting; • Site security. Controls to be implemented in consultation with DPIE. Where feasible controls cannot be identified, revision of the completion criteria should be considered while still ensuring these criteria achieve the domain rehabilitation objectives.	
Surface water	*Discharge from the site water management system resulting in contamination of water resources*	Surface water quality monitoring identifies water parameters outside the completion range criteria and/or EPL.	Notify relevant regulatory authorities (e.g. EPA/DPIE). Delta Coal personnel investigate to identify source of pollution, and make recommendations to repair or upgrade site water management controls (specialist to be engaged as required). Controls to be implemented and details of incident and actions taken or to be implemented provided to relevant regulatory authorities.	5
Contaminated land and hydrocarbon management	*Contamination remains following closure*	Completion of Phase 2 ESAs (to be undertaken following completion of mining) identifies contamination remaining on site.	Remedial action plan to be developed if required based on results of Phase 2 ESAs. Any contamination identified from the site investigations to be remediated in accordance with the requirements identified within the Phase 2 ESA reports and remedial action plan.	6

Issue	Potential Hazard	Trigger	Action/Response	TARP Ref #
			Validation Report (indicating completion of any required remediation work) is provided to DPE and other relevant stakeholders.	
Hazardous materials	*Explosives remain following closure and present public safety risk.* *Note: No explosives to remain at premises following closure.*	Delta Coal becomes aware that: • explosives are remaining on site. • explosives have not been licensed and/or management not in accordance with *Explosives Act 2003*.	Trained and competent personnel (WorkCover accreditation) investigate to identify potential remaining explosives. Actions taken to manage any remaining explosives in accordance with *Explosives Act 2003*.	7
Bushfire	*Significant impact to rehabilitation as a result of bushfire occurring prior to successful establishment of revegetation*	Bushfire occurs on-site and vegetation is destroyed or significantly damaged.	Rehabilitation specialist to be engaged to identify likelihood of bushfire to cause long-term damage to establishment of vegetation communities (resulting in failure to establish vegetation). If necessary, provide recommend actions to improve vegetation outcomes, which may include the following: • Maintenance fertilizing; • Re-seeding or replanting; • Site security; • Amended bushfire controls.	8

10.1 Roles and Responsibilities

Roles and responsibilities specific to completing the requirements of the RMP are identified in **Table 10-3**.

Table 10-3: Rehabilitation Roles and Responsibilities

Role	Responsibilities
Mining Engineering Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the RMP. Including rehabilitation activities and security deposits. • Allocate adequate resources to undertake activities, including monitoring in accordance with this RMP. • Provide high level oversight to ensure mining activities are undertaken consistent with those identified in the RMP.
Technical Services Manager	• Uphold and advocate the RMP within the Senior Leadership Team • Facilitate development and adaptive management of the RMP. • Develop mine plans and manage authority to mine process to ensure mining activities are consistent with the RMP. • Provide input into RMP development and future mine planning to ensure alignment and consistency.
Environmental Compliance Coordinator	• Develop and implement the RMP including consultation with the Technical Services Manager and Registered Mine Surveyor. • Establish and ensure activities are undertaken in consistency with this RMP. • Undertake reviews, revisions and audits of this document as per Section 11. • Ensure the site domains and infrastructure is maintained in a manner consistent with this RMP. • Coordinate the closure risk assessment process and development of a detailed mine closure plan. • Ensure that ongoing rehabilitation in accordance with the RMP is being implemented. • Develop a care and maintenance plan for CVC and/or MC should it be placed on care and maintenance. • Review and update the RMP for consistency with any future approvals or modifications. • Coordinate and supervise mine closure activities, monitoring and procedures in accordance with this RMP. Coordinate the environmental monitoring programs in accordance with this RMP • Consult with regulatory authorities and other stakeholders as required • Report the progress of mine closure and rehabilitation in the Annual Review in accordance with this RMP
Registered Mine Surveyor	• Develop RMP Plans for mine closure activities in accordance with this RMP. • Develop relinquishment plans for lease relinquishment when closure criteria are achieved.
All employees and contractors	• Comply with the requirements of this RMP.

11 Review, Revision and Implementation

As required under Schedule 8A of the Mining Regulation 2016, this RMP will be reviewed on an annual basis and revised as required. In accordance with Clause 11 of Schedule 8A to the Mining Regulation 2016, the RMP is required to be amended in the following circumstances:

- as a consequence of an amendment made to the rehabilitation objectives, rehabilitation completion criteria or final landform and rehabilitation plan
- to reflect any changes to the risk control measures in the rehabilitation management plan that are identified in a rehabilitation risk assessment
- whenever directed in writing to do so by the Secretary.

The RMP must remain current and relevant to ensure it defines the rehabilitation outcomes to be achieved in relation to the mining area and sets out the strategy to achieve those outcomes. This is partly informed by ensuring that the effectiveness of the rehabilitation risk assessment and controls adopted in the life of mine progressive rehabilitation schedule and rehabilitation phases are routinely evaluated throughout the life cycle of a project. Whenever any foreseeable hazard is identified that presents a risk to achieving the rehabilitation objectives, the rehabilitation completion criteria and the final landform and rehabilitation plan is required to be updated, as well as the rehabilitation risk assessment and the rehabilitation management plan.

Additionally, under Development Consent SSD-5465 and Project Approval MP06-0311 This document will be reviewed, and if necessary revised, within three months of the following;

- The submission of an Annual Review;
- The submission of a related incident report;
- The submission of an independent environmental audit; and
- Following any modification to the project approval.

Delta Coal personnel responsible for the monitoring, review and implementation of this RMP are detailed in Section 10.1.

The review and updating of the RMP will include and be informed by (as relevant) additional stakeholder consultation (Section 4.2).

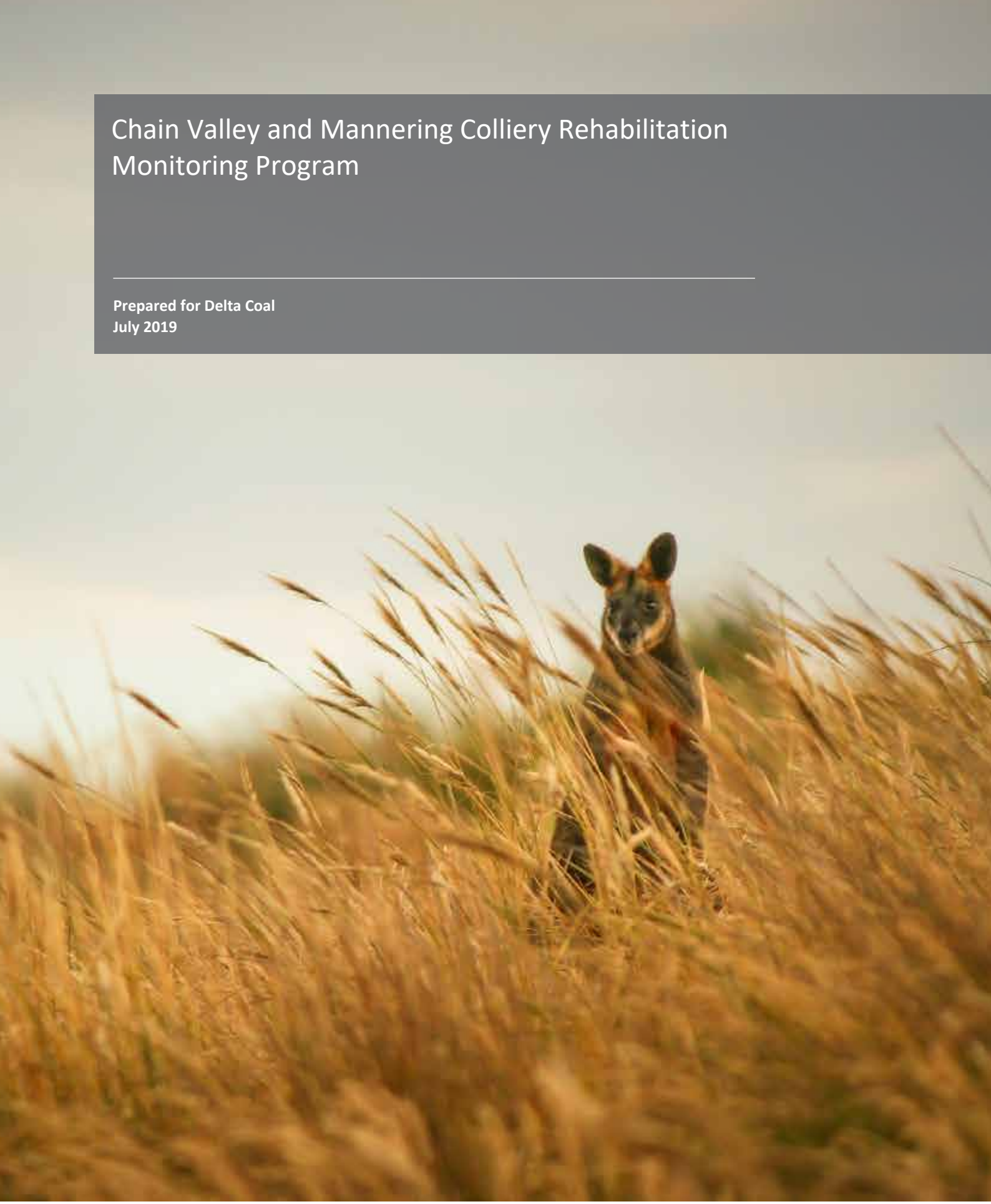
Table 11-1: Plan Revisions

Date	Version	Revision Details
31/07/2022	1	Development of RMP to comply with Schedule 8A amendments to Mining Regulation 2016.
15/01/2024	2	Revised following approval of Rehabilitation Objectives and the progress of rehabilitation phase at the Former CVC mine cottages.

Appendix 1: Rehabilitation Monitoring Program

Chain Valley and Mannering Colliery Rehabilitation Monitoring Program

Prepared for Delta Coal
July 2019



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Chain Valley and Mannering Colliery Rehabilitation Monitoring Program

Report Number

H190028 RP

Client

Delta Coal

Date

4 July 2019

Version

v3 Final

Prepared by



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Senior Ecologist
4 July 2019

Approved by



Katie Diver
National Technical Leader - Ecology
4 July 2019

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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1 Introduction

1.1 Introduction

Chain Valley Colliery (CVC) and Mannering Colliery (MC) (the mines) are underground coal mines located at the southern extent of Lake Macquarie, approximately 60 km south of Newcastle. The mines are operated by Delta Coal Pty Ltd (Delta Coal) and produce thermal coal for the domestic and export markets.

The mines operate in accordance with Chain Valley and Mannering Collieries Mining Operation Plan and rehabilitation management plan (MOP) 2018 to 2021 (ENV 00028). Operations at CVC and MC are not planned to cease during the term of this MOP. Significant changes to the surface facilities were not proposed to occur during the MOP term. Delta Coal has approached DRE with the intention to demolish the Mine Cottages in Q4 2019. In addition, there is an intention to seek modifications to the CVC and MC project approval permits. At a minimum Delta Coal plan to continue operations at MC beyond the 30 June 2022 limit to align with the current approval for CVC, that is, until the 31 December 2027. During this time all surface operation areas will be utilised therefore no restoration is likely until after 2027. Following 2027, decommissioning may occur if no further development approval is granted, which would include rehabilitation of the entire surface operation areas (27 ha).

This report outlines the vegetation monitoring program (VMP) and methods proposed to assess compliance with the rehabilitation objectives. The success of the rehabilitation will be compared against analogue sites in comparatively undisturbed areas of equivalent vegetation around the surface operation areas. The baseline data from the analogue sites provide relative benchmarks for rehabilitation and act as a control against environmental variability throughout the monitoring program.

This report also includes the baseline results from the initial survey of analogue sites (Appendix A). Soil testing required by the MOP has been commissioned separately by Delta Coal and will be documented in a separate report to this VMP.

1.2 Rehabilitation monitoring plan requirements

Chapter 8 of the MOP requires that a monitoring program is conducted to assess vegetation establishment in the revegetation areas. Specific requirements stated in Section 8.1.2 are outlined in Table 1.1.

Table 1.1 Vegetation monitoring requirements

Requirement	Section addressed
A quantitative assessment of revegetation success based on landscape function analysis or other similar methodology proposed by specialist consultants	Chapter 2 describes a modified BioBanking plot and transect method to detect rehabilitation trends, and particularly progression to benchmark values. Delta Coal has engaged a specialist soil consultant that will undertake soil monitoring of the rehabilitation sites using landscape function analysis. This will be documented in a separate report to the VMP.
Monitoring of analogue/reference sites outside the domain	Section 1.4, Chapter 2 and Appendix B
Assessment of weed species present and feral animal occurrence	Section 2.3, and 2.8
Taking photographs from series of fixed photo points which will enable a qualitative/visual analysis of changes in vegetation structure, condition and regeneration over the lifetime of the rehabilitation strategy	Section 2.2 and 2.7
General field observations including the identification of significant rehabilitation issues.	Section 2.8 and Section 2.11.2

1.2.1 Consultation

The Department of Planning and Environment (DPE) were provided with a draft rehabilitation monitoring program on 12 March 2019. Their submissions were returned on 10 April 2019 and are outlined below (Table 1.2). Responses are summarised in the table with relevant section of the report referenced.

Table 1.2 Summary of DPE submissions and corresponding responses

DPE comments	Response
There is no detail as to how many analogue sites will be established per rehabilitation domain or detail regarding the appropriateness of analogue sites being selected based on rehab domain attributes (ie slope / aspect)	The rehabilitation areas will be flat or very slightly sloping, consistent with the both the original landform and the surrounding landforms (where the analogue sites are located). Therefore, the four analogue sites are appropriate based on landform attributes, as detailed in Section 1.3.
Monitoring is proposed to be undertaken during 2019 and then when rehabilitation at CVC and MC is being performed (est. 2027). The Monitoring Plan does not identify:	
• How analogue sites will be managed during this time;	Star pickets will be used to mark the location of the analogue site, in addition to GPS locations (Section 2.2). These sites are not currently managed, and no maintenance is required.
• How variability (eg rainfall / drought etc) within the analogue sites will be recorded and monitored (ie should baseline results from 2019 be impacted by drought, whether these will be low commensurate to required criteria eg low groundcover results. This may subsequently set inappropriate benchmarks);	Coastal areas had rainfall preceding the baseline analogue surveys with many species actively growing and detectable. Anecdotal observation during repeated field surveys over the last five years, had not detected significant variation in the community composition owing to climatic conditions. Moreover, the analogue site will be surveyed simultaneously with the rehabilitation sites, therefore any climatic variation will apply to both sites. Therefore, results including apparent anomalies in rehabilitation sites, will be able to be interpreted considered in context with the analogue site.
• How continued appropriateness of analogue sites will be demonstrated (ie should analogue sites transition between vegetation communities / become dominated by weeds / disturbances etc). As such, additional justification for one monitoring event during 2019 until rehabilitation of CVC/MC (est. 2027) is required.	In order to ensure continued appropriateness of analogue sites until mine closure, analogue sites will be monitored every four years. If the analogue site is substantially altered (such as significant weed invasion, fire etc), then suitable management measures will be undertaken, or an alternative site selected. Three of the analogue sites are located in the same community therefore if one is affected by stochastic factors, data can be used from the other analogue sites.
• Section 2.8 Monitoring event conditions. “During each monitoring event, any observations which help to inform the success of the rehabilitation or provide context to quantitative results should be recorded. Such observations may include but are not limited to weed prevalence, erosion…” It’s the Regulators view that these observations are of considerable value, therefore wording such as ‘should’ and ‘may’ require reconsideration.	Section 2.8 updated in accordance with regulator comments.

1.3 Rehabilitation of surface operation areas

The purpose of rehabilitation of the surface operation areas at CVC and Mannering is to restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of local native plant species and produce a landform consistent with the surrounding environment (MOP 2018).

Rehabilitation will be designed to match the original plant community type prior to disturbance, based on landforms and the surrounding vegetation communities present. In addition, seed will be preferentially sourced from local provenance. Further to the above, some areas will be revegetated to grassland where this is consistent with the final land use and surrounds. This applies to the areas within existing high voltage power line easements, where the existing grassland vegetation communities are actively managed to ensure they have no impact to the transmission of electricity for the state. Accordingly, a grassland community is both consistent with other areas within the easement and considerate of future management requirements (as the high voltage power lines will remain and require periodic maintenance following mine closure).

The total of area of rehabilitation is approximately 27 ha with Plan 4 and Plan 4A in the MOP detailing the conceptual final landform and revegetation status at the surface operation areas for lease relinquishment. The plans currently detail areas which will either be grassland, bushland, or water management and are summarised below.

At MC, rehabilitation is stated to include:

- Broad-Leaved Scribbly Gum Open Forest (for pit top); and
- Grassland (for downcast shaft).

At CVC, rehabilitation will include:

- Coastal Open Woodland (for pit top);
- Swamp Sclerophyll Forest (for upcast shaft); and
- Grassland (for pit top area under high voltage power line).

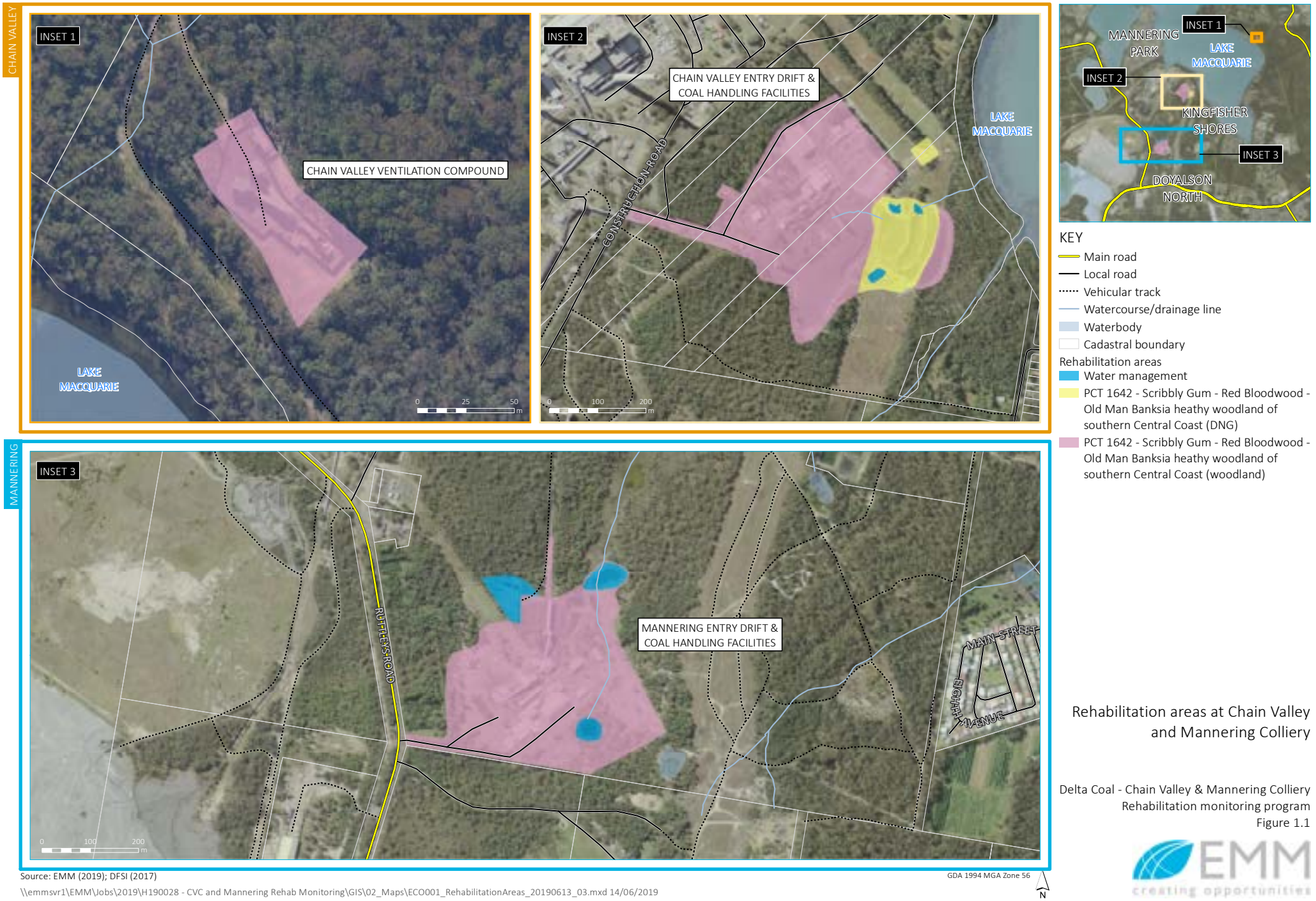
1.3.1 Updates to rehabilitation areas

The broad vegetation types detailed in the MOP does not assign vegetation to Plant Community Types (PCT), which is the current method for categorising vegetation communities within NSW. Furthermore appropriate PCT attribution is necessary for obtaining benchmark data (see Section 2.10). Each PCT also assigned a zone, which indicates a broad condition class.

Based on collection of detailed plot data and our knowledge of the site, rehabilitation areas were assigned to the PCT and zones shown in Table 1.3

Table 1.3 Assignment of PCT to the rehabilitation areas

Location	Rehabilitation area in MOP	Rehabilitation area – this monitoring program	Rationale
MC pit top	Broad-Leaved Scribbly Gum Open Forest	PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	Species composition aligns with PCT 1642 and the intent of the rehabilitation is to establish woodland.
MC Downcast shaft	Grassland	N/A	Not considered further as this area will be incorporated into the Delta Power Station ash dam and will not be rehabilitated as part of the MC process.
CVC pit top	Coastal Open Woodland	PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	Species composition aligns with PCT 1642 and the intent of the rehabilitation is to establish woodland.
CVC upcast shaft	Swamp Sclerophyll Forest	PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	Judging by the surrounding communities and landforms, PCT 1642 appear to be the most appropriate rehabilitation aim. The area is somewhat ecotonal, however Swamp Sclerophyll forest is largely distributed immediately downslope of the upcast shaft rehabilitation area.
CVC pit top area under high voltage power line	Grassland	PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_DNG	PCT 1642_DNG (derived native grassland) has been assigned given that the grassland is likely derived from the surrounding woodland.



Source: EMM (2019); DFSI (2017)

GDA 1994 MGA Zone 56

N

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Rehabilitation areas at Chain Valley and Mannering Colliery

Delta Coal - Chain Valley & Mannering Colliery
Rehabilitation monitoring program
Figure 1.1

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1.4 Establishment of analogue sites

Analogue sites are required in retained bushland areas adjacent to future rehabilitation areas. These provide local benchmarks for vegetation, inform completion criteria and act as a control against environmental variation when directly compared with rehabilitation monitoring results.

In alignment with the revegetation community types, analogue sites will be established at MC within the following adjacent vegetation zones:

- PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland.

In alignment with the revegetation community types, analogue sites will be established at CVC within the following adjacent vegetation communities:

- PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland; and
- PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_DNG

The location of analogue sites is provided in the baseline report (Appendix A).

2 Monitoring program

This section outlines the monitoring program designed to assess rehabilitation success, in particular the coverage and diversity of native vegetation, and a progression toward benchmark values of the intended community type.

An adapted BioBanking plot and transect method will be used in both the analogue sites and the rehabilitation sites. This method is repeatable and provides reliable estimates of percentage cover. Detailed data will be collected on species composition, structure and function.

2.1 Plot stratification

Plots will be stratified according to the vegetation types, with two plots conducted for each intended vegetation type within each rehabilitation area. The exception is the vent shaft area, where the rehabilitation area is of insufficient size to accommodate more than one plot, requiring two plots at MC and five at CVC. A single plot is proposed for each vegetation community per analogue site, with one plot proposed at MC and three at CVC.

Table 2.1 Plot and transects stratified per community

Community type	Rehabilitation area	Analogue site
Mannering		
PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	2	1
Chain Valley		
PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland (pit top)	2	1
PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland (pit top)	2	1
PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_DNG (vent shaft)	1	1
Total	**7**	**5**

2.2 Plot establishment

Plots will be established in each rehabilitated vegetation type, ensuring that they are representative of the overall condition and not within a transitional area into another vegetation type. Plots will not be located across tracks or other areas of disturbance.

A transect of 50 m will bisect the middle of the plot, orientated from north (start) to south). This will be marked by GPS and a permanent start picket at each end. A metric 50 m measuring tape will be laid the full length of the transect.

A total of four landscape photos will be taken at the start point. These will be taken facing north, east, south and west (in that order). A copy of the original baseline photos will be taken on all subsequent events to ensure a similar frame is captured.

At each monitoring event, a 20 m x 20 m plot will be arranged from the start of the 50 m transect. At a minimum, a 60 m measuring tape should be used to bound three of the sides.

2.3 Species composition – 20 m x 20 m plot

A comprehensive species list will be recorded for the plot.

An estimate of the cover will also be recorded for each species, using the following scale:

- Less than 1%: increments of 0.1;
- 1% to 10%: nearest whole number; and
- 10 to 100%: nearest 5%.

An estimate of the abundance of each species will be recorded using the following intervals:

- 1-10, 20, 50, 100, 500, 1000 +.

Note that the cover and abundance estimate will not be used for quantitative analysis. Rather, it will allow for broad interpretation of any changes over time – for example if particular species is driving increases in coverage.

2.4 Structure and coverage 50 m transect

A point intersect method will be used at 1 m intervals to record the ground cover vegetation. At each point, the presence of groundcover vegetation will be recorded, defined by vegetation less than 1 m in height. Species will be assigned to one of six categories, comprising native shrubs, exotic shrubs, native grasses, exotic grass, native other and exotic other. A maximum of one is recorded per category, per point, yet more than one category may be recorded at a single point. The total number of hits per category is multiplied by 2 to provide a % cover.

At 5m intervals (10 points), percentage cover of mid-story (shrubs >m) and canopy cover is estimated. The average of the 10 points provides the percentage cover for both mid-story and canopy cover.

2.5 Structural attributes 50 m x 20 m plot

Within the 50 m x 20 m area the following is recorded:

- number of hollow bearing trees;
- length of fallen timber (those greater than 10 cm diameter and to the nearest meter); and
- regeneration, the number of sapling species compared to the number of tree species.

2.6 Leaf litter plots

A total of five quadrats (1 m x 1 m) are spaced regularly along 50 m transect; at 5, 15, 25, 35 and 45 m. The first plot is deployed perpendicular to the midline, offset by 5 m to the left. Subsequent plots are then laid alternately, 5 m either side of the midline. Within each plot, the percentage of leaf litter is estimated with a photograph taken encompassing the quadrat.

2.7 Photo points

In addition to the seven photo points taken during the seven plots, a further photo point will be implemented at both CVC and MC pit top areas (nine in total). Each of these photo points will be marked with GPS and a star picket. Four landscape photos will be taken, consistent with the method for plot photopoints

Photopoints will be orientated north, east, south and west (in that order). A copy of the original baseline photos should be taken on all subsequent events to ensure a similar frame is captured.

2.8 Monitoring event conditions

During each monitoring event, any observations which help to inform the success of the rehabilitation or provide context to quantitative results will be recorded. Such observations will include but are not limited to weed prevalence, erosion, dieback of vegetation, herbivory (native or exotic), evidence of pest species, overall vigour of vegetation, and relevant environmental conditions such as drought.

Scat and track searches will also be undertaken to provide an indication of feral species such as Domestic Cat (*Felis catus domestica*) and European Fox (*Vulpes vulpes*). The location of any recording and number of observations will be recorded.

2.9 Schedule

i Analogue sites

A baseline survey of the analogue sites was completed in May 2019. The baseline report is provided in Appendix A.

It is envisaged that analogue site surveys will be repeated concurrent with each rehabilitation works monitoring event.

ii Rehabilitation area

Once rehabilitation is completed (timeframe not known) monitoring will be conducted at a frequency determined at that time.

2.10 Assessment against benchmarks

The results from analogue sites were used to verify the plant community type for the vegetation adjacent to the rehabilitation area. The results were consistent with the target plant community type, namely PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast

BioBanking benchmarks were obtained for the PCT, which is provided in Appendix B. A second set of benchmarks were established for the DNG, given that there will be an absence of trees or midstory or shrub species. Biobanking benchmarks were adjusted to be relevant Following each monitoring event plot, attributes will be scored and weighted, according to the benchmarks relevant to the PCT. This will allow a single score per plot to be generated (refer to Table 2.2).

The score for each plot provides a baseline against which rehabilitation success can be judged over time.

Table 2.2 Site attribute scores and weighting

Site attribute		Site attribute score				Weighting for site score attribute
		1	2	3	4	
A	Native plant species richness	0	0-<50% of benchmark	50-<100% of benchmark	≥ benchmark	25%
B	Native over-storey cover	0-10% or >200% of benchmark	10-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	10%
C	Native mid-storey cover	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	10%
D	Native ground-cover (grasses)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.50%
E	Native groundcover (shrubs)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.50%
F	Native groundcover (other)	0-10% or >200% of benchmark	0-<50% or >150-200% of benchmark	50-<100% or >100-150% of benchmark	Within benchmark	2.50%
G	Exotic plant cover (all strata)	>66%	>33-66%	>5-33%	0-5%	5%
H	Number of trees with hollows	0 (unless benchmark includes 0)	0-<50% of benchmark	50-<100% of benchmark	≥ benchmark	20%
I	Proportion of over-storey species occurring as regeneration	0	>0-<50%	50-<100%	100%	12.50%
J	Total length of fallen logs	0-10% of benchmark	>10-<50% of benchmark	50-<100% of benchmark	≥ benchmark	10%

2.11 Reporting and data analysis

2.11.1 Baseline report – Analogue site

A report detailing the baseline results at the analogue sites is provided in Appendix A.

2.11.2 Monitoring report

A monitoring report will be produced following monitoring of analogue and rehabilitation sites. The first report following rehabilitation will document the level of vegetation establishment. It will provide analysis of the planting success rate and survival. Average survival assessment of less than 70% will require review planting activities, including abiotic factors, to determine if poor survival is due to climatic conditions or operational matters. Further site assessment may be required if the cause cannot be identified. A review of the procedure should be made considering the findings with replanting during favourable conditions.

For the subsequent monitoring reports, both rehabilitation and analogue sites will be compared against the prior scores. It is anticipated that the score of each rehabilitation monitoring site should improve on an annual basis, with the analogue site remaining relatively consistent. If the score for any rehabilitation sites does not increase year on year, further analysis should be undertaken to determine the likely cause. This will include drilling down into specific monitoring attributes, the observations recorded and comparison of the photo points. Remediation actions with specific follow up monitoring may be required to rectify the problem.

The current MOP and rehabilitation management plan should also be updated in line with any relevant management actions and improvements. It is intended that this vegetation management plan is adaptive, and able to incorporate any on-site learnings.

Appendix A

Analogue sites - baseline report



Analogue baseline monitoring report

Chain Valley Colliery and Mannering Colliery

Prepared for Delta Coal
July 2019

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Analogue baseline monitoring report

Chain Valley Colliery and Mannering Colliery

Report Number

H190028 RP#

Client

Delta Coal

Date

3 July 2019

Version

v2 Final

Prepared by



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3 July 2019

Approved by



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3 July 2019

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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1 Introduction

Chain Valley Colliery (CVC) and Mannering Colliery (the mines) are underground coal mines located at the southern extent of Lake Macquarie, approximately 60 km south of Newcastle. The mines are operated by Delta Coal Pty Ltd (Delta Coal) and produce thermal coal for the domestic and export markets.

The mines operate in accordance with Chain Valley and Mannering Collieries Mining Operation Plan and rehabilitation management plan (MOP) 2018 to 2021 (ENV 00028). A vegetation monitoring program (VMP) has recently been prepared (EMM 2019), which includes the requirement to conduct baseline monitoring of analogue site. This report details the locations and results for the initial baseline survey of the analogue site.

2 Method

The baseline monitoring was undertaken in accordance with the Section 2 of the Rehabilitation monitoring program (EMM 2019). The monitoring was conducted on 9 May 2019, by two senior EMM ecologists.

Plot 1 could not be permanently marked with starpickets, owing to its location in a maintained transmission easement. The location of Plot 1 was recorded using hand-held GPS, whilst the remaining three plots were marked with GPS and starpickets. Refer to Figure 3.1 for the plot locations.

A total of four plots were surveyed. Plot locations were selected based on their proximity to the proposed rehabilitation areas, whilst avoiding edge effects from cleared areas (in the case of woodland sites). Plot were also selected based on their similarity of landform and on the assumption that the rehabilitation area would aim to have similar characteristics and community composition.

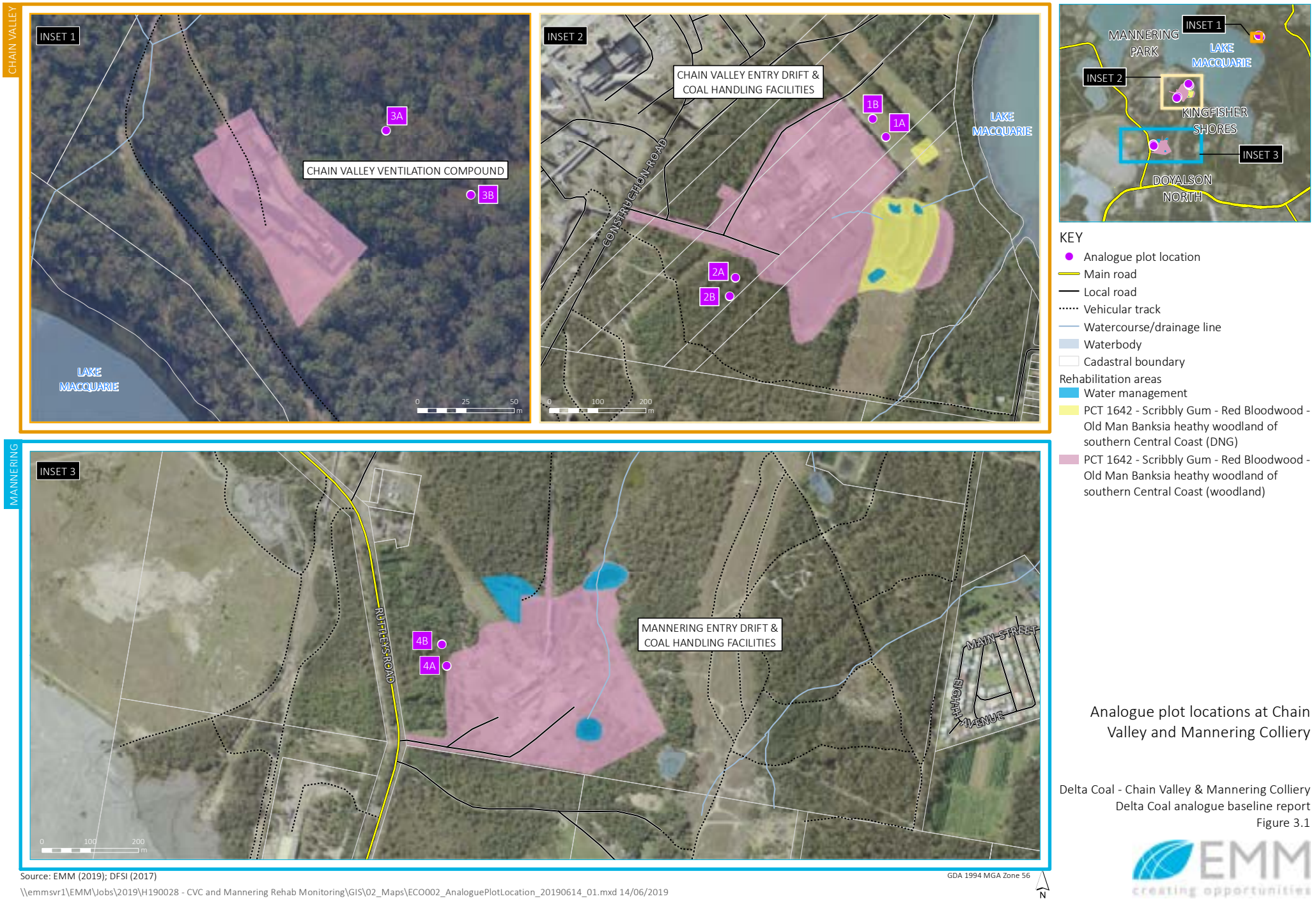
3 Results

Analysis of Plant Community Types (PCTs) present within the Mannering, Chain Valley Colliery and Summerland Point site concluded that PCT 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast, was the most appropriate PCT to assign to all of the plot locations and rehabilitation areas. Previously it has been stated that the Summerland Point vent shaft will become Swamp Sclerophyll Forest when rehabilitated. The majority of the vent shaft area is upslope of the swamp sclerophyll forest, despite being in a somewhat ecotonal situation, it was concluded that drier PCT 1642 is more appropriate than selecting swamp sclerophyll PCT.

A summary of the plot characteristics are provided below (Table 3.1) with location provided in Figure 3.1. The full baseline results and plot photographs are provided in Appendix A and B respectively.

Table 3.1 Plot location and plant community zone

Plot number	Start location (0 m)	End location (50 m)	PCT	Zone
1	0364907 m E, 6329798 m S	0364879 m E, 6329836 m S	1642	Derived native grassland (DNG)
2	0364596 m E, 6329507 m S	036484 m E, 6329489 m S	1642	Woodland
3	0366697 m E, 6331081 m S	0366741 m E, 6331050 m S	1642	Woodland
4	363986 m E, 6328229 m S	363976 m E, 6328273 m S	1642	Woodland



Source: EMM (2019); DFSI (2017)

GDA 1994 MGA Zone 56

\\emmsvr1\EMM\Jobs\2019\H190028 - CVC and Mannering Rehab Monitoring\GIS\02_Maps\ECO002_AnaloguePlotLocation_20190614_01.mxd 14/06/2019

Analogue plot locations at Chain Valley and Mannering Colliery

Delta Coal - Chain Valley & Mannering Colliery
Delta Coal analogue baseline report
Figure 3.1

EMM creating opportunities

4 Summary and recommendations

A total of four plots have been established to provide analogue sites for the future rehabilitation of Chain Valley Colliery, Manning Colliery and associated infrastructure. Given that there is potential for a long lag between this baseline survey and the rehabilitation of the collieries, it is recommended that the analogue sites are resurveyed in conjunction with the first monitoring event of the rehabilitation area.

Appendix A

Plot data sheets

CVC Biodiversity rehabilitation monitoring - Transect

Site ID	**Date:**	**Data collectors:**
Plot 1	9/05/2019	ED & EL

20 x 20 m plot - Survey species and provide cover abundance scores

Species	Cover	Abun	**Species**	Cover	Abunda
*Andropogon virginicus**	40	1000			
Capillipedium parviflorum	10	500			
Casuarina glauca	0.1	4			
*Chloris gayana**	0.5	20			
Conyza bonariensis	0.1	1			
*Cortaderia selloana**	0.1	8			
Cymbopogon refractus	2	50			
Cynodon dactylon	40	1000			
Glycine tabacina	0.1	1			
*Hydrocotyle bonariensis**	0.1	5			
Imperata cylindrica	5	500			
*Lilium formosanum**	0.5	20			
*Medicago lupulina**	0.1	1			
*Paspalum urvillei**	2	100			
*Plantago lanceolata**	0.1	8			
*Richardia brasiliensis**	0.1	10			
*Setaria parviflora**	2	100			
Sporobolus creber	0.1	20			
*Verbena rigida**	2	50			

Cover: <1% entered as estimate (eg 0.4). 1-5% entered as number. >5% entered as nearest 5%
Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000+

*Denotes exotic species.

CVC Biodiversity rehabilitation monitoring - Transect

Site ID: Plot 1	**Date:** 9/5/19
PCT: 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_dng	**Data collectors:** ED & EL
Waypoint number	1a (start) & 1b (end)
Transect start: Easting/Northing	0364907 m E, 6329798 m S
Transect end: Easting/Northing	0364879 m E, 6329836 m S
Transect start photo	B.1
Transect end photo	B.2

Five quadrats **(1m x 1m)** spaced regularly along 50m transect, offset by 5m and alternate perpendicular to midline.

Quadrat number	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Mean**
Leaf litter cover (%)	10	5	20	5	25	13
Photo number	B.3	B.4	B.5	B.6	B.7	

50 m x 20 m plot	
HBT's (count) (only hollows > 5 cm):	0
Fallen Logs length (>10 cm, 0.5 m):	0
Regen (no. spp and no. regenerating)	1 1

50 m Transect (every 5 m)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**Avg (%)**
Canopy Cover (% - see Specht)	0	0	0	0	0	0	0	0	0	0	0
Mid Storey Cover (shrubs > 1m)	0	0	0	0	0	0	0	0	0	0	0

50 m Transect Groundcover (every 1 m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**%**
Native shrubs (< 1m)																																		x																	2
Native grasses				x	x	x	x			x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x				x						x	x	66
Native other (forbs, fern etc)																																																			0
Exotics	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	86

Notes: (eg weed prevelance, erosion, dieback, herbivory, evideince of pest species, overall vigour of vegetation, relevant envionmental conditions)	The plot is located in a maintained transmission easement, which is periodically slashed/mown. Tree and shrub species are limited to occasional seedlings. Ground cover is mixture of native and exotic grasses and forbs. The majority of grasses were seeding and tall in height. The maintainaence regime will need to be taken into consideration during subsequent monitoring and analysis of results.

CVC Biodiversity rehabilitation monitoring - Transect

Site ID	**Date:**	**Data collectors:**
Plot 2	9/05/2019	ED & EL

20 x 20 m plot - Survey species and provide cover abundance scores

Species	Cover	Abun	**Species**	Cover	Abunda
Acacia stricta	4	10	*Imperata cylindrica*	10	100
Actinotus minor	0.1	20	*Isopogon anemonifolius*	0.1	2
*Andropogon virginicus**	2	100	*Isopogon anethifolius*	0.1	1
Angophora costata	5	2	*Lambertia formosa*	3	20
Banksia serrata	10	5	*Lepidosperma laterale*	5	20
Banksia spinulosa	3	4	*Lindsaea linearis*	0.1	5
Billardiera scandens	0.1	20	*Macrozamia communis*	0.1	1
Cassytha pubescens	0.1	2	*Micrantheum ericoides*	0.1	20
Clematis aristata	0.1	5	*Parsonsia straminea*	0.1	1
Corymbia gummifera	15	4	*Polyscias sambucifolia*	0.1	8
Cryptostylis erecta	0.1	20	*Pratia purpurascens*	0.1	20
Darwinia spp.	0.1	10	*Pteridium esculentum*	20	50
Daucus glochidiatus	0.1	50	*Richardia brasiliensis**	0.1	4
Desmodium varians	0.1	10	*Themeda australis*	15	500
Dodonaea triquetra	5	20	*Xanthorrhoea latifolia*	2	20
*Ehrharta erecta**	0.1	5			
Entolasia stricta	10	500			
Epacris pulchella	1	50			
Eragrostis brownii	1	20			
Eucalyptus capitellata	5	2		`	
Eucalyptus haemastoma	20	8			
Gahnia clarkei	1	3			
Geranium solanderi	0.1	20			
Glochidion ferdinandi	5	4			
Glycine clandestina	0.1	5			
Glycine tabacina	0.1	10			
Gompholobium pinnatum	0.1	8			
Hardenbergia violacea	0.1	10			
*Hypochaeris radicata**	0.1	1			

Cover: <1% entered as estimate (eg 0.4). 1-5% entered as number. >5% entered as nearest 5%

Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000+

*Denotes exotic species.

CVC Biodiversity rehabilitation monitoring - Transect	
Site ID: Plot 2	**Date:** 9/5/19
PCT: 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	**Data collectors:** ED/EL
Waypoint number	2a (start) & 2b (end)
Transect start: Easting/Northing	0364596 m E, 6329507 m S
Transect end: Easting/Northing	036484 m E, 6329489 m S
Transect start photo	B.8
Transect end photo	B.9

Five quadrats (1m x 1m) spaced regularly along 50m transect, offset by 5m and alternate perpendicular to midline.

Quadrat number	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Mean**
Leaf litter cover (%)	100	100	95	70	80	89
Photo number	B.10	B.11	B.12	B.13	B.13	B.14

50 m x 20 m plot		
HBT's (count) (only hollows > 5 cm):		0
Fallen Logs length (>10 cm, 0.5 m):		14
Regen (no. spp and no. regenerating)	4	4

50 m Transect (every 5 m)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**Avg (%)**
Canopy Cover (% - see Specht)	10	20	40	35	35	25	30	30	20	15	26
Mid Storey Cover (shrubs > 1m)	2	3	0	3	3	0	0	15	0	2	2.8

50 m Transect Groundcover (every 1 m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**%**
Native shrubs (< 1m)				x				x										x							x		x									x														x	18
Native grasses	x	x	x		x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x		x			x		x		x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	80
Native other (forbs, fern etc)	x	x	x	x	x				x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	88
Exotics																																																				0

Notes: (eg weed prevelance, erosion, dieback, herbivory, evideince of pest species, overall vigour of vegetation, relevant envionmental conditions)	Largely intact woodland, with little influence of exotic species. Overall condition was good with no recent disturbance observed. No signs of pest species.

CVC Biodiversity rehabilitation monitoring - Transect

Site ID	**Date:**	**Data collectors:**
Plot 3	9/05/2019	ED & EL

20 x 20 m plot - Survey species and provide cover abundance scores

Species	Cover	Abun	**Species**	Cover	Abunda
Acacia longifolia	10	50			
Allocasuarina littoralis	0.1	3			
Angophora costata	2	1			
Baumea acuta	0.1	20			
Billardiera scandens	0.1	10			
Corymbia gummifera	4	2			
Desmodium varians	0.1	5			
Dodonaea triquetra	30	100			
*Ehrharta erecta**	0.1	20			
Entolasia stricta	2	100			
Eucalyptus haemastoma	15	8			
Eucalyptus microcorys	20	12			
Eucalyptus pilularis	15	2			
Glycine clandestina	0.1	5			
Gompholobium pinnatum	0.1	3			
Imperata cylindrica	4	50			
Lepidosperma laterale	3	100			
Leptospermum spp.	1	20			
Lomandra filiformis	0.5	20			
Melaleuca quinquenervia	4	1			
Pimelea linifolia	0.1	10			
Pratia purpurascens	0.1	10			
Pteridium esculentum	0.5	10			
Pultenaea spp.	0.5	50			
Themeda australis	4	50			

Cover: <1% entered as estimate (eg 0.4). 1-5% entered as number. >5% entered as nearest 5%
Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000+

*Denotes exotic species.

CVC Biodiversity rehabilitation monitoring - Transect	
Site ID: Plot 3	**Date:** 9/5/19
PCT: 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	**Data collectors:** ED & EL
Waypoint number	3a (start) & 3b (end)
Transect start: Easting/Northing	0366697 m E, 6331081 m S
Transect end: Easting/Northing	0366741 m E, 6331050 m S
Transect start photo	B.15
Transect end photo	B.16

Five quadrats (1m x 1m) spaced regularly along 50m transect, offset by 5m and alternate perpendicular to midline.

Quadrat number	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Mean**
Leaf litter cover (%)	100	60	95	90	75	84
Photo number	B.17	B.18	B.19	B.20	B.21	

50 m x 20 m plot		
HBT's (count) (only hollows > 5 cm):		3
Fallen Logs length (>10 cm, 0.5 m):		63
Regen (no. spp and no. regenerating)	6	6

50 m Transect (every 5 m)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**Avg (%)**
Canopy Cover (% - see Specht)	30	30	40	50	50	50	50	35	35		37
Mid Storey Cover (shrubs > 1m)	3	0	3	4	2	4	0	2	2		2

50 m Transect Groundcover (every 1 m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**%**
Native shrubs (< 1m)	x	x	x	x	x	x	x	x				x		x	x	x	x	x	x	x	x									x				x		x	x	x	x												60
Native grasses	x	x	x							x								x		x	x											x		x	x		x				x				x	x	x	x			32
Native other (forbs, fern etc)									x	x	x	x		x	x		x		x		x	x	x	x		x	x			x	x	x	x	x	x	x			x	x	x	x	x			x				58
Exotics																																																				0

Notes: (eg weed prevelance, erosion, dieback, herbivory, evideince of pest species, overall vigour of vegetation, relevant envionmental conditions)	Largely intact forest with very low presence of exotic species and no signs of pest species. Conditon of vegetation good. Strong regeneration of tree species of a similar age class and dense shrubs (especially Dodonaea triquetra), indicates a single disturbace event such as a fire or clearance several years ago. The PCT was attributed based on best fit, though several canopy species are not indicative of the PCT.

CVC Biodiversity rehabilitation monitoring - Transect

Site ID	**Date:**	**Data collectors:**
Plot 4	9/05/2019	ED & EL

20 x 20 m plot - Survey species and provide cover abundance scores

Species	Cover	Abun	**Species**	Cover	Abunda
Allocasuarina littoralis	15	20	*Themeda australis*	5	100
*Andropogon virginicus**	4	100	*Trachymene incisa*	0.1	5
Angophora costata	15	2	*Wahlenbergia stricta*	0.1	1
Aristida spp.	0.5	10			
Banksia integrifolia	3	1			
Baumea acuta	10	100			
Cassytha pubescens	0.1	10			
Corymbia gummifera	15	2			
Cryptostylis erecta	1	50			
Dianella caerulea	0.1	2			
Epacris pulchella	0.1	10			
Eragrostis brownii	2	50			
Eragrostis leptostachya	4	10			
Eucalyptus haemastoma	15	3			
Gahnia clarkei	1	2			
Glochidion ferdinandi	2	3			
Imperata cylindrica	0.5	20			
Isopogon anethifolius	1	10			
Lambertia formosa	0.1	2			
Lepidosperma laterale	8	500			
Leptospermum polygalifolium	3	3			
Lomandra filiformis	3	50			
Lomandra obliqua	0.5	10			
Parsonsia straminea	1	3			
Pimelea linifolia	0.1	1			
*Pinus radiata**	20	500			
Pratia purpurascens	0.1	20			
Scaevola ramosissima	0.1	1			
*Sonchus spp.**	0.1	1			

Cover: <1% entered as estimate (eg 0.4). 1-5% entered as number. >5% entered as nearest 5%
Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000+

*Denotes exotic species.

CVC Biodiversity rehabilitation monitoring - Transect	
Site ID: Plot 4	**Date:** 9/5/19
PCT: 1642 - Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland	**Data collectors:** ED & EL
Waypoint number	4a (start) & 4b (end)
Transect start: Easting/Northing	363986 m E, 6328229 m S
Transect end: Easting/Northing	363976 m E, 6328273 m S
Transect start photo	B.22
Transect end photo	B.23

Five quadrats (1m x 1m) spaced regularly along 50m transect, offset by 5m and alternate perpendicular to midline.

Quadrat number	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Mean**
Leaf litter cover (%)	99	100	95	95	95	96.8
Photo number	B.24	B.25	B.26	B.27	B.28	

50 m x 20 m plot		
HBT's (count) (only hollows > 5 cm):		0
Fallen Logs length (>10 cm, 0.5 m):		5
Regen (no. spp and no. regenerating)	4	1

50 m Transect (every 5 m)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**Avg (%)**
Canopy Cover (% - see Specht)	40	30	35	5	10	10	30	20	5	40	22.5
Mid Storey Cover (shrubs > 1m)	2	0	2	0	3	5	0	0	0	0	1.2

50 m Transect Groundcover (every 1 m)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**%**
Native shrubs (< 1m)							x																		x																											4
Native grasses		x		x	x	x	x	x	x	x		x		x		x	x	x		x								x	x	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x	x	x	66
Native other (forbs, fern etc)	x	x	x			x			x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x				x			x		x		72
Exotics	x							x																																				x							6

Notes: (eg weed prevelance, erosion, dieback, herbivory, evideince of pest species, overall vigour of vegetation, relevant envionmental conditions)	Some evidence of rubbish dumping. High abbundace of Radiata Pine (Pinus radiata) trees and seedlings, otherwise mostly native species present.

Appendix B

Plot photographs

B.1 Plot 1



Photograph B.1 Plot 1 start



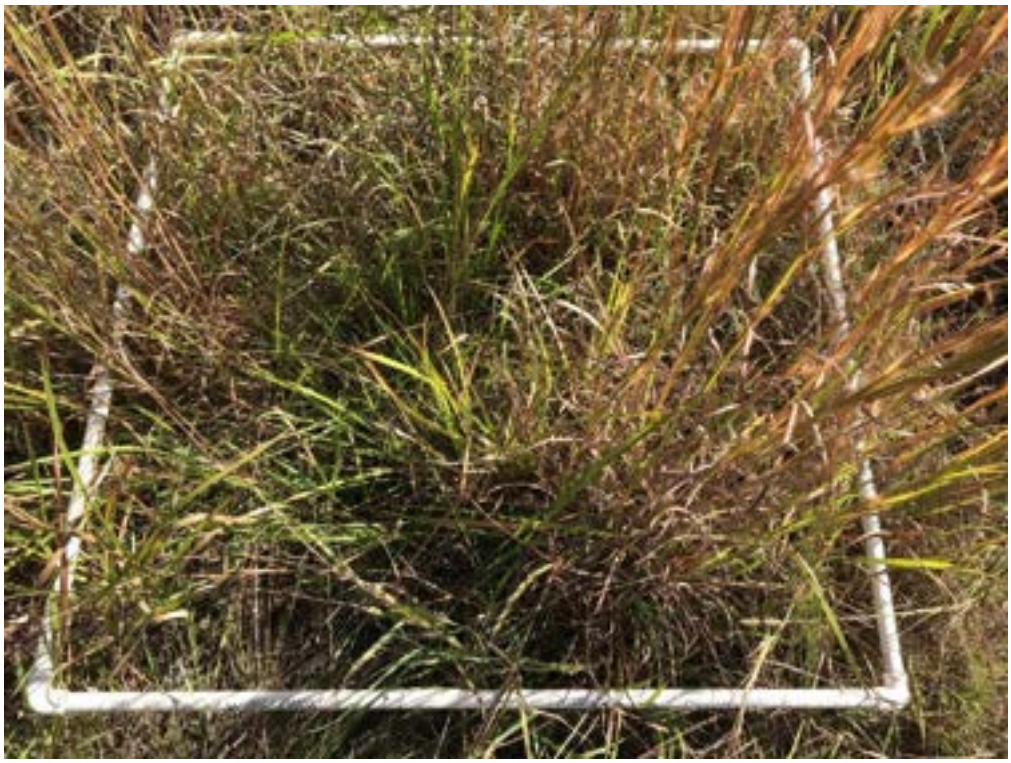
Photograph B.2 Plot 1 end



Photograph B.3 Subplot 1



Photograph B.4 Subplot 2



Photograph B.5 Subplot 3



Photograph B.6 Subplot 4



Photograph B.7 Subplot 5

B.2 Plot 2



Photograph B.8 Plot 2 start



Photograph B.9 Plot 2 end



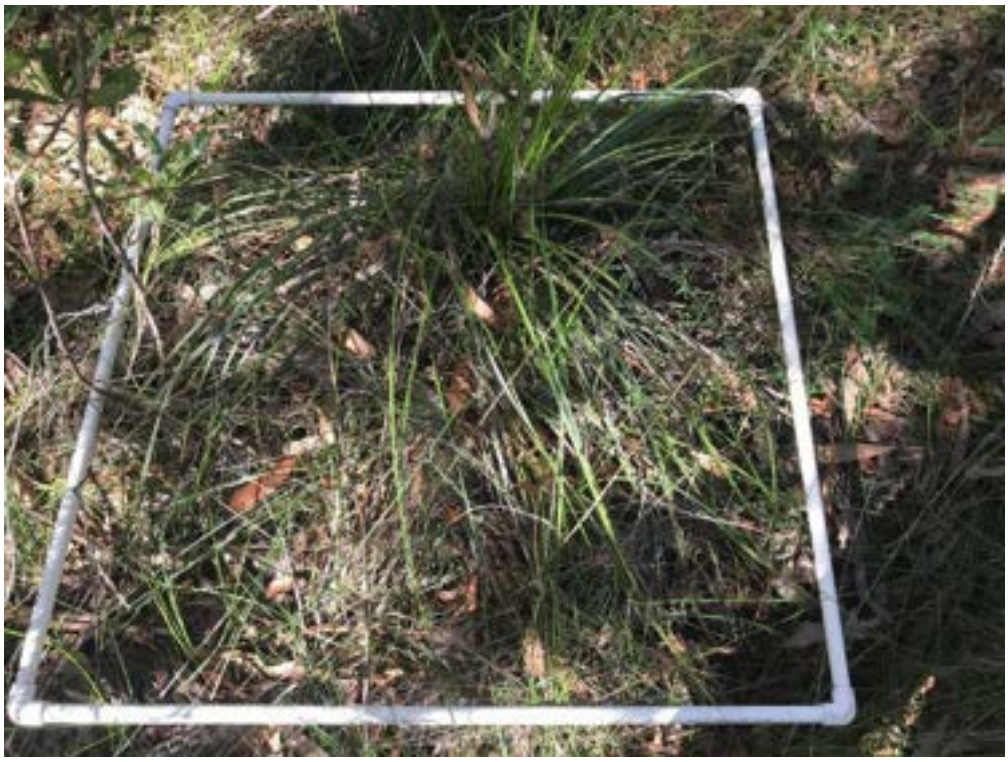
Photograph B.10 Subplot 1



Photograph B.11 Subplot 2



Photograph B.12 Subplot 3



Photograph B.13 Subplot 4



Photograph B.14 Subplot 5

B.3 Plot 3



Photograph B.15 Plot 3 start



Photograph B.16 Plot 3 end



Photograph B.17 Subplot 1



Photograph B.18 Subplot 2



Photograph B.19 Subplot 3



Photograph B.20 Subplot 4



Photograph B.21 Subplot 5

B.4 Plot 4



Photograph B.22 Plot 4 start



Photograph B.23 Plot 4 end



Photograph B.24 Subplot 1



Photograph B.25 Subplot 2



Photograph B.26 Subplot 3



Photograph B.27 Subplot 4



Photograph B.28 Subplot 5

Appendix B

PCT 1642 Benchmarks

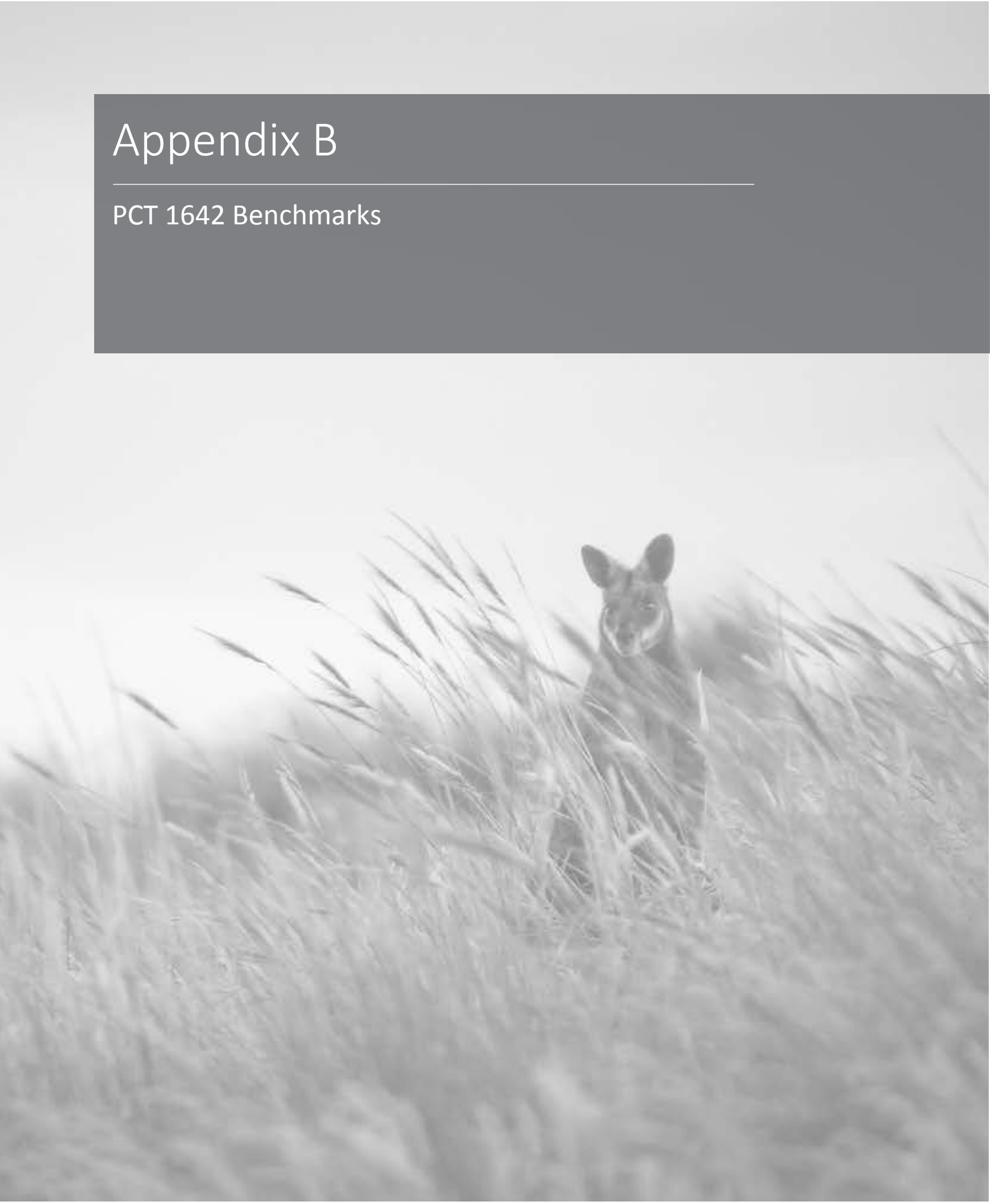


Table B.1 PCT 1642 Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_woodland – condition benchmarks and attributes.

Characteristic	Benchmarks
Formation (Keith 2004)	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class ID (Keith 2004)	Sydney Coastal Dry Sclerophyll Forests
Former Catchment Management Area region (now Local Land Services Area)	Hunter Central Rivers
NativePlantSpRichness	35
NativeOSCoverMIN	18
NativeOSCoverMAX	45
NativeMSCoverMIN	13
NativeMSCoverMAX	60
NativeGCGrassMIN	1
NativeGCGrassMAX	30
NativeGCShrubsMIN	5
NativeGCShrubsMAX	30
NativeGCOtherMIN	3
NativeGCOtherMAX	30
NumberTreesWithHollows	3
TotalLengthFallenLogs	70
CMA Percent Cleared Estimate	30

Table B.2 PCT 1642 Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast_DNG – condition benchmarks and attributes.

Characteristic	Benchmarks
Formation (Keith 2004)	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation ClassID (Keith 2004)	Sydney Coastal Dry Sclerophyll Forests
Former Catchment Management Area region (now Local Land Services Area)	Hunter Central Rivers
NativePlantSpRichness	20
NativeOSCoverMIN	0
NativeOSCoverMAX	0
NativeMSCoverMIN	0
NativeMSCoverMAX	0
NativeGCGrassMIN	50
NativeGCGrassMAX	80
NativeGCShrubsMIN	0
NativeGCShrubsMAX	0
NativeGCOtherMIN	5
NativeGCOtherMAX	40
NumberTreesWithHollows	0
TotalLengthFallenLogs	0
CMA Percent Cleared Estimate	30

Appendix C

Field sheet template



CVC Biodiversity rehabilitation monitoring - Transect

Site ID	**Date:**	**Data collectors:**

20 x 20 m plot - Survey species and provide cover abundance scores

Species	Cover	Abun	**Species**	Cover	Abunda

CVC Biodiversity rehabilitation monitoring - Transect	
Site ID:	**Date:**
PCT:	**Data collectors:**
Waypoint number	
Transect start: Easting/Northing	
Transect end: Easting/Northing	
Transect start photo (portrait/landscape)	
Transect end photo (portrait/landscape)	

Five quadrats (1m x 1m) spaced regularly along 50m transect, offset by 5m and alternate perpendicular to midline.

Quadrat number	Q1	Q2	Q3	Q4	Q5	Mean
Leaf litter cover (%)						
Photo number						

50 m x 20 m plot			
HBT's (count) (only hollows > 5 cm):			
Fallen Logs length (>10 cm, 0.5 m):			
Regen (no. spp and no. regenerating)			

50 m Transect (every 5 m)	5	10	15	20	25	30	35	40	45	50	Avg (%)
Canopy Cover (% - see Specht)											0
Mid Storey Cover (shrubs > 1m)											0

50 m Transect Groundcover (every 1 m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	%
Native shrubs (< 1m)																																																			
Exotic shrubs (< 1m)																																																			
Native grasses																																																			
Exotic grasses																																																			
Native other (forbs, fern etc)																																																			
Exotic other																																																			

Notes: (eg weed prevelance, erosion, dieback, herbivory, evideince of pest species, overall vigour of vegetation, relevant envionmental conditions)	



Appendix 2: Rehabilitation Risk Assessment

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
			1. General		
1.1	Inadequate information, skills/experience creates a lack of clearly defined responsibilities for rehabilitation, closure and relinquishment	• Historic records were not retained or were destroyed/damaged • Inadequate management of records for works undertaken • Age of the site (limited electronic records) • No established or inadequate Rehabilitation Quality Assurance Process • Inadequate knowledge of existing obligations • Inadequate consultation and engagement with regulators • Inadequate information captured • Loss of knowledge in business	• Survey records and lease information • Record tracings • Closure risk assessments to identify potential knowledge gaps/required activities • Trial and monitoring to inform future rehabilitation methodologies • Engineering design for construction works • Australian Standard 2601-2001 – Demolition of Structures • Ongoing consultation with Resources Regulator • Approved Mining Operations Plan (MOP) / Rehabilitation Management Plan (RMP) developed in consultation with stakeholders • Annual rehabilitation management plan review • Rehabilitation Management Plan	• Hazardous Materials Assessment of pit top infrastructure at decommissioning. • Site services scanning prior to decommissioning • Include in RMP - Establish quality assurance for rehabilitation • Compliance database maintained • Review roles and responsibilities of RMP • Engage appropriate specialists/knowledge	• Section 4.1.1 • Section 7 • Section 10.1

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
1.2	Ongoing management of the site required for post mining land use	• Inability to meet rehabilitation criteria Inadequate planning and practices during operations • Change in rehabilitation policy (e.g. residual risk)	• Approved MOP/RMP developed in consultation with stakeholders • Rehabilitation Cost Estimate (RCE) provision review process – reviewed annually • Annual review of RMP	• Stakeholder Engagement Strategy in Mine Closure Plan. Criteria and obligations developed in consultation with stakeholders i.e. Land Owner – Delta Electricity.	• Section 2.3
1.3	Inadequate rehabilitation provision under current Resources Regulator requirements, funding for or prioritisation of rehabilitation activities	• Additional costs required • High residual risk payment requirements • Litigation • Delay or inability to relinquish the lease"	• Approved RCE – based on Department Planning and Environment (DPE) template • Approved MOP/RMP developed in consultation with stakeholders • Inspections • Progressive rehabilitation of areas available • Annual budget process • Approved RCE – based on DPE template • Annual review of RCE under Schedule 8A of Mining Regulation. • Site contamination assessments to be completed in accordance with the National Environmental Protection (Assessment of Site Contamination) Measure, 2013 (NEPM ASC 2013).	• Hazmat survey prior to demolition activities	• Section 4.1.1
1.4	Approvals required for intended final land use.	• Approval not provided to achieve final land use	• Final land use detailed in MOP and RMP requiring stakeholder consultation and approval.		Section 2.3

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
1.5	Impacts to air quality (e.g. methane).	• Potential ongoing release of methane post-closure	• Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams. • Delta Coal Principal Control Plan – Ventilation Control Plan (Section 9.8 – Sealing the mine or parts of the mine. • Testing of shaft sealing		Section 4.1.1
1.6	Completed/planned rehabilitation or closure activities not meeting external or internal stakeholder expectations	• Poor public perception • Community/stakeholder complaints • Regulator requires additional consultation • Delays to site relinquishment • Additional costs for ongoing management • Inability to complete required tasks	• Approved Mining Operations Plan (MOP) /Rehabilitation Management Plan (RMP) developed in consultation with stakeholders • RCE holdings and approval by Resources Regulator. • CCC meetings continue to relinquishment • Annual review of RCE/RMP • MOP/RMP is publicly available	• Community consultation strategy in Mine Closure Plan. • Expected outcomes of rehabilitation included in Rehabilitation Management Plan • Stakeholder Engagement Strategy in Mine Closure Plan. Outline expected outcomes of easement bisecting CVC pit-top dams in consultation with AusGrid.	Section 4.1 Section 4.1 Section 2.3
1.7	Social Impacts	• Negative social/economic impacts on local communities	• Existing Approvals • Continued Community Consultative Committee meetings to relinquishment.		Section 4.2

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
1.8	Failure to meet rehabilitation and closure criteria objectives leading to ongoing management issues and costs or public safety issues	• Delays to site relinquishment • Poor reputation • Significant costs to meet rehabilitation criteria • Community expectations not met • Failure to meet rehabilitation and closure criteria objectives • Ongoing management issues and costs • Failure to achieve successful rehabilitation • Ongoing liability • Public safety issues	• All infrastructure/pit top areas are fenced. • Baseline ecological and rehabilitation survey completed • Inspections • Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • Site contamination assessments prior to rehabilitation to be completed in accordance with the NEPM ASC 2013	• Hazardous Materials Survey of structures prior to demolition. • Capture roles and responsibilities in Rehabilitation Management Plan.	• Section 4.1.1 • Section 10.1
1.9	Visual/lighting/noise/dust impacts upon regional receptors during rehabilitation	• Community complaints • Non-compliances	• All works during standard business hours • Vegetation screening/low potential for receptors to see planned works • Approved environmental management plans • Environmental Protection Licenses • Equipment standard for noise • Introduction to site process	• Monitoring programs throughout remediation phases • Detail standard business hours within the Remediation Management Plan.	• Section 6.2 • Section 6.2

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
1.10	Unauthorised access to rehabilitation areas and potential vandalism	• Injury • Delays to rehabilitation schedule	• Pit top and infrastructure areas (including rehabilitation) to be fenced from public access • Fences, signage and security • Inspections • Repair of fencing where triggered by inspections • Site security	• Address access and site security requirements in Rehabilitation Management Plan	• Section 6.2.2.1
1.11	Final landform unsuitable for final land use.	• Cost in reworking final land form • Unstable slopes remain delaying/preventing site relinquishment.	• Approved MOP and Rehabilitation Management Plan. • Approved contours/final land form prior to commencement of rehabilitation works • Progressive rehabilitation • Regular review and revision of mine plans		Section 6.2.3
1.12	Impact to existing remnant native species or established rehabilitation	• Impact to land / soil / site erosion • Loss/impacts to flora outside disturbed or previously rehabilitated areas • Non-compliance with approvals	• Vegetation communities mapped • land clearing permit • Training and awareness package for contractors on-site	• Areas of disturbance and landform establishment works to be demarcated on site prior to decommissioning	• Section 6.2.2.2 • Section 6.2.3.2
1.13	Access delayed for execution of rehabilitation works	• Project delays • Delays to lease relinquishment • Additional costs • Community/stakeholder complaints • Poor public perception	• All infrastructure areas and pit top owned and managed by Delta Coal / Delta Electricity. • Approved MOP/RMP detailing scope of rehabilitation works.		N/A
2. Active Mining					

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
2.1	Less than adequate biological resource (e.g. subsoil, topsoil, vegetative material, seedbank, rocks, habitat resources) salvage for rehabilitation works	• Business cost • Delay to relinquishment • Unavailability of seed from native species in vicinity of the site (i.e. seasonal variation)	• Soil management practices in accordance with MOP/RMP • Minimal soil volumes required for achieving final land form (cut at CVC and MC and estimated Fill works 1630 m^3 at CVC Ventilation compound.	• Development of a topsoil securement strategy in mine closure plan. • Development of a flora seed/stock securement strategy in mine closure plan.	• Section 6.2.1.1 • Section 6.2.1.2
2.2	Adverse geochemical/chemical composition of material	Environmental impacts Business cost Delay to relinquishment	• Soil testing (characterisation) prior to use • Imported material testing of Excavated Natural Material/VENM • monitoring of rehabilitation	• Development of a topsoil securement strategy in mine closure plan, informed by soil sampling to identify soil amelioration requirements.	• Section 6.2.1.1
2.3	Material and landform unsuitable to support final land use	• Environmental impacts • Business cost • Delay to relinquishment	• Rehabilitation monitoring program • Soil testing requirements within Mine Closure Plan prior to commencement of mine closure • Approved MOP/RMP • Final landform design and contour plan • Ameliorate consideration in RCE	N/A	• Section 6.2.1.1 • Section 5 • Appendix 1
			3. Decommissioning		
3.1	Unintended interaction with Heritage site or artefact	• Unauthorised impact to Aboriginal site or artefact.	• Permit to dig • Site survey conducted. • AHIMS register for identified Aboriginal Heritage sites • Env Awareness training for all persons on-site in induction	N/A	• Section 6.2.1.13 • Section 6.2.2.2 • Figure 1-7

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.2	Loss of habitat to threatened species from closure (e.g. Microbats)	• Loss of biodiversity values	• Monitoring programs and inspection • Rehabilitation in existing disturbed areas.	• Infrastructure survey for threatened species prior to demolition	• Section 6.2.2.2
3.3	Waste remaining at site and/or inadequate capacity of local landfills to accept benign wastes	• Increased cost of rework • Negative impact to company reputation • Increase in disposal costs	• Stakeholder consultation • Progressive rehabilitation • Waste management contracts • Proposed volumes of waste soil to be generated in achieving final landform at CVC and MC is 26,066 m^3 with a bulking factor of 1.25 (generic for soil) is 32,582.5 m^3.	• Include in RMP: prior to mine closure stage, undertake in-situ assessment for beneficial re-use (ENM/VENM Order) and waste classification of soils to be removed to achieve final land-form.	• Section 6.2.1.1
3.4	Retained infrastructure poses a hazard to personnel and the public prior to or following final closure.	• Unrestricted access • Inadequate asset transfer/ management • Undocumented agreements • Landholder expectations for retention	• No retained infrastructure in final land use. • Security during operation and rehabilitation of site.		• Section 6.2.2.1 • Section 6.2.2.2 • Section 6.2.2.3

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.5	Contamination, hazardous materials and dangerous goods remaining on the site at closure	• Exposure and health impacts • Litigation • Constraints on future land use • Inability to reach closure and relinquishment of the lease. • Groundwater contamination. • Land contamination	• Phase 1 and Phase 2 contamination assessment to be completed in accordance with the NEPM ASC 2013 to identify contamination prior to development of a detailed mine closure plan. • Hazardous Materials Register for site • Monitoring and inspections • Hazardous Materials survey of infrastructure prior to demolition.		• Section 6.2.2.4 • Section 6.2.2.5
3.6	Contamination of groundwater from operations	• Groundwater contamination • Impact to the environment • Impact to human health	• Phase 1 and Phase 2 contamination assessments to be completed in accordance with NEPM ASC 2013. • No underground storage tanks for fuel on-site (excludes in ground sumps and pits).		• Section 6.2.2.4
3.7	Impact to aquifers and groundwater	• Reduction in existing groundwater level • Impact to Groundwater Dependent Ecosystems	• Groundwater Impact Assessments undertaken for approval of mining areas. • Secondary extraction subject to an extraction plan • Aquifer drawdown predictions in Groundwater Management Plan • Mine design beneath land - <20mm subsidence limit.		• Section 6.2.1.12

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.8	Groundwater accumulation in underground workings (e.g. potential to fill and spill or impacts on regional ground water users).	• Inability to reach closure and relinquishment of the lease • Uncontrolled seepage and discharge to the environment. • Impacts to biodiversity values • Impacts to surface water quality in creeks • Non-compliance with approvals or water quality criteria.	• Environmental monitoring • Water Management Plan • Location, workings are below sea level • Pit top and mine shafts located above sea level • Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • Groundwater Management Plan and Environmental Impact Statement (EIS) and Statement of Environmental Effects (SEE) includes drawdown predictions.		• Section 6.2.2.6
3.9	High rainfall event with inadequate drainage or inadequate material storage (erosion controls) during decommissioning / rehabilitation.	• Impacts to surface water quality/quantity in creeks • Community reputation • Impacts to biodiversity values • Non-compliance with approvals • Non-compliance with water quality criteria	• Reduced flow received to sediment dams during rehabilitation as no dewatering will be required reducing load received to the dam system. Rehabilitation plan includes retaining sediment dams during primary earthworks and initial revegetation. • Vegetation establishment • Site Inspections • Contamination assessments • Water Management Plan and Water Management TARP's		• Section 6.2.1.10 • Section 6.2.3.1

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.10	Discharge of poor quality water including contaminated water from site	• Requirement to treat water long term. • Non compliance with statutory or other legislative requirements • Impact to aquatic ecology • Impacts to biodiversity values • Impacts to surface water quality in creeks • Non compliance with approvals	• Environmental monitoring • Environmental Management System • Environmental Inspection program • Implement erosion and sediment controls • Separation of clean and dirty water • Monitoring of water quality • Sediment control dams in place • Site contamination assessment following decommissioning of the site's infrastructure and prior to landform establishment, allowing for remediation of contaminated soil.	• Water management to be addressed in RMP	• Section 6.2.1.10 • Section 6.2.3.1
3.11	Inadequate management of reject material	• Harm to environment • Non-compliance • Additional rehabilitation costs	• No reject material generated by operation, with reject remaining from the MC Surface Rotary Breaker within the MC Waste Management Area. • Water Management Plan details stockpile management.	• Develop strategy for management of reject material remaining at MC.	• Section 6.2.1.9

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.12	Ventilation shafts/entries/ boreholes unlocated	• Inability to relinquish • Company reputation damage • Regulatory action • Settling of fill material under capping • Significant cost to undertake detailed investigation across the site • Equipment damage	• Signage • Security • Fencing • Locked sites • Controlled access • Monitoring/inspections • Adequate records • Industry standards for sealing • Survey plan with boreholes. • Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • Sealing of boreholes to requirements of EDG01 – Borehole sealing requirements on Land: Coal Exploration • RMP/MOP includes sealing of mine openings.		• Section 6.2.2.6

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
3.13	Mine entries improperly sealed and do not meet current regulatory requirements.	• Inability to relinquish • Company reputation damage Regulatory action Significant cost to undertake detailed investigation and corrective action.	• Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • RMP/MOP includes sealing of mine openings.		• Section 6.2.2.6
			4. Landform Establishment		
4.1	Final landform unsuitable for final land use (e.g. large rocks present affecting cultivation, settlement and surface subsidence leading to extended ponding).	• Lack of vegetation establishment • Ponding of water outside designed areas	• Soil sampling undertaken during landform establishment to guide ameliorant application. • Mine design beneath land - <20mm subsidence limit. • Rehabilitation Monitoring Program • Completion criteria requires landscape function analysis to show continued ecosystem function improvements		• Section 6.2.3 • Section 6.2.6
4.2	Slopes remaining on site exceed approved final landform design criteria	• Unstable slopes • Non-compliance with approved landform	• Approved MOP/RMP • Completion criteria includes re-profiled slopes not exceeding 10°. • Regular survey during landform establishment		• Section 6.2.3.2

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
4.3	Volume / percentage of carbonaceous material inadequate.	• Relinquishment not allowed • Fire risk • Business cost	• Assessment of combustion risk to be undertaken at cessation of mining • Approved MOP requires removal of carbonaceous material as practicable and blending below combustible limits • Majority of carbonaceous material removed from CVC in 2020.	• Include carbonaceous material management in RMP	• Section 6.2.2.4
4.4	Significant erosion and runoff	• Geotechnical failures of backfilled materials • Inability to relinquish lease • Company reputation damage • Land contamination • Surface water contamination • Failure to achieve successful rehabilitation or impacts to surface water quality in creeks or ongoing management issues and costs.	• Rehabilitation methodology includes Surface water runoff directed to sediment control structures prior to discharge (either retained sediment dams within Water Management Area or new temporary sediment controls as required) • Rehabilitation works in accordance with Managing Urban Stormwater: Soils and construction (‘Blue Book’) • Diversion channels/drains to remain stable and non-eroding • Monitoring programs and inspections • Stable and vegetated landforms • Completion criteria includes re-profiled slopes not exceeding 10°. • Characterisation of materials • Vegetation establishment		• Section 6.2.3.1
4.5	Acid generation and drainage from material of unknown origin	• Acid generation (localised) • Water quality impacts • Inability to reach closure and relinquishment of the lease	• Monitoring programs and inspections • Historical surface and groundwater monitoring programs • Soil testing of imported material to meet VENM/ENM order and acid sulphate soil assessment.		• Section 6.2.1.8

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
4.6	Spontaneous combustion / heating events at surface or in underground workings	• Bushfire • Damage to property, equipment • Injury • Community complaints • Failure to meeting rehabilitation and closure criteria objectives • Inability to complete rehabilitation • Impact on established rehabilitation • Cost of managing spontaneous combustion • Inability to reach closure and relinquishment of the lease	• Monitoring programs and inspections • Monitoring programs and inspections • WHS management process • Material onsite has low propensity for spontaneous combustion • No exposed coal seams at the surface • Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • Sealing of boreholes to requirements of EDG01 – Borehole sealing requirements on Land: Coal Exploration • No reject emplacement area		• Section 6.2.1.7

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
4.7	Geotechnical failure – dam failure	• Failure to achieve successful rehabilitation • ongoing management issues and costs or public safety issues. • Geotechnical failure • Non-compliance • Environmental impact	• Stable and vegetated landform • Monitoring programs and inspections • Surface water management system • Final landform requires removal of majority of retention dams.	• RMP to detail final water management structures	• Section 5 • Section 6.2.3.1
			5. Growth Media Development		
5.1	Poor quality and/or limited available topsoil/subsoil/growth medium for rehabilitation, it is noted that due to age of mine no topsoil was preserved for mine closure.	• Increased costs to source offsite materials • Inability to reach closure criteria and relinquishment of the lease	• Soil testing of imported material • Material inventory and current	• Development of a topsoil securement strategy in mine closure plan.	• Section 6.2.1.1 • Section 6.2.4
			6. Ecosystem and Land Use Establishment		
6.1	Lack in availability and/or quality of seed resources	• Inability to reach closure and relinquishment of the leases • Additional costs for rework	• Ability to purchase suitable seed if seed harvesting not viable	• Development of a flora seed/stock securement strategy in mine closure plan	• Section 6.2.1.2 • Section 6.2.5

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
6.2	Seed mix not suitable for intended final land use (i.e. vegetation community requirements)	• Inability to reach closure and relinquishment of the leases • Additional costs for rework	• Seed mix to be preferentially harvested from adjacent vegetation communities • Seed mix to be developed based on surrounding vegetation communities.	• Development of a flora seed/stock securement strategy in mine closure plan	• Section 6.2.1.2 • Section 6.2.5
6.4	Areas not available for revegetation in optimal seasonal conditions or weather conditions limit/prevent establishment of rehabilitation	• Erosion • Poor rehabilitation success • Additional cost for rework Failure to meet closure criteria	• Monitoring programs and inspections • Progressive rehabilitation of areas as they become available • Erosion management in accordance with water management plan	• Forward work program to be included in mine closure plan.	• Section 6.1
6.5	Weeds and pests inadequately managed onsite	• Rehabilitation criteria not met • Additional cost	• Current weed action plan and monitoring • Ongoing weed management throughout operation • Biodiversity management plan • Annual biodiversity monitoring (including feral pest monitoring)		• Section 6.2.1.2 • Section 6.2.4 • Section 6.2.6 • Section 8.2
			7. Ecosystem and Land Use Development		
7.1	Insufficient establishment of target species and limited species diversity	• Inability to reach closure and relinquishment of the leases • Additional costs for rework	• Biodiversity baseline assessments and rehabilitation base line in Rehabilitation Monitoring Program • Approved MOP including rehabilitation TARP	• Include rehabilitation TARP in RMP	• Section 10
7.2	Lack of rehabilitation maintenance	• Inability to reach closure and relinquishment of the leases • Additional costs for rework	• Approved MOP including rehabilitation TARP • Rehabilitation Monitoring Program • Weed and pest management • Environmental inspections	• Include in RMP resourcing for maintenance (roles and responsibilities).	• Section 10.1

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
7.3	Inadequate bushfire management	• Impacts on rehabilitation success. • Additional cost • Delay to relinquishment	• Access to site to be maintained for bushfire fighting • Bushfire Management Plan • Staff trained in bushfire response	• Bushfire risk management to be included in Mine Closure Plan including consultation with RFS.	• Section 10, Table 10-1
7.4	Ignition of coarse coal reject following bushfire	• Rework of rehabilitation • Additional costs	• Coal reject material to be removed and scraped from site with remaining content to be below combustible limits. • Assessment of combustion risk to be undertaken at cessation of mining.		• Section 6.2.1.7
			8. Mine Subsidence		
8.1	Unlocated subsidence impacts i.e.: Historical subsidence impacts associated with failure of pillars designed to be long term stable	• Injury • Infrastructure damage • Company reputation damage	• Mining beneath land designed to be long term stable with <20mm of subsidence • Subsidence assessments and monitoring • No visible surface impacts associated with bord and pillar operations at the site • Monitoring and inspections • Baseline mapping / record tracings • Survey programs		• Section 6.2.1.12
8.2	Methane or other gas emission to surface (e.g. fugitive emissions resulting from fracturing etc.).	• GHG emissions. • Ignition	• Known depth of cover • Shaft sealing to MDG 6001 – Guideline for the Permanent Filling and Capping of Surface Entries to Coal Seams • Sealing of boreholes to requirements of EDG01 – Borehole sealing requirements on Land: Coal Exploration		• Section 6.2.2.6

No	Description of Risk	Potential Hazard	Existing Controls	Proposed Controls	Section addressed in RMP
8.3	Redirection of surface water flows or extended water ponding.	Not applicable as subsidence <20mm below land, high water mark and seagrass protection barriers.			

Appendix 13 Subsidence Monitoring Program

Environmental Management System

Chain Valley Colliery

Miniwall S5, Northern Mining Area and Northeast and North Headings Pillar Extraction

Author	Nigel Birt Technical Services Manager Delta Coal – Chain Valley Colliery
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Date:	19th November 2025

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1 Introduction

Chain Valley Colliery is an underground coal mine located on the southern end of Lake Macquarie, approximately 80km north of Sydney and 60km south of Newcastle, adjacent to the Vales Point Power Station, producing thermal coal for the domestic and export markets.

A formal Extraction Management Plan has been developed in order to manage the process of mining layout design and mitigate any subsidence impacts on surface infrastructure and/or stakeholders.

The Subsidence Monitoring Program is an element of the Chain Valley Colliery Extraction Management Plan, and has been developed to satisfy the requirements of Development Consent SSD-5465:

Condition 7(k) and Tables 6-7 in Schedule 4, which states:

> "7. The Applicant shall prepare and implement an Extraction Plan for all second workings on site, to the satisfaction of the Director-General. Each Extraction Plan must:
>
> (k) include a Subsidence Monitoring Program which has been prepared in consultation with RR, 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; and
> - informs the contingency plan and adaptive management process;

Condition 1, Schedule 4 of SSD5465 states:

> "The Applicant must ensure that vertical subsidence within the High Water Mark Subsidence Barrier and within Seagrass beds is limited to a maximum of 20 millimetres (mm). If at any stage predicted subsidence levels are exceeded within these areas, an ecological monitoring program shall be initiated to assess the impacts to ecological communities and threatened species and if appropriate, offsets are to be provided for any impacts detected."

C*ondition 2 within Schedule 4 of SSD-5465* also requires that:

> "The Applicant must ensure that the development does not cause any exceedance of the performance measures in Table 6 to the satisfaction of the Planning Secretary"

The relevant subsidence monitoring requirements from Table 6 within Schedule 4 of the Development Consent, including the relevant notes, are recreated in Table 1.

Condition 4 within Schedule 4 of SSD-5465 also requires that:

> "The Applicant must ensure that the development does not cause any exceedances of the performance measures in Table 7, to the satisfaction of the Planning Secretary."

The relevant subsidence monitoring requirements from Table 9 within Schedule 4 of the Development Consent, including the relevant notes (Table 2).

Table 1 - Subsidence Impact Performance Measures - Natural and Heritage Features

Biodiversity	
Threatened species or endangered populations	Negligible environmental consequences
Seagrass beds	Negligible environmental consequences including: • Negligible changes in size and distribution of seagrass beds; • Negligible change in the function 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 and approved Extraction Plan.

Notes:

• The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).

• Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.

• The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.

Condition 9 within Schedule 4 of SSD-5465 also states that:

> "The Applicant may carry out first workings within Subsidence Zones A and B as shown in Appendix 3, other than in accordance with an approved Extraction Plan, provided that the first workings are designed to remain stable and non-subsiding in the long-term and do not generate more than 20 mm of vertical subsidence at the surface, except insofar as they may be impacted by approved second workings."

Table 2 - Subsidence Impact Performance Measures – Built Features

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 compensated
Public Safety	
Public Safety	Negligible additional risk

Notes:

- *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Secretary will be the final arbiter.*
- *The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.*

Requirement's regarding safety or serviceability do not preclude preventative actions or mitigation being taken prior to or during mining in order to achieve or maintain these outcomes.

Requirement's under this condition may be met by measures undertaken in accordance with the Mine Subsidence Compensation Act 1961

All first workings developed within Subsidence Zone A as per Figure 1 will be designed in accordance with relevant geotechnical and engineering standards to ensure negligible direct subsidence impacts to surface and built features.

2 Purpose

The purpose of this Subsidence Monitoring Program is to:

- define the subsidence monitoring scope;
- outline subsidence predictions;
- outline the methodology to be used to monitor subsidence impacts
- identify subsidence monitoring locations;
- identify reporting requirements;
- analyse the relationship between predicted and resulting subsidence effects;
- identify the requirements for incident or exceedances reporting.

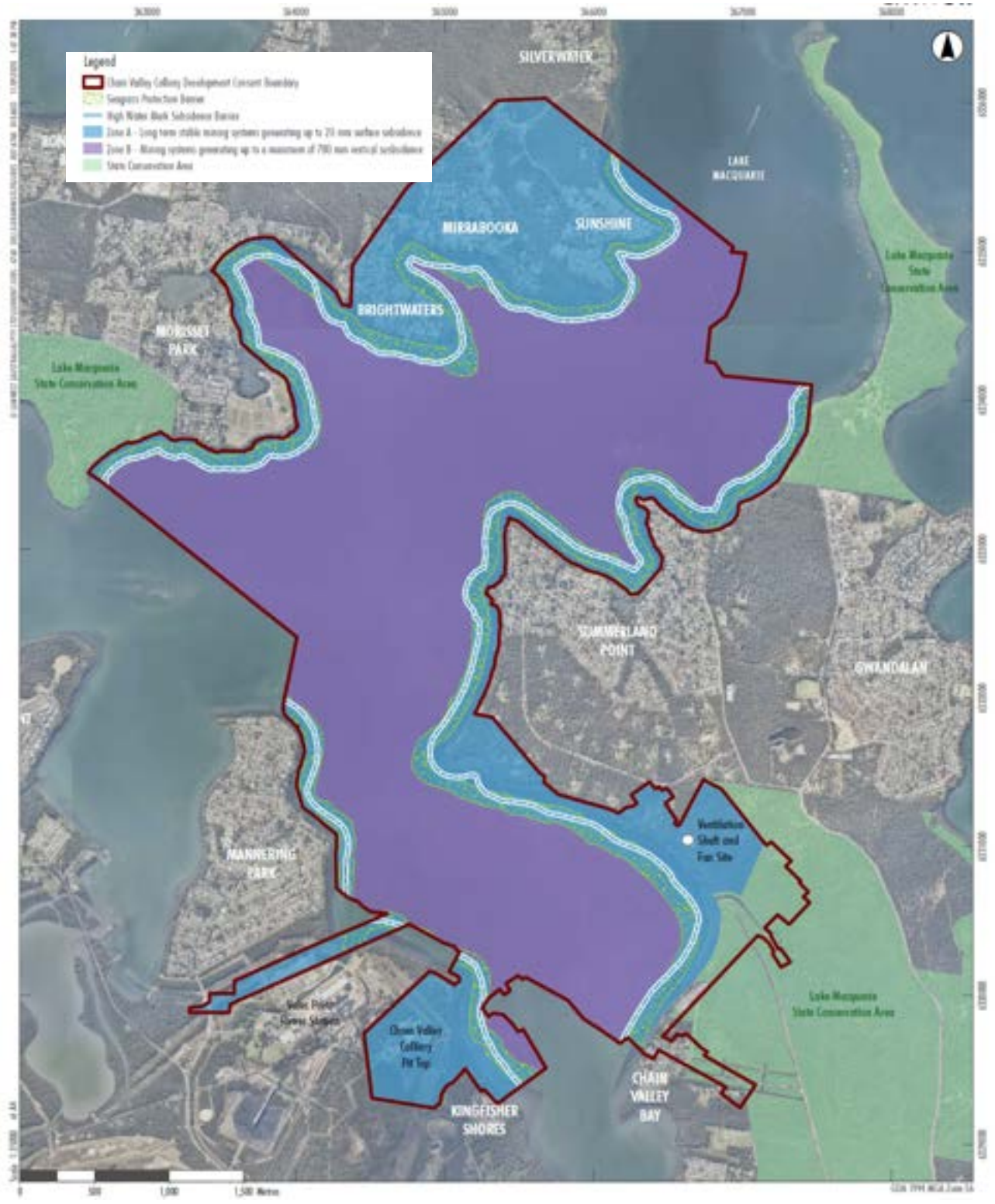


Figure 1 - Layout of the Chain Valley Project, showing Subsidence Zones A and B

3 Background

3.1 Operations

Chain Valley Colliery is an underground coal mine with current coal mining methods including development of roadways in the coal seam known as first workings and secondary extraction.

Lake Macquarie is the largest saline lake in New South Wales. It lies on the Central Coast between Sydney and Newcastle within the local government areas of Wyong and Lake Macquarie. Lake Macquarie has a catchment of 700 square kilometres and a water surface area of 125 square kilometres (Bell & Edwards, 1980). The lake has a permanent entrance to coastal waters at Swansea and has an average depth of around 6 meters (Laxton, 2005).

The catchment of Lake Macquarie is largely rural with large areas of bush land and grazing land. The shoreline of Lake Macquarie is heavily urbanised, especially the eastern, western and northern shorelines. The region has a relatively long history of coal mining and power generation, with mining occurring since the late 1800s and the first power station at Lake Macquarie commencing operations in 1958.

The Chain Valley Colliery is situated on the southern shores of Lake Macquarie near Mannering Park, NSW. The mine has been operating since 1962. Mining is currently undertaken using extraction methods within 'Zone B' where subsidence of up to 780mm is permitted, and first workings in 'Zone A' where nil surface impacts are approved. All mining is currently occurring in the Fassifern seam, in line with Development Consent SSD–5465. The general layout of the Chain Valley Extension Project in respect to Lake Macquarie is shown on **Figure 1**

3.2 Subsidence Predictions

This management plan references various reports for extraction under Lake Macquarie.

Reports completed by Mr David Hill of Strata2 Ground Control Consulting are referenced for the extraction of S2 to S5 miniwalls, these are:

- "Geotechnical Aspects of S2 and S3 Panel Design" Strata2 Report: CHV-006 (Hill, 2018)
- "Geotechnical Aspects of S4 Panel Design" Strata2 Report: CHV-010 (Hill, 2019)
- "S5 Panel - Geotechnical Environment, Subsidence Estimates and Impacts" Strata2 Report: CHV-019 (Hill, 2020)
- "Miniwall S5 and the Adjacent Herringbone Panels of the Northern Mining Area (NMA) - Geotechnical Environment, Subsidence Estimates and Impacts" Strata2 Report: CHV-024 (Hill, 2020)

Subsidence modelling predicted up to approximately 500mm of subsidence to the Lake floor associated with miniwall mining in S2 to S5.

The report[1] by Byrnes Geotechnical is referenced for the pillar extraction in the Northern Mining Area:

- Seedsman & Byrnes (2024). Subsidence prediction – Northern Mining Area. (Report No. DCV-23).

[1] Seedsman & Byrnes (2024). Subsidence prediction – Northern Mining Area. (Report No. DCV-23).

Subsidence modelling to the Lake floor associated with the planned partial extraction of first workings withing the Northern Mining Area (Figure 2) resulted in the following subsidence prediction, presented along its likely hood:

- Likely 18mm
- Possible 113mm
- Very Unlikely 226mm

For the purposes of this monitoring program, a maximum predicted subsidence (Smax) associated with the pillar extraction in the Northern Mining Area of 226mm will be used.

No additional subsidence is expected to occur within the seagrass and the lake foreshore areas as a result of Fassifern extraction.

The approved maximum subsidence (SSD 5465 as modified) within Zone B is 780mm. Respective triggers points for monitoring and response are included in the Subsidence Management TARP.

The reports[2] by Mine Advice is referenced for the pillar extraction in the Northeast and North Headings:

- Mine Advice 2024, Assessment of Proposed Secondary Extraction, North Headings, NE Headings and Herringbone Mains, Fassifern Seam. Report No. Chain Valley 10/1.
- Mine Advice 2025, Assessment of Double-Sided Lifting for Secondary Extraction, NE and North Main Headings, Fassifern Seam. Report No. Chain Valley 11/1.
- Mine Advice 2025, Adequacy of Barrier Pillars Between Extracted Miniwalls (MW's 1 to 3, 6 to 12 and S2 to S5) and Proposed Double-Sided Lifting-Off in the Northeast and North Main Headings. Report No. Chain Valley 12/2.

[2] Mine Advice 2024, Assessment of Proposed Secondary Extraction, North Headings, NE Headings and Herringbone Mains, Fassifern Seam. Report No. Chain Valley 10/1.
Mine Advice 2025, Assessment of Double-Sided Lifting for Secondary Extraction, NE and North Main Headings, Fassifern Seam. Report No. Chain Valley 11/1.
Mine Advice 2025, Adequacy of Barrier Pillars Between Extracted Miniwalls (MW's 1 to 3, 6 to 12 and S2 to S5) and Proposed Double-Sided Lifting-Off in the Northeast and North Main Headings. Report No. Chain Valley 12/2.

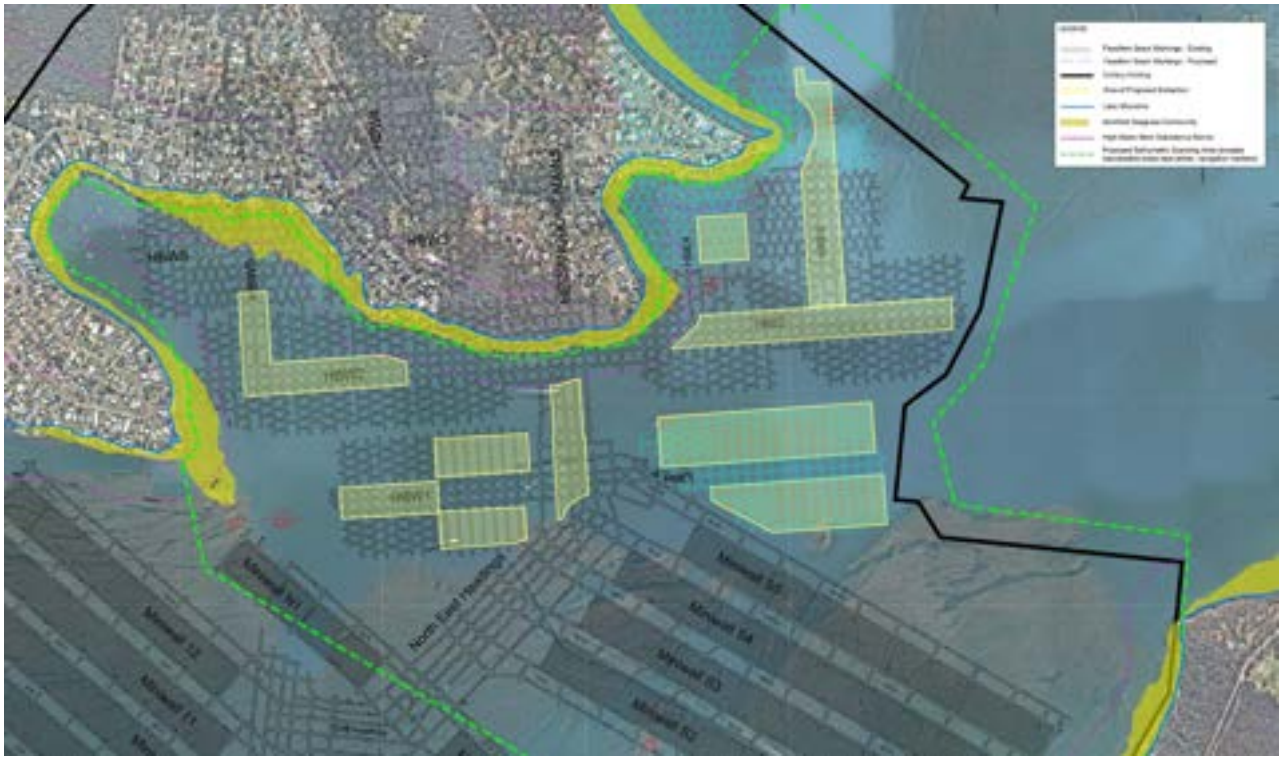


Figure 2 - Predicted Subsidence impact areas due to extraction methods under Lake Macquarie in the Northern Mining Area.

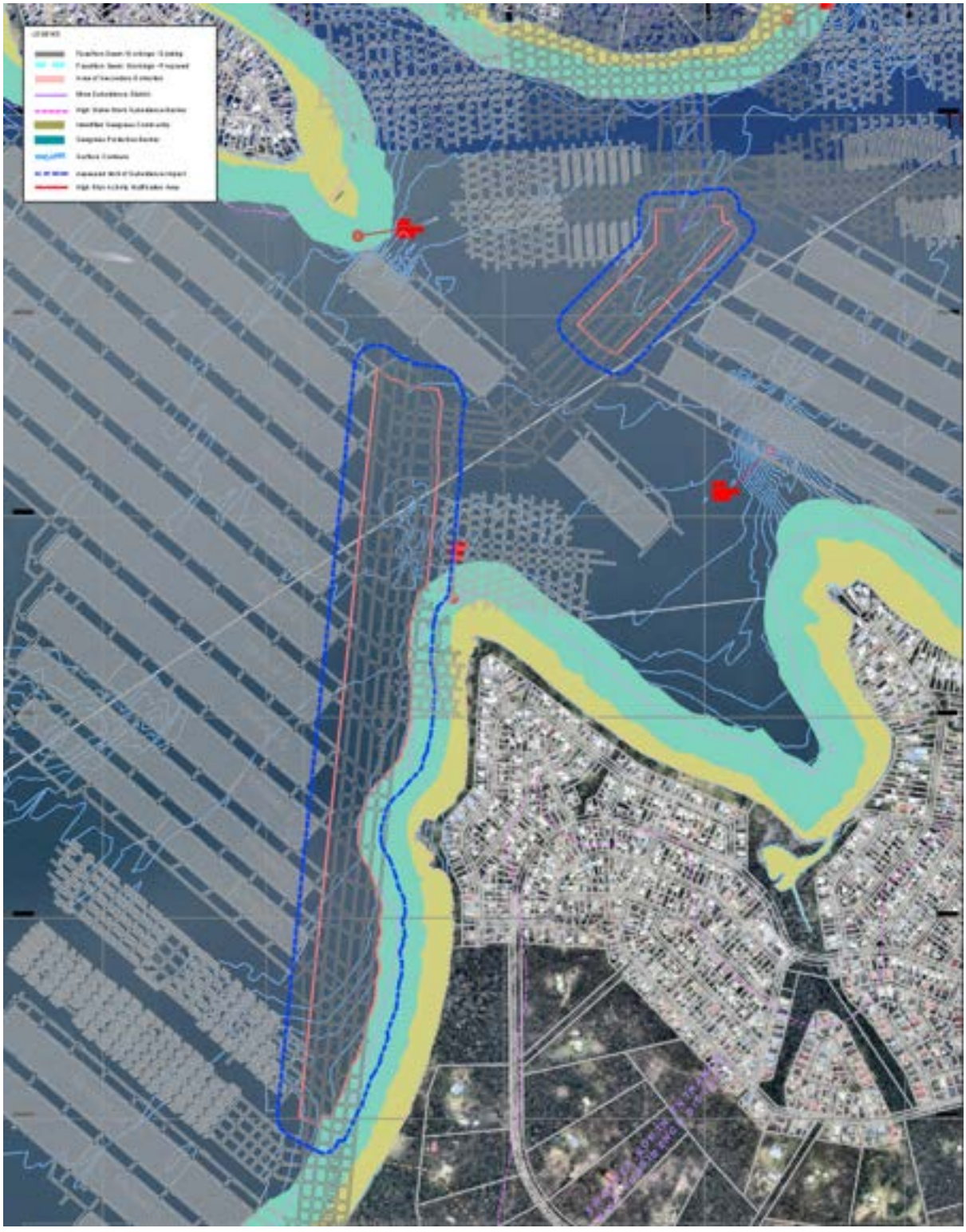


Figure 3 - Predicted Subsidence impact areas due to extraction methods under Lake Macquarie in the Northeast and North Headings.

3.3 Surface Monitoring - Scope

3.3.1 Shoreline (High Water Mark)

The High Water Mark Subsidence Barrier (HWMSB) is defined in the seam by a line defined by an angle of draw of 35° drawn lakeward from the high water level of Lake Macquarie, and on the land side, a line drawn from the 2.44m contour at 35° towards the land (Figure 5).

Condition 1, Schedule 4 of SSD5465 states:

> "The Proponent shall ensure that vertical subsidence within the High Water Mark Subsidence Barrier and within Seagrass beds is limited to a maximum of 20 millimetres(mm)…."

A key objective of the mine design is to minimise vertical subsidence within the HWMSB and prevent additional subsidence above the high water mark. To ensure effectiveness of the mine design, monitoring of the shoreline is proposed via the installation and monitoring of fixed reference marks surveyed at regular intervals.

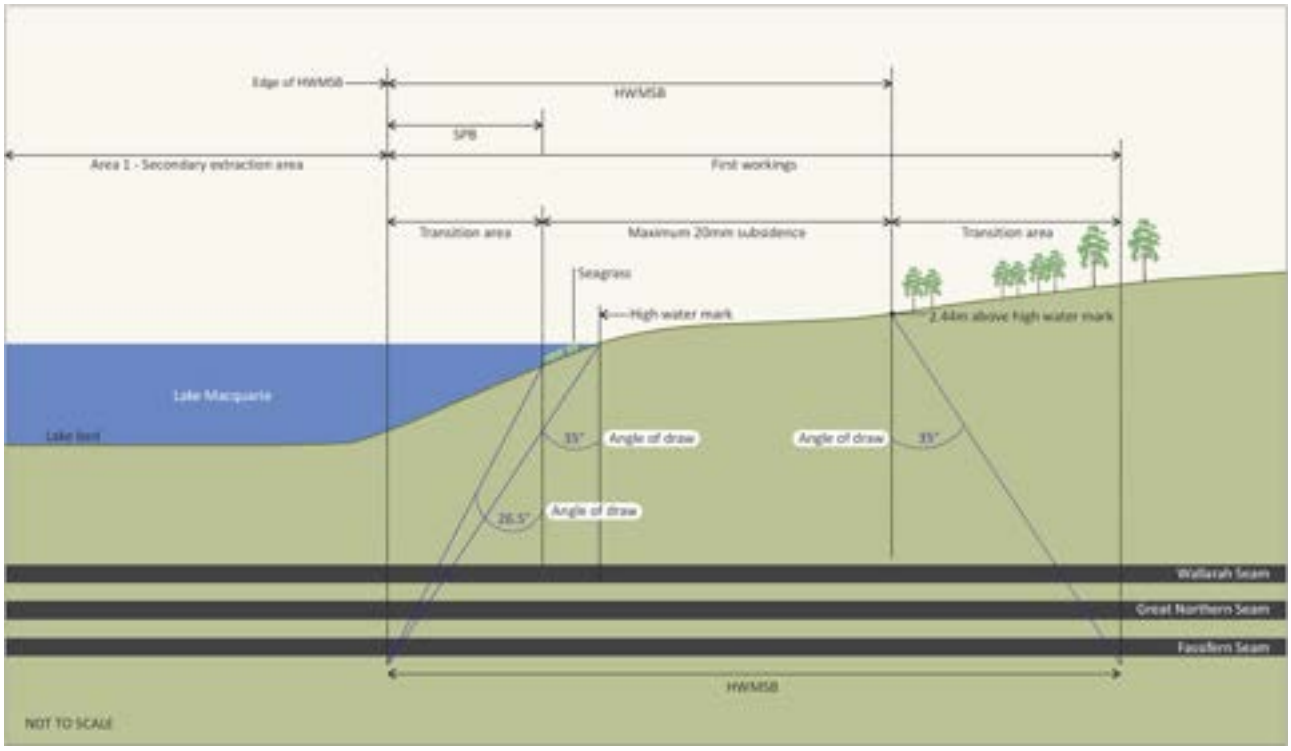


Figure 4 - High Water Mark Subsidence Barrier Typical Diagram

3.3.2 Seagrass

Condition 2, Schedule 4 of SSD-5465 specifies negligible environmental impacts on the species of seagrass found within the current area of mining operations as a condition of approval. Seagrass distribution within estuaries is naturally influenced by light penetration, depth, salinity, nutrient status, bed stability, wave energy, estuary type, and the evolutionary stage of the estuary.

Surveys of the seagrass extents are undertaken in order to monitor impacts on the seagrass population. Delta Coal's *Seagrass Management Plan* outlines the methodology used to determine changes to composition and quantity of seagrass populations in Lake Macquarie.

A 26.5° line taken from the lake side of the mapped seagrass location projected to the Fassifern Seam has been defined as a protection barrier, and no secondary extraction is to take place within this barrier.

3.3.3 Benthic Communities

The basin is inhabited by a diverse number of marine organisms. Condition 2, Schedule 4 of SSD-5465 specifies minor environmental consequences on the Benthic communities, including minor changes to species composition and/or distribution as a condition of approval. Surveys of the lake bed are undertaken in order to monitor variations in the composition and density of benthos due to mining, environmental and/or other seasonal factors. Delta Coal's *Benthic Communities Management Plan* outlines the methodology used to determine changes to species diversity and abundance.

3.3.4 Surface Built Features

Mine workings beneath Morisset East peninsula are planned in the vicinity of the suburbs of Brightwaters, Mirrabooka and Sunshine.

Condition 9 within Schedule 4 of SSD-5465 also states that:

"The Applicant may carry out first workings within Subsidence Zones A and B as shown in Appendix 3, other than in accordance with an approved Extraction Plan, provided that the first workings are designed to remain stable and non-subsiding in the long-term and do not generate more than 20 mm of vertical subsidence at the surface, except insofar as they may be impacted by approved second workings."

A key objective of the mine design is to ensure vertical subsidence within Subsidence Zone A is limited to a negligible amount (considered less than 20mm). To ensure effectiveness of the mine design, monitoring of the land area is proposed via the installation and monitoring of fixed reference along a number of the major access roads (**Figure 5**) where practical to verify subsidence performance measures.



Figure 5 - Morisset East Peninsula

4 Subsidence Monitoring

4.1 Subsidence Monitoring Methods

4.1.1 Bathymetric Surveys

Bathymetric data from the NSW Office of Environment and Heritage (OEH) was obtained in draft format during 2012. Delta Coal was granted a license to use this OEH data for the purposes of monitoring changes in the bed of Lake Macquarie and acknowledges the OEH's data which has enabled the subsidence comparison to be undertaken based on this 2010 data and data subsequently obtained in 2012 by Delta Coal. OEH notes that the data was obtained via use of differential GPS and a 200 kHz echosounder, which is noted to provide general data accuracy of 0.1m.

Lake Macquarie has an average depth of about 8 meters, with its deepest point reaching approximately 11 meters[3].The lakebed features submerged vegetation, rocky outcrops, and remnants of old river channels. The thickness of unconsolidated sediment varies significantly throughout the lake, to fill the remnant river channels to produce the average depth of the lake.

Precise monitoring of the lakebed and minor subsidence are difficult due to the varying thickness of the unconsolidated sediments, and other naturally occurring features (i.e. vegetation, waves, currents and seiche waves[4,5]). Additionally, general commercially available multibeam bathymetric surveys has an accuracy of ± 100mm; therefore, when comparing bathymetric surveys, the accuracy is ±200mm.

[3] NSW Government, Department of Planning, Industry and Environment. (2021). Lake Macquarie Estuary Management Plan.
[4] Cox, D.R., C.A. Adamantidis, W.L. Peirson & A.F. Nielsen. (2001). Wind-Induced Currents and Dispersion in a Coastal Lake with Weak Tidal Forcing., Preprints 15th Aust. Conf. on Coastal & Ocean Eng., Gold Coast, IEAust.
[5] Nielsen, A.F. & J.W. Walker (2001). Field Data on the Re-Suspension of Freshly Deposited Silts under Wave Action, Preprints 15th Aust. Conf. on Coastal & Ocean Eng., Gold Coast, IEAust.



Figure 6 - Shoreline Subsidence Monitoring Locations, Summerland Point (Delta Coal Plan C4A0099_7)

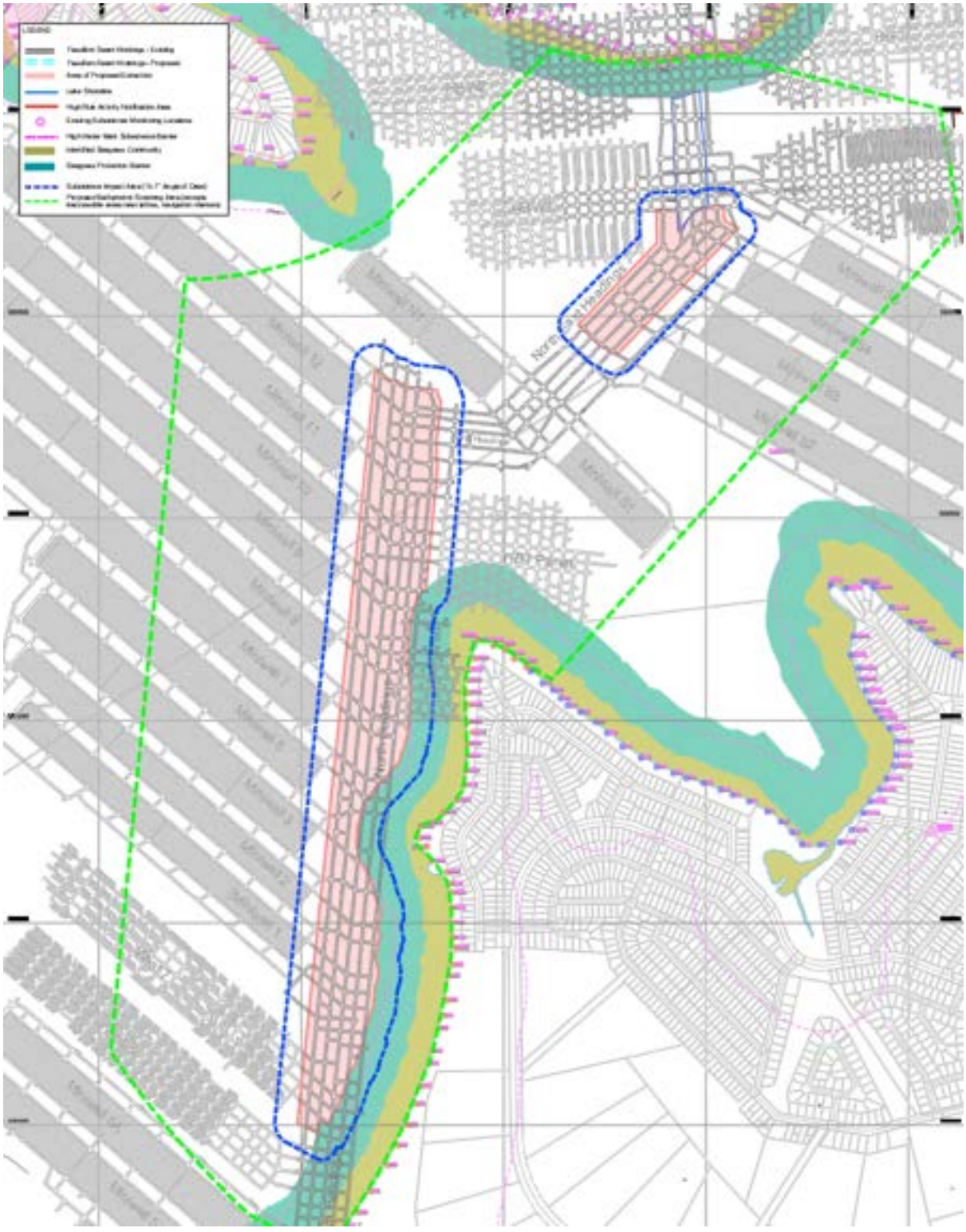


Figure 7 - Shoreline Subsidence Monitoring Locations, Summerland Point (Delta Coal Plan C4A0111_7)

Monitoring of the lakebed via bathymetric survey over the current secondary extraction areas will assist with the determination of approximate subsidence levels. This becomes more complex when the predicted subsidence is within (or close to) the accuracy of the bathymetric surveys.

Delta Coal commissioned Astute Surveying in 2012 to undertake a bathymetric survey annually over the areas of current and proposed workings. The bathymetric surveys will inform other surveys, specifically the benthic communities and seagrass surveys.

The surveys have shown that subsidence from the miniwall mining can be monitored with a useful level of accuracy and annual surveys over the extraction area will be continued to cover future mining areas and areas where mining has been completed.

4.1.2 Fixed Monitoring Surveys

Subsidence monitoring around Pt Wolstoncroft, Brightwaters peninsula, Summerland Point and Morrisette peninsula have been established due to previous mining operations

The foreshore monitoring points will be monitored as follows:

- The points are to be established for Miniwall S5 & NMA Pillars as per figure 8 and Northeast and North Headings as per Figure 7.
- X and Y locations will be measured using GPS equipment for plotting purposes (±0.050m)
- AHD RL (Z) component will be leveled using Automatic or Digital levelling equipment to an accuracy of 5mm/km.
- Surveys are to be conducted at intervals prescribed in **Table 3**, during mining operations and after completion of a panel.
- The results are uploaded to DRE's online subsidence web portal within 14 days of survey.



Figure 8 Existing Fixed Monitoring locations and Visual Inspection Locations Morisset peninsula

4.1.3 Remote LiDAR Monitoring Methods

Due to the nature of the shoreline in the vicinity of the mine subsidence monitoring areas, it may at times not be practical to install fixed monitoring marks due to access arrangements, environmental/cultural sensitivity and worker safety concerns. Airborne LiDAR (Light Ranging and

Detection) techniques may be used to monitor areas of the shoreline where land access may not be available. Calibration, or 'ground-truthed' locations will be established and monitored with the same techniques utilised for the fixed foreshore monitoring surveys.

The remote scanning methodology would be carried out by:

- Utilising a survey ground crew to ground truth designated control sites
- LiDAR and imagery flown
- Low level drone imagery collected of the steep slope / cliff face areas
- Filtering drone imagery data and merge with LiDAR information

There are currently no areas where LiDAR will be used, however Delta Coal could potentially use the monitoring technique. Results will be provided to the DRE if surveys have been completed for the purpose of subsidence monitoring.

4.1.4 Surface Visual Inspection Methods

As a part of the foreshore survey monitoring, observations will be made for visual impact or changes to public safety risk. A Subsidence Inspection Proforma will be completed with each survey. The proforma includes visual inspection of steep slopes, boulder or tree instability, ponding and other potential effects of mine subsidence.

Inspections are to be conducted at intervals prescribed in Table 3, during mining operations and after completion of a panel. Results of the Surface Visual Inspections will regularly be provided to the DRE.

4.1.5 Underground Geotechnical Inspection Methods

Regular underground geotechnical inspections will be carried out to inspect and monitor partially extracted areas to assess if there are any floor heave associated with pillar punching. These inspections will only be carried out in areas which are safely accessible. An Inspection Proforma will be developed and then completed after each inspection.

Inspections are to be conducted at intervals prescribed in Table 3, during mining operations and after completion of a panel.

4.2 Subsidence Monitoring Frequency Requirements

To validate model outcomes, we will establish the following monitoring frequencies. These measures will enable early detection of subsidence trends that exceed predicted impact levels. This approach allows for the timely application of containment, adaptive, and contingency measures to prevent impacts outside the approved areas, particularly on the foreshore.

The frequency of monitoring is summarised in Table 3. The evaluation of monitoring results will be made against the criteria outlined in the Subsidence Monitoring TARP.

4.3 Subsidence Monitoring Review

Chain Valley Colliery will undertake a review of available subsidence monitoring data against predictions and expected outcomes annually within its Annual Review as required by SSD-5465.

4.4 Consultation

The Subsidence Monitoring Plan is required to be prepared in consultation with DRE. DRE have been consulted during the preparation and approval process for SSD-5465 (Modification 4).

Roads and Maritime Services Project Officer (North Area) has previously been contacted during the development of the secondary Extraction Plan(s) and referred the matter to the RMS asset team, with monitoring program(s) developed in consultation with RMS representatives.

DPHI and NSW Resource Regulator – Subsidence Division has been consulted regarding the partial pillar extraction planned in the Northern Mining Area.

The Community Consultative Committee (CCC) for the mine are routinely updated on subsidence monitoring results and any change in impact or public safety concern.

Table 3 - Subsidence Monitoring Frequencies (S2-S5, NMA Pillar Extraction Panels and Northeast and North Heading Extraction)

	Areas	Pre-Extraction	During Extraction	Post Extraction
Bathymetric surveys	Area per 6 and 7	Baseline survey prior to commencement of extraction	End of panel survey for S5 Annual surveys over areas of pillar extraction	Annual for 3 years unless TARP triggered
Terrestrial based subsidence monitoring (foreshore)	Points as per Figure 8	Baseline survey prior to commencement of extraction	End of panel survey for S5 Quarterly surveys during primary and secondary extraction over areas undermined, unless TARP triggered	6 monthly surveys for the first year after secondary extraction Annual for 5 years unless TARP triggered
Terrestrial based subsidence monitoring (general)	Points as per Figure 8	Baseline survey prior to commencement of extraction	Quarterly surveys during primary extraction over areas undermined, unless TARP triggered	Annual for 5 years unless TARP triggered
Remote Sensing LiDAR	As required		As required	As required for a maximum of 3 years unless TARP triggered
Surface Visual Inspection	Points as per Figure 8, unless the areas are inaccessible.		Monthly inspections during primary and secondary extraction over areas undermined, unless TARP triggered	None

Underground Geotechnical Inspection	Partial pillar extraction panels, **only areas that remains safely accessible.**	Inspection prior to commencement of pillar extraction	Monthly inspections during secondary extraction panels.	6 monthly inspections for the first year after secondary extraction Annual for 3 years unless TARP triggered

5 Roles and Responsibilities

Roles, responsibilities specific to completing the requirements of this Subsidence Monitoring Program are identified in **Table 4**.

Table 4: Subsidence Monitoring Program Roles and Responsibilities

Role	Responsibilities
Mining Engineering Manager	• Ensure that adequate financial and personnel resources are made available for the implementation of the Subsidence Monitoring Program
Technical Services Manager	• Co-ordinate visual and geotechnical inspection along foreshore and in relevant mining areas and underground data collection. • Review subsidence monitoring results against Subsidence Management TARP triggers

Mine Surveyor	• Co-ordinate subsidence monitoring, through the use of bathymetric surveys, conventional surveys along foreshore and in relevant mining areas and underground data collection.
	• Review subsidence monitoring results against Subsidence Management TARP triggers
	• Inform relevant stakeholders as to the subsidence monitoring results
	• Review, and if necessary revise this document:
	  ○ In the event of any exceedance in impact thresholds
	  ○ Following any modification to the development consent

Environment Compliance & Approvals Coordinator	• Develop management actions in consultation with regulatory agencies as/if required from the monitoring results. • Respond to any potential or actual non-compliance and report these as required to regulatory bodies and other stakeholders. • Notify the relevant Government Agencies and other affected parties of any exceedances of the performance measures • Coordinate the meeting of the Subsidence Review Committee • Ensure complaint handling and response is undertaken, including determination of sources and potential remedial action to avoid recurrence.

Appendix 14 Graphical Plans

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Proposed Extraction
- Colliery Holding
- Lake Shoreline
- High Risk Activity Notification Area
- Previous High Risk Activity Notification Area

E.364500 E.365000 E.365500 E.366000 E.366500

N.6334500 N.6334000 N.6333500 N.6333000 N.6332500 N.6332000

HBW2 HBW1 HBE2 HBE1

Belt Road MAIN OVERCAST LINE

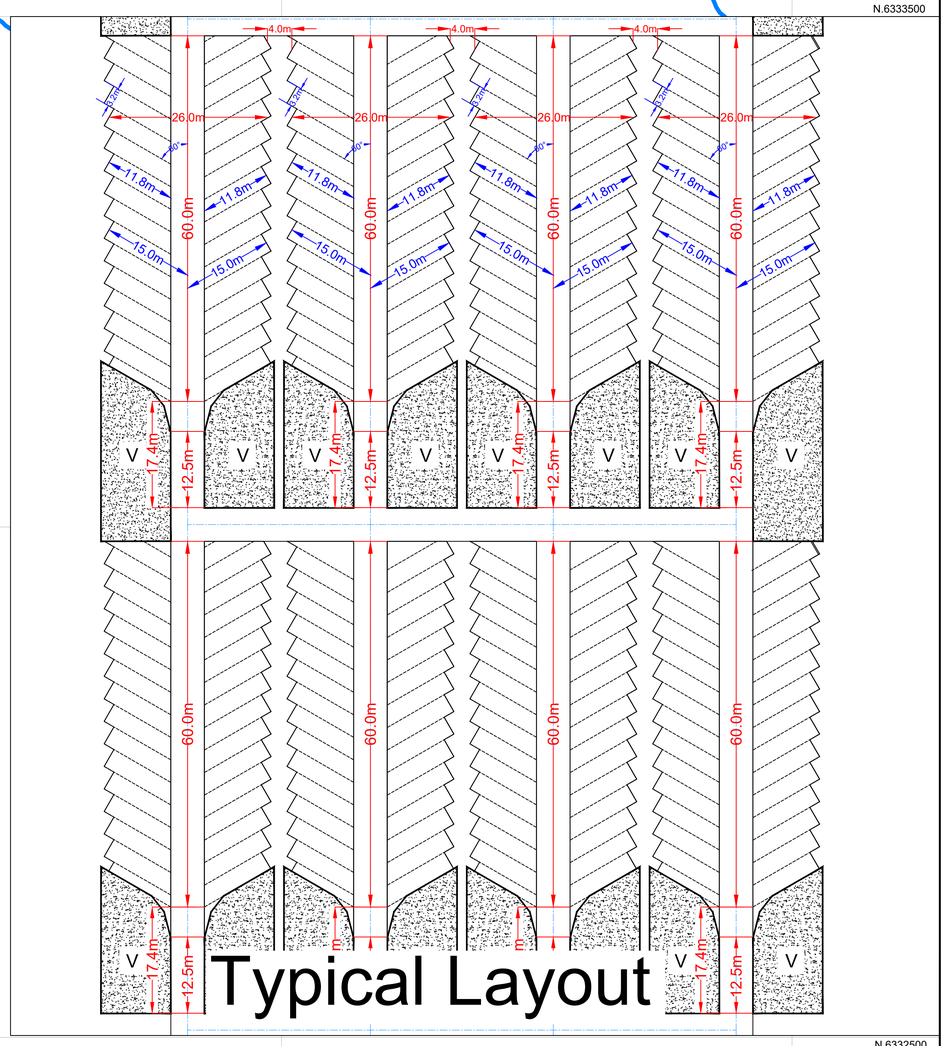
Miniwall N1 Miniwall 12 Miniwall 11 Miniwall 10 Miniwall 9 Miniwall 8 Miniwall 7 Miniwall 6 Miniwall 3 Miniwall 2 Miniwall 1 Miniwall 5A Miniwall 5 Miniwall 4

Miniwall S5 Miniwall S4 Miniwall S3 Miniwall S2 Miniwall S1

North East Headings Drift Headings HB1 Panel HB2 Panel North Headings

West 7 West 6

EAST MAINS



MINING HEIGHTS - 1ST WORKINGS 3.2m
2ND WORKINGS 3.5m

TYPICAL ROADWAY WIDTH 5.5m

MANAGER OF MINING ENGINEERING
I certify that the information shown on this plan is a true indication of the proposed development.

SIGNED ***DATE***

REGISTERED MINE SURVEYOR
I certify that the survey information shown in this plan is correctly represented, in accordance with the relevant legislative requirements.

SIGNED ***DATE***

DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 1 - EXISTING & PROPOSED WORKINGS

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_1
CHECKED:	P Van Rooyen	REV NO:	0
SIGNED:	J Cornford	SIZE:	A0

Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Secondary Extraction
- Mine Subsidence District
- High Water Mark Subsidence Barrier
- Identified Seagrass Community
- Seagrass Protection Barrier
- Surface Contours
- Assessed limit of Subsidence Impact
- High Risk Activity Notification Area

WEST LAKE MINE SUBSIDENCE DISTRICT

SWANSEA NORTH ENTRANCE MINE SUBSIDENCE DISTRICT

HBW2 HBW1 HBE2 HBE1

Buoy

Fixed Navigation Marker

Shallow Water Buoy

HB1 Panel

HB2 Panel

North East Headings

Drift Headings

North Headings

Miniwall N1 Miniwall 12 Miniwall 11 Miniwall 10 Miniwall 9 Miniwall 8 Miniwall 7 Miniwall 6 Miniwall 3 Miniwall 2 Miniwall 1 Miniwall 5A Miniwall 5 Miniwall 4

Miniwall S5 Miniwall S4 Miniwall S3 Miniwall S2 Miniwall S1

West 7 West 6

Fassifern seam HWM Subsidence Barrier

EAST MAINS

MAIN OVERCAST LINE

Belt Road

ZONE CONTROL SUBSIDENCE

E.364500 E.365000 E.365500 E.366000

N.6334000 N.6333500 N.6333000 N.6332500 N.6332000

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DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 2 - SURFACE FEATURES

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_2
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SIGNED:	J Cornford	SIZE:	A0

Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Proposed Extraction
- Fassifern Seam Thickness
- Fassifern Seam Depth of Cover to Lake Bed
- High Risk Activity Notification Area
- Lake Shoreline
- Mapped / Projected Faults
- Exploration Borehole

HBE2
HBW2
HBW1
HBE1
Miniwall N1
Miniwall 12
Miniwall 11
Miniwall 10
Miniwall 9
Miniwall 8
Miniwall 7
Miniwall 6
Miniwall 3
Miniwall 2
Miniwall 1
Miniwall 5A
Miniwall 5
Miniwall 4
Miniwall S5
Miniwall S4
Miniwall S3
Miniwall S2
Miniwall S1
North East Headings
Drift Headings
HB1 Panel
HB2 Panel
North Headings
West 7
West 6
EAST MAINS
MAIN OVERCAST LINE
Belt Road
JCV3
JMO3
CCV16
CCV16A
CCV18
JCV15A
JCV15
JCV15B
JC15A
AMO2
JCV5
160
170
150
200
190
180
210
220
230
240
N.6334000
N.6333500
N.6333000
N.6332500
N.6332000
E.364500
E.365000
E.365500
E.366000
E.366500

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DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 3 - GEOLOGICAL FEATURES

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_3
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Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Proposed Extraction
- High Risk Activity Notification Area
- Wallarah Seam Workings - Existing
- Great Northern Seam Workings - Existing
- Wallarah Seam Thickness
- Wallarah Seam Depth of Cover to Lake Bed
- Great Northern Seam Thickness
- Great Northern Seam Depth of Cover to Lake Bed
- Lake Shoreline
- Exploration Borehole

HBW2
HBW1
HBE2
HBE1
MAIN OVERCAST LINE
Belt Road
North East Headings
Miniwall N1
Miniwall 12
Miniwall 11
Miniwall 10
Miniwall 9
Miniwall 8
Miniwall 7
Miniwall 6
Miniwall 3
Miniwall 2
Miniwall 1
Miniwall 5A
Miniwall 5
Miniwall 4
Miniwall S5
Miniwall S4
Miniwall S3
Miniwall S2
Miniwall S1
Drift Headings
HB1 Panel
HB2 Panel
North Headings
West 7
West 6
EAST MAINS
JCV3
JMO3
CCV16
CCV16A
CCV18
JCV15
JCV15A
JCV15B
JC15A
AMO2
JCV5
2.1
2.3
2.5
2.7
2.9
N.6334500
N.6334000
N.6333500
N.6333000
N.6332500
N.6332000
E.364500
E.365000
E.365500
E.366000
E.366500

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HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 4 - OVERLYING WORKINGS

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_4
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SIGNED:	J Cornford	SIZE:	A0

Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Proposed Extraction
- Lake Shoreline
- High Risk Activity Notification Area
- Cadastral Lot / DP Boundaries
- Mining Tenement Boundaries
- Privately owned land
- Crown / Public lands
- Development Consent Boundary

HBW2
HBE2
HBW1
HBE1
MAIN OVERCAST LINE
Belt Road
North East Headings
Miniwall N1
Miniwall S5
Miniwall S4
Miniwall S3
Miniwall S2
Miniwall S1
Miniwall 12
Miniwall 11
Miniwall 10
Miniwall 9
Miniwall 8
Miniwall 7
Miniwall 6
Miniwall 3
Miniwall 2
Miniwall 1
Miniwall 5A
Miniwall 5
Miniwall 4
Drift Headings
HB1 Panel
HB2 Panel
North Headings
West 7
West 6
EAST MAINS
ML1784
ML1785
ML1051
CCL707
E.364500
E.365000
E.365500
E.366000
N.6334000
N.6333500
N.6333000
N.6332500
N.6332000

Lease No	Area (total)	Particulars
ML1051	1301ha	Expires 13/10/2043
ML1785	1301ha	Expires 13/10/2043

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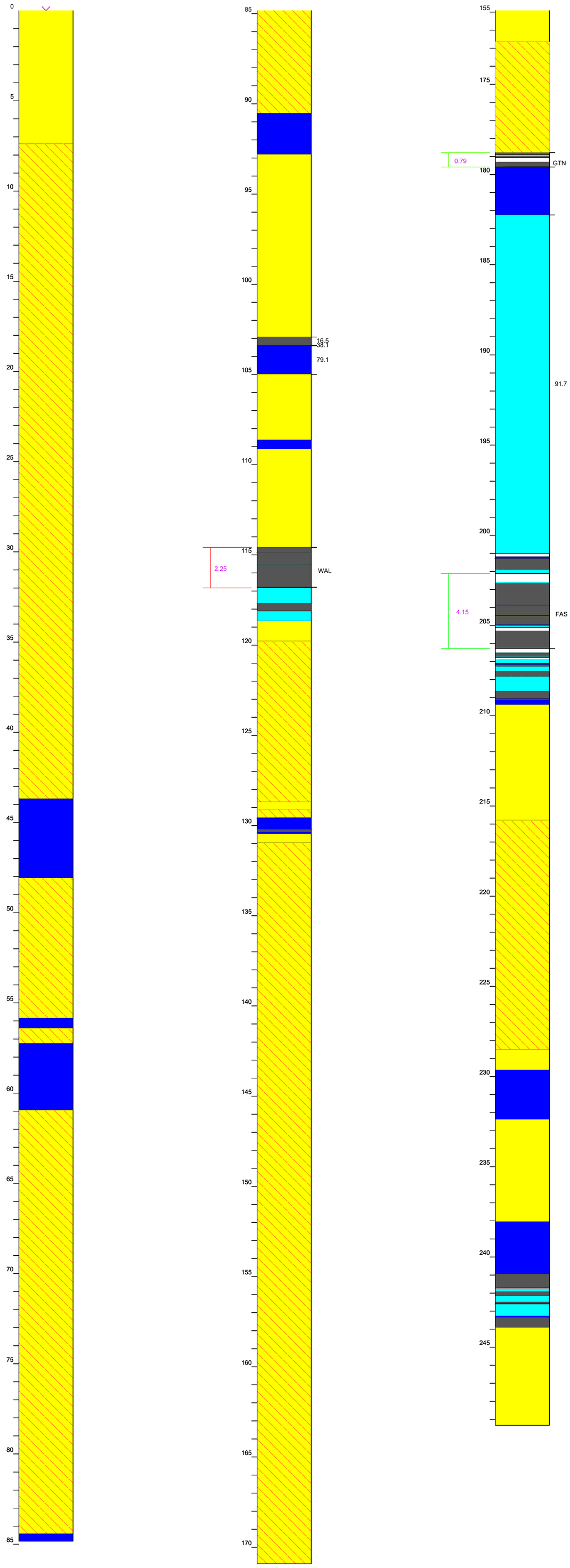
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NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION

PLAN 5 - TITLES

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_5
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SIGNED:	J Cornford	SIZE:	A0

Delta coal

JCV 03



Legend

Lithology Reference

- SOIL
- GRAVEL
- SANDSTONE
- Pebble Conglomerate
- CLAYSTONE
- NO RECOVERY
- CONGLOMERATE
- SIDERITE
- SILTSTONE
- AIR
- COAL Stony
- WATER
- COAL
- ALLUVIUM
- MUDSTONE
- SILT
- CORE-LOSS / NOT RECOVERED
- COAL Heat altered
- SHALE
- Rock Mass Boundary
- COAL Shaly
- CLAY
- CARB. SHALE
- COAL Smutty
- CALCITE
- NON-CORED
- CHERT
- COAL Weathered
- IGNEOUS
- COAL Undifferentiated
- COAL Cindered
- COAL Shaly
- SAND
- Siltshale

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DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION

PLAN 6 - GEOLOGICAL INFORMATION

SCALE:	NTS	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_6
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APPROVED:	J Cornford	SIZE:	A1

Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Fassifern Seam Workings - Proposed
- Area of Proposed Extraction
- Lake Shoreline
- High Risk Activity Notification Area
- Cadastral Lot / DP Boundaries
- Existing Subsidence Monitoring Locations
- High Water Mark Subsidence Barrier
- Identified Seagrass Community
- Seagrass Protection Barrier
- Subsidence Impact Area (15.7° Angle of Draw)
- Proposed Bathymetric Scanning Area (excepts inaccessible areas near jetties, navigation markers)

HBW2
HBW1
HBE2
HBE1
North East Headings
Drift Headings
HB1 Panel
HB2 Panel
North Headings
South Headings
EAST MAINS
Miniwall N1
Miniwall 12
Miniwall 11
Miniwall 10
Miniwall 9
Miniwall 8
Miniwall 7
Miniwall 6
Miniwall 3
Miniwall 2
Miniwall 1
Miniwall 5A
Miniwall 5
Miniwall 4
Miniwall S1
Miniwall S2
Miniwall S3
Miniwall S4
Miniwall S5
West 7
West 6
Fassifern seam
HWM Subsidence Barrier
21400
E.364500
E.365000
E.365500
E.366000
E.366500
N.6334000
N.6333500
N.6333000
N.6332500
N.6332000

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HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 7 - SUBSIDENCE MONITORING PLAN

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_7
CHECKED:	P Van Rooyen	REV NO:	0
SIGNED:	J Cornford	SIZE:	A0

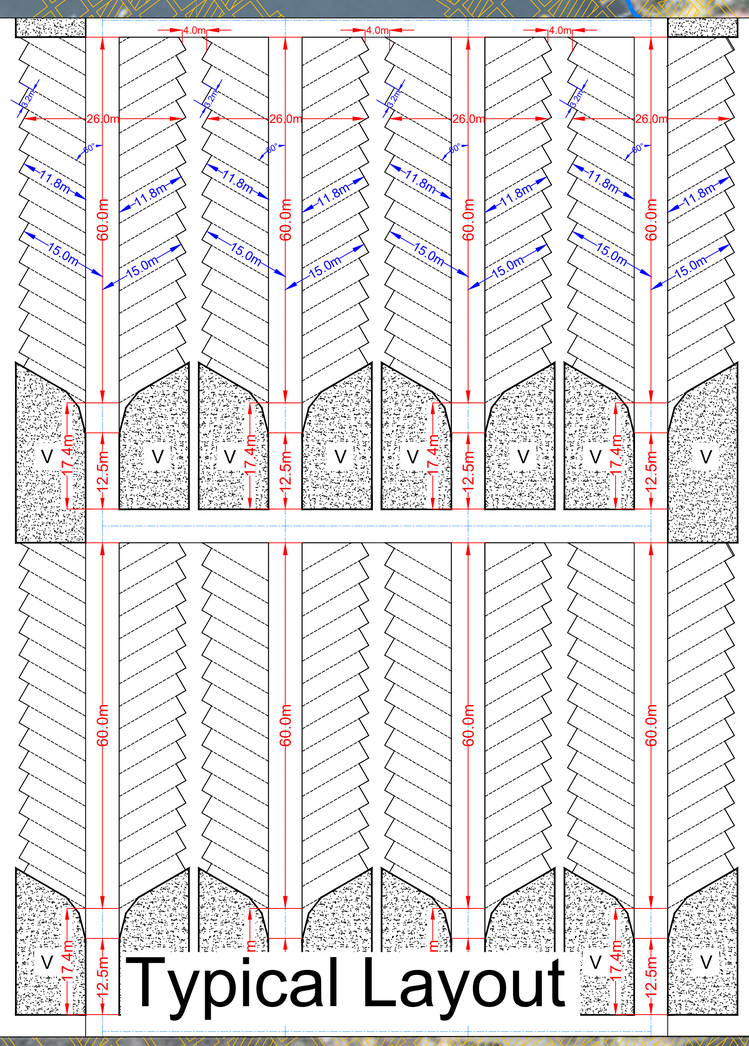
Delta coal

LEGEND

- Fassifern Seam Workings - Existing
- Area of Proposed Extraction
- High Risk Activity Notification Area
- Wallarah Seam Workings - Existing
- Great Northern Seam Workings - Existing

HBW2
HBW1
HBE2
HBE1
HB1 Panel
HB2 Panel
North East Headings
Drift Headings
North Headings
Miniwall N1
Miniwall 12
Miniwall 11
Miniwall 10
Miniwall 9
Miniwall 8
Miniwall 7
Miniwall 6
Miniwall 3
Miniwall 2
Miniwall 1
Miniwall 5A
Miniwall 5
Miniwall 4
Miniwall S5
Miniwall S4
Miniwall S3
Miniwall S2
Miniwall S1
West 7
West 6
EAST MAINS
MAIN OVERCAST LINE
Belt Road
E.364500
E.365000
E.365500
E.366000
E.366500
N.6334500
N.6334000
N.6333500
N.6333000
N.6332500
N.6332000

Typical Layout



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DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 8 - EXTRACTION AREA PLAN

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_8
CHECKED:	P Van Rooyen	REV NO:	0
SIGNED:	J Cornford	SIZE:	A0

Delta coal

E.364500 E.365000 E.365500 E.366000 E.366500

N.6334500 N.6334000 N.6333500 N.6333000 N.6332500 N.6332000

HBW2 HBE2 HBW1 HBE1

Belt Road

MAIN OVERCAST LINE

North East Headings

A

Miniwall N1 Miniwall 12 Miniwall 11 Miniwall 10 Miniwall 9 Miniwall 8 Miniwall 7 Miniwall 6 Miniwall 3 Miniwall 2 Miniwall 1 Miniwall 5A Miniwall 5 Miniwall 4

Miniwall S5 Miniwall S4 Miniwall S3 Miniwall S2 Miniwall S1

Drift Headings

HB1 Panel

HB2 Panel

North Headings

West 7 West 6

EAST MAINS

V 1 2 3 4 8 7 6 5

Method A

Note:
Mining shall only take place generally in accordance with these method and sequence plans.

MINING HEIGHTS - 1ST WORKINGS 3.2m
2ND WORKINGS 3.5m

TYPICAL ROADWAY WIDTH 5.5m

MANAGER OF MINING ENGINEERING
I certify that the information shown on this plan is a true indication of the proposed development.

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REGISTERED MINE SURVEYOR
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SIGNED *DATE*

DELTA COAL - CHAIN VALLEY COLLIERY

HIGH RISK ACTIVITY NOTIFICATION - ML1051 & ML1785
NORTH & NORTHEAST HDGS - SECONDARY EXTRACTION
PLAN 9 - MINING SEQUENCE

SCALE:	1:3000 @ A0	DATE:	21 November 2025
DRAWN:	G Lord	DRG NO:	C4A0111_9
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Delta coal

Appendix 15 Subsidence Prediction Report

Appendix 15.1 – MWS5 and NPA Subsidence prediction Report

LAKE COAL
CHAIN VALLEY COLLIERY

Miniwall S5 and the Adjacent Herringbone Panels of the Northern Mining Area (NMA): Geotechnical Environment, Subsidence Estimates and Impacts

DECEMBER 2020

Report No: CHV-024-Rev2

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

REPORT TO : Mr. D. McLean
Mine Manager
Chain Valley Colliery

REPORT ON : Miniwall S5 and the Adjacent Herringbone Panels of the Northern Mining Area (NMA): Geotechnical Environment, Subsidence Estimates and Impacts

REPORT NO : CHV-024-Rev2

REFERENCE : Purchase Order D115918

Rev	Date	Prepared	Status	Signature
A	09.10.2020	D. Hill	Draft	
0	08.12.2020	D. Hill	Final	
1	09.12.2020	D. Hill	Final, amended	
2	10.12.2020	D. Hill	Final, amended	

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Appendix A: Glossary of Terms

1.0 INTRODUCTION

This report addresses key geotechnical aspects of the design of the S5 miniwall panel (MW S5) and the adjacent "herringbone" bord and pillar panels to the north and north-west, in the Fassifern Seam workings at Chain Valley Colliery ("CVC"), including estimates of subsidence effects and impacts. The location of the workings, within the "Northern Mining Area" (NMA) is shown in **Figure 1**. Depth ranges from approximately 140m to 180m in the area of interest, generally increasing to the SE and SW, see **Figure 1**. Total seam thickness increases from 4.8m in the SE to 5.2m in the NW. The nominal height of extraction (miniwall and herringbone) will be 3.5m, leaving around 1.5m of top coal during extraction.

The area of interest covers a range of surface conditions and associated subsidence constraints, from lake floor with a currently approved subsidence limit of 780mm, to highly sensitive foreshore areas, within which negligible subsidence (≤ 20mm) is mandated.

This report builds on the following, earlier **Strata²** reports:

i) CHV-005-Rev0: **Geotechnical Aspects of Herringbone Design**.

ii) CHV-015-Rev0: **Geotechnical Aspects of Secondary Extraction of Herringbone Pillar Panels**.

iii) CHV-019-Rev0: **S5 Panel: Geotechnical Environment, Subsidence Estimates and Impacts**.

This report updates the previous state of knowledge where appropriate (for example, by reviewing the latest subsidence monitoring data following the extraction of MW S3) and brings the relevant information together into one document that addresses the entire area of interest, such that reference to the earlier reports is unnecessary.

Key aspects of the MW S5 layout are as follows, see **Figures 1** and **2**:

i) As per MWs S2-4, S5 Panel is orientated at 119°, rather than the 134° of earlier panels in the MW7-12 area. This orientation is more favourable with respect to the dominant 131° structural direction.

ii) The panel void width is 97m, consistent with recent CVC practice.

iii) Twin heading gate roads with typically 100m long (centres) pillars.

iv) 5.4m wide by 3.2m high roadways.

v) The maingate (MG) and tailgate (TG) S5 chain pillars are 32.6m and 40m wide (solid) respectively, to limit (a) subsidence over MW S2 to S5 Panels and (b) abutment load transfer to the herringbone workings to the north.

Key aspects of the herringbone layout are as follows, see **Figures 1** and **3**:

i) 30m long pillars (centres) for the sub-mains, as this maximises the free cut length at ~14m.

ii) Given that the sub-mains design is fixed on a length of 30m centres, the performance of the system in terms of stability and subsidence is governed by:

   a) Barrier pillar width (typically 40m to 70m).
   b) Sub-Mains pillar width (27m centres).
   c) Mining height, on development and extraction.
   d) Extraction width (span).
   e) Percentage recovery within the extraction area.

iii) Mining height will vary between 3.0m on development (the practicable lower limit for the equipment) and 3.5m on extraction (assuming that some top coal is taken in the lifts).

iv) The extraction span has a controlling influence on overburden caving and the magnitude of the abutment loads transferred to the sub-mains and barrier pillars. The proposed span averages 85m.

v) Percentage recovery within the extraction area is a function of both the herringbone pillar design and the secondary extraction process. Percentage extraction would be expected to range up to a maximum of 85%.

vi) There are no interaction issues between the planned herringbone workings and the previous mining operations of either CVC or Myuna Colliery to the north, see **Figure 1**. Specifically:

   a) The barrier between the proposed CVC herringbone workings and the Myuna Colliery Fassifern Seam workings is ≥ 51m, such that no stress transfer would occur at the depths involved.

   b) There are Myuna Colliery first workings in the overlying Wallarah Seam, but these are ≥ 102m beyond the northern limit of the planned CVC herringbone workings and >1km from MW S5.

   c) There are also some Myuna Colliery workings in the overlying GN Seam, but these are ≥ 847m beyond the northern limit of the planned CVC herringbone workings.

   d) There are CVC workings in the overlying Wallarah Seam in the vicinity of HB1 herringbone panel, but potential secondary extraction of HB1 Panel is excluded from the scope of this study.

The issues addressed herein are as follows:

A. The role of the geological and geotechnical environment.
B. Heights of connective fracturing.
C. Pillar stability on development and subsequent to extraction.
D. Subsidence estimates.
E. Subsidence impacts.

2.0 KEY ASPECTS OF THE GEOLOGICAL / GEOTECHNICAL ENVIRONMENT

The overburden consists of Triassic and Permian strata, comprising massive conglomerate beds (the Munmorah, Karignan, Teralba and Karingal Members), sandstone, carbonaceous shale, coal and claystone (**DGS, 2018**). From a geotechnical / subsidence perspective, the units of particular interest are the massive conglomerate beds in the overburden and the claystone in the floor of the Fassifern Seam, as both will tend to influence subsidence development. The closest boreholes that extend to the Fassifern Seam to the area of interest, **Figure 1**, are:

- JCV 13 in the south-east, (**Figure 4a**),
- JCV 3 in the south (**Figure 4b**),
- EWN 7 in the north-west (**Figure 4c**),
- EWN 2 in the east (**Figure 4d**) and
- EWO 2 in the north (**Figure 4e**).

The significance of the major conglomerates is that voussoir beam analysis suggests they are generally capable of spanning extraction void widths of up to 100m at thicknesses of >15m. This spanning ability begins to break down if the pillars yield and the effective span increases over multiple panels, resulting in increased subsidence.

Important features of the area of interest are:

- the Karingal Conglomerate, beneath the Great Northern (GN) Seam, thins from 39m in the NW to 6m in the SE, see **Figure 5**,
- the Teralba Conglomerate, immediately above the GN Seam, thins from 30m in the SE to 12m in the NW, see **Figure 6**,
- the interburden from the Fassifern Seam extraction horizon to the GN Seam floor thins from 62m in the NW to 44m in the south, see **Figure 7** and
- the other major unit in the overburden is the Munmorah Conglomerate, which is typically around 50m thick and 100m above the Fassifern Seam.

The Fassifern Seam floor includes interbedded coal / carbonaceous shale beds, plus moisture sensitive claystone. The individual claystone beds are 50mm to 300mm thick and the cumulative thickness of claystone in the first 2m of floor in the vicinity of MW S5 and the NMA Herringbone Panels is 0.9m to 1.2m, slightly thinner than that encountered in the MW7-12 area. The claystone typically has a strength of <5MPa and is considered weak.

The significance of the weak claystone floor is that:

a) It can be associated with pillar bearing failure and increased subsidence, if chain pillar stresses are high (critical average stresses are in the 15 to 20MPa range, depending on the pillar geometry).

b) Uncertainties with regard to the long-term mechanical properties and behaviour of weak claystone has favoured the utilisation of empirical design methods based on equivalent mining environments.

3.0 PILLAR DESIGN

From a pillar design perspective, a key issue is the reducing thickness of weak claystone layers within 2m of the working floor to the north and north-west. 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 has been categorised as “marginally weak” and a conservative pillar design approach has been applied.

In the north-west of the current area of interest, the total thickness of weak rock almost certainly reduces below 1m, suggesting that a more conventional (less conservative) design approach could be adopted. However, the data is currently limited and the approach adopted herein has therefore been to continue with the recent approach of linking the empirically derived pillar strength to a Lake Macquarie database of pillar performance in weak floor conditions.

3.1 Pillar Strength and Design Criteria

The empirical coal pillar design formulae applied herein were developed at the University of New South Wales (UNSW) (**Salamon *et al*, 1996**). These UNSW formulae are founded on extensively researched and broadly-based databases of mining experience. These formulae represent the culmination to-date of work commenced 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 (**Hill, 2010).**

The range of parameters in the UNSW 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:

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

where:

w_m = minimum pillar width (m)
h = roadway height (m)

Factor of Safety (FoS) can be related to the nominal probability of failure of a panel. A probability of stability of 99.9% is attained at a FoS of 1.63, see **Figure 8**, 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, risk management suggests that the probability of failure for long-term workings under 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 failure probability 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 underpinning the design methodology; currently the average is around 60 years (i.e. of the order of 120 years of 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 instability traditionally associated with weak floor, for example, can very 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.

For subsidence estimation purposes, the design approach applied herein is calibrated to a database of 71 Lake Macquarie "weak floor" pillar case studies. These case studies encompass the Great Northern, Wallarah and Fassifern Seams, covering four decades of experience. This database incorporates the recent CVC miniwall subsidence experiences.

Figure 9a/b illustrates several key relationships within the Lake Macquarie database. In **Figure 9a**:

i) The 71 Lake Macquarie weak floor cases have initially been divided into nominally stable and failed on the basis of subsidence outcomes. 46 cases associated with ≤ 200mm of subsidence are classed as stable (i.e. strata deformation largely due to elastic system compression), whereas 25 cases that resulted in >200mm of subsidence are classed as failed (i.e. higher deformation, more typical of an overloaded system).

ii) The Lake Macquarie "failed" cases have Factors of Safety ranging from 0.55 to 2.66 and the "stable" cases have Factors of Safety ranging from 1.45 to 25.0.

iii) The failed cases involving high width to height (w/h) ratio pillars have high pillar stresses (e.g. miniwall chain pillars).
iv) The overlap between the failed and stable cases is largely a function of natural variability in the geotechnical properties of the strata (i.e. some failures are associated with particularly weak rock, whilst some of the stable cases are associated with relatively stronger strata).

In **Figure 9b**, cases involving average pillar stresses of >15MPa have been excluded. The failed case with the highest FoS of 2.66 involved 220mm of subsidence (i.e. marginal in terms of the 200mm failed / stable criterion). The associated data point is for CVC MG4 (Fassifern Seam).

In **Figure 9c**, cases involving average pillar stresses of >15MPa have again been excluded and the data is presented in FoS versus subsidence form. The trendline for the failed cases crosses the CVC 780mm extraction approval limit at a Factor of Safety of around 1.7.

Figures 10a/b reproduce the database in histogram form. **Figure 10a** includes all Lake Macquarie data and, most importantly, confirms that that the approved subsidence limit of 780mm can be met at a Factor of Safety of ≥ 2.11, irrespective of pillar stress.

Figure 10b excludes those cases involving average pillar stresses of >15MPa and indicates that a lower FoS range can meet the design criteria under controlled circumstances. At a Factor of Safety of ≥ 1.8, but <2.2, subsidence averages 202mm, with a maximum value of 700mm, the latter being unacceptably close to the approval limit. However, the maximum value involves a chain pillar with an average pillar stress of 14.1MPa. If this value is excluded, the average reduces to 102mm, with a maximum value of 200mm.

Having reviewed the interrelationships within the database, the design matrix summarised in **Table 1** is recommended for:

- miniwall chain pillars and
- the barriers and sub-mains pillars of the herringbone pillar layout,

in secondary extraction situations requiring limited and predictable subsidence (i.e. <500mm), related largely to elastic system compression (noting that the detailed subsidence analysis is summarised in **Section 5.0**).

Table 1: Pillar Design Matrix for Subsidence Controlled to <0.5m

FoS Range	Pillar Stress (MPa)
≥ 1.8, <1.9	≤ 13
≥ 1.9, <2.0	≤ 14
≥ 2.0, <2.1	≤ 15
≥ 2.11	Practically unlimited

Furthermore, for the first workings in areas requiring negligible subsidence (i.e. ≤ 20mm), the following criteria are recommended:

- **average final pillar stresses of <12MPa and**
- **Factors of Safety of ≥ 2.3.**

3.2 Pillar Loading

The key aspects of the pillar loading environment are as follows:

i) On development, tributary area theory provides a reasonable, often conservative estimate of pillar loading (**Salamon and Oravecz, 1976**).

ii) On extraction, caving is likely to be capped at the base of the Teralba Conglomerate (26-30m thick), some 40m to 50m above the extraction horizon (immediately above the Great Northern Seam. The average goaf stress is therefore lower than normal, at 1-2MPa. Conversely, pillar abutment loading is higher than normal.

iii) Final pillar loading for the extraction panels can therefore be conservatively estimated by ignoring caving above the Teralba Conglomerate, such that the effective abutment angle is ~36° for the 97m void width of MW S5 and 33° for the 85m void width of the NMA Herringbone Panels.

iv) In the case of Maingate S5, there may be minor load transfer to the herringbone panels to the north. This component can be estimated using the Stress Reduction Factor, R (**Peng and Chiang, 1984, Mark, 1990**) and has also been modelled.

v) There is also load sharing between the sub-mains and final “dog kennel” pillars of the herringbone panels, noting that these have solid widths of 21.5m and 21.1m respectively (the latter being the average of 17.6m and 24.7m for the dog kennel pillars), see **Figure 11**. Again, the apportionment of the single abutment load between the pillars is estimated using the ‘R’ Factor.

3.3 Pillar Design Outcomes

A uniform roadway width of 5.4m is assumed for design purposes.

3.3.1 MW S5

The design outcomes for the MW S5 pillars are summarised in **Table 2**.

Table 2: Design Outcomes for the Chain Pillars of MW S5 Panel

Location	Loading Condition	Depth (m)	Pillar						Pillar FoS (Salamon)	R Value
			Height (m)	Width (m)	Length (m)	w/h Ratio	Stress (MPa)	Strength (MPa)		
TG S5 (I/B)	Double Abutment	178	3.2	40.0	94.6	12.5	14.9	45.9	3.1	N/A
TG S5 (O/B)		158					12.9		3.6	
MG S5 (I/B)	Single Abutment	177		32.6		10.2	10.0	33.6	3.4	0.91
MG S5 (O/B)		153					8.6		3.9	0.94
MG S5 (I/B)	Double Abutment	177					15.4		2.2	N/A
MG S5 (O/B)		153					12.9		2.6	

The following comments are made regarding these results:

i) The chain pillars are all long-term stable in their final condition, with FoS values of ≥ 2.2.

ii) Stress transfer from the MG S5 chain pillar to the northern area, including the herringbone workings, would be negligible (i.e., the R value is >0.9).

iii) Under single abutment loading (i.e., prior to the herringbone workings), the MG S5 chain pillar FoS is ≥ 3.4, which is indicative of negligible subsidence.

iv) Under (localised) double abutment loading due to subsequent herringbone extraction to the north, the MG S5 chain pillars would remain long-term stable (i.e., FoS values of ≥ 2.2, with <0.5m of associated subsidence).

3.3.2 NMA Herringbone Panels

A uniform roadway and stub width of 5.5m is assumed for design purposes.

3.3.2.1 First Workings – Run-out Pillars

The design outcomes for the run-out pillars are summarised in **Table 3**.

Table 3: Design Outcomes for the Run-out Herringbone Pillars

Depth (m)	Pillar						Stub		Pillar FoS (Salamon)
	Height (m)	Width (m)	Length (m)	w/h Ratio	Stress	Strength (MPa)	Interval (m)	Length (m)	
≤ 150	3.1	16.5	24.5	5.3	6.1	14.8	19.1	14.1	2.4
160		17.0		5.5	6.5	15.1	19.6		2.3
170		18.0		5.8	6.8	15.6	20.8		2.3
180		19.5		6.3	7.1	16.4	22.5		2.3

All of the run-out pillars would be consistent with ≤ 20mm of subsidence in a "first workings" scenario, with no reliance on stress transfer to any of the larger sub-mains or barrier pillars.

3.3.2.2 Secondary Extraction

The design outcomes for the three-heading, sub-mains pillars at depths of cover of between 140m and 180m are summarised in **Table 4**. A mining height of 3.1m is assumed, implying no secondary bottom coaling of the sub-mains pillars.

Table 4: Herringbone Sub-Mains Pillar Design Outcomes

Loading Condition	Extraction Width (centres, m)	Depth (m)	Pillar						Pillar Fos
			Height (m)	Width (m)	Length (m)	w/h Ratio	Stress (MPa)	Strength (MPa)	
First Workings	N/A	140	3.1	21.5	24.5	6.9	5.4	17.5	3.2
		160					6.2		2.8
		180					6.9		2.5
Post-Extraction (Single Abutment Loading)	80	140					6.5		2.7
		160					7.7		2.3
		180					8.9		2.0

The following comments are made regarding these results:

i) First workings Factors of Safety are very high, at ≥ 2.5.

ii) Post-extraction pillar stresses are moderate (<9MPa), consistent with the design criteria.

iii) Post-extraction, Factors of Safety remain high at ≥ 2.0, also as per the design criteria.

iv) Accordingly, <0.5m of subsidence would be expected, across the expected depth range of 140m to 180m, following extraction.

With regard to the barriers, the key assumptions are as follows:

i) Final pillar load equals the initial tributary area load, plus the double abutment load, see **Figure 11**.

ii) The mining height is increased to 3.5m, due to potential removal of top coal within the extraction area.

iii) The geometry is irregular, see **Figure 12**, and the average or "effective" width has been calculated.

iv) Previous analyses indicated that an effective width of 35m would suffice. However, reference to the mine plan, **Figure 1**, indicates that actual effective widths are >40m and typically >50m. Therefore, further analyses have been performed with regard to both the theoretical minimum (35m) and the representative minimum (40m) and the results are summarised in **Tables 5a** and **5b** respectively.

Table 5a: Theoretical Minimum (35m) Barrier Design Outcomes

Loading Condition	Extraction Width (centres, m)	Depth (m)	Pillar					Pillar FoS
			Height (m)	Width (solid, m)	w/h Ratio	Stress (MPa)	Strength (MPa)	
First Workings	N/A	140	3.5	35.0	10.0	4.3	31.4	7.3
		160				4.9		6.4
		180				5.5		5.7
Post-Extraction (Double Abutment Loading)	80	140				10.9		2.9
		160				12.7		2.5
		180				14.5		2.2

Table 5b: Representative Minimum (40m) Barrier Design Outcomes

Loading Condition	Extraction Width (centres, m)	Depth (m)	Pillar					Pillar FoS
			Height (m)	Width (solid, m)	w/h Ratio	Stress (MPa)	Strength (MPa)	
First Workings	N/A	140	3.5	40.0	11.4	4.2	38.2	9.1
		160				4.8		7.9
		180				5.4		7.0
Post-Extraction (Double Abutment Loading)	80	140				10.0		3.8
		160				11.7		3.3
		180				13.3		2.9

The following comments are made regarding these results:

i) The analysis confirms that the theoretical effective solid width of 35m would be adequate, with a FoS of ≥ 2.2, see **Table 5a**.

ii) The analysis confirms that the representative effective solid width of 40m would be conservative, with a FoS of ≥ 2.9, see **Table 5b**.

iii) Accordingly, <0.5m of subsidence would be expected across the expected depth range of 140m to 180m, following extraction.

4.0 HEIGHT OF CONNECTIVE FRACTURING

4.1 Connective Fracturing Theory

The strata above an extracted area forms a goaf made of a number of zones, as presented in the **Forster and Enever (1992)** longwall model, which is shown in **Figure 13a**; the approximate location of the overlying Great Northern Seam, Karingal, Teralba and Munmorah Conglomerates in the overburden profile are shown in **Figure 13b**. Note that there are no overlying workings in this case.

Commencing at the extraction horizon, the first zone is the "Caved Zone", which comprises loose blocks of detached rock occupying the cavity created by mining. This typically extends to a height above the seam of 5 to 10 times the extraction height, or between 17.5m and 35m for a Fassifern Seam mining height of 3.5m. In this case, the Caved Zone is expected to be arrested at the base of the Teralba Conglomerate, 45m to 50m above the extraction horizon (see **Section 4.4**).

Above this is the "Fractured Zone", in which the rock sags, with significant bending, fracturing, joint dilation and bed separation. **Forster's** model suggests that the combined height of the caved and fractured zones extends to between 21 and 33 times the extracted height for super-critical longwall panels (or between 73.5 and 115.5m for an extraction height of 3.5m). A similar outcome is predicted by the **Kendorski (1993)** longwall model. Within this combined caved and fractured zone, very large increases in bulk horizontal and vertical permeability are expected (termed "connective cracking").

Above the Fractured Zone is the "Constrained Zone" (**Forster**) or "Dilated Zone" (**Kendorski**). This zone is characterised by bedding dilation and discontinuous fracturing. This results in an increase in the horizontal permeability and associated drawdown in groundwater levels, which recover over time. Based on the Wyee longwall experience, **Forster (1995)** suggests the minimum thickness of the Constrained Zone should equate to "12T" for longwall mining, assuming no significant geological structure within the zone. At an extraction height of 3.5m, this equals 42m.

Other Australian workers (e.g. **MSEC, 2005**) have related the height of the combined Caved plus Fractured Zones solely to the mined panel width. Such approximations are probably appropriate for longwall mining at typical Australian extraction heights of around 3m to 3.5m. Other workers have also noted that the upward extent of fracturing is a function of the extracted span (**Mills and O'Grady, 1998**).

British researchers (**Whittaker and Reddish, 1989; Follington and Isaac, 1990**) considered the influence of both panel span and mining height on sub-surface fracture heights. Physical modelling suggested that sub-surface fracture heights could be estimated from the predicted maximum surface tensile strain ($+E_{max}$) values (**Whittaker and Reddish, 1989**); thereby linking sub-surface fracturing to the overall geometry. **Follington and Isaac** found that the failure height increased relative to the mining height, as panel width increased, see **Figure 14**. As panel width increased from 80m to 120m, the failure height increased from 18 to 25 times the mining height (i.e. close to **Forster's** lower bound value of 21 times the mining height).

More recently, Australian workers have sought to assess the combined effect of panel width and mining height on sub-surface fracturing (**Tammetta, 2013**; **Ditton and Merrick, 2014**).

The **Tammetta (2013)** method appears to relate to the height of the Constrained / Dilated Zone (i.e. all appreciable fracturing and bedding / joint dilation). The **Tammetta** equation defines H, the "Complete Height of Groundwater Drainage" (CHGD) as follows:

$H = 1{,}438\ ln(4.315 \times 10^{-5}u + 0.9818) + 26$

where $u = wt^{1.4}d^{0.2}$
and w = void width (m)
t = extraction height (m)
d = depth (m)

The extraction height is 3.5m for MW S5, but reduces to effectively 3.0m in the herringbone panels, allowing for the lower in-panel extraction (i.e. 3.5m x 85%).

The **Tammetta** equation generates "CHGD" values of:

- 93-96m for MW S5 (i.e. the equivalent of ~27T) and
- 65-69m for the herringbone panels (i.e. the equivalent of 22-23T).

Tammetta also suggests that an Upper 95% Confidence Limit can be defined by adding 37m to the mean value (e.g. producing a U95%CL value of 132m in the case of MW S5, the equivalent of ~38T). It should be noted that it is not rational for the U95%CL to be defined by adding a constant 37m; this value should bear some relationship to the geometry and the mean value (otherwise, in the extreme, a panel width of 0m would have an associated U95%CL value of 37m, which is not credible).

The **Ditton and Merrick** equations aim to define the height of the "A Zone", a term originally proposed by **Whittaker and Reddish** and analogous to the Fractured Zone. **Ditton and Merrick** derived two equations, one solely based on geometry and a second intended to reflect the positive impact (i.e. reduction in "A Zone" height) of a massive spanning bed within the overburden. The latter is considered by **Ditton** to be more relevant to the CVC geotechnical environment and the associated equation was applied successfully for the MW1-12 area, as well as more recently for MWs CVB1, S1-4 and N1.

The **Ditton and Merrick** geology equation is as follows:

$A = 1.52W'^{0.4}\ H^{0.535}T^{0.464}t^{0.4} \qquad +aW'$

Where W' = the minimum of actual panel void width and "critical" panel width (taken as 1.4H)
H = depth
T = extraction height
t = effective thickness of the massive unit (19m according to **Ditton** in this case)

The +aW' term defines an Upper 95% Confidence Limit or "U95%CL". For sub-critical panels, 'a' is 0.15.

The following comments are made regarding the results obtained with this equation, see also **Figure 15**:

i) The average fracture height for MW S5 varies between 77m and 83m (i.e. 22-24T) and the upper bound fracture height varies between 92m and 98m (i.e. 26-28T and almost the same as the mean values from the **Tammetta** equation).

ii) The average fracture height for the herringbone panels varies between 65m and 74m (i.e. 22-25T, similar to the Tammetta mean values) and the upper bound fracture height varies between 78m and 87m (i.e. 26-29T).

iii) The **Ditton and Merrick** equation is less conservative than the **Tammetta** equation at the miniwall void width of 97m. The two equations converge at the reduced panel width of 85m associated with the herringbone panels.

4.2 Local Experience

Table 6 summarises the key geometrical parameters and subsidence outcomes for the local (Wyee and CVC) database of 8 longwall and 18 miniwall panels on the Fassifern Seam.

Table 6: Wyee (Mannering) and Chain Valley Collieries - Longwall and Miniwall Panel Geometry and Subsidence Database

Case	Void Width (m)	Depth (m)	Mining Height (m)	Inter-Panel Chain Pillar Width (m)	Subsidence (m)	Comment
Wyee LW1	216	212	3.44	N/A	2.20	Multi-seam workings
Wyee LW17	130	174	3.2	45	0.45	3 adjacent panels
Wyee LW18	130	172	3.2		0.55	3 adjacent panels
Wyee LW19	130	170	3.2		0.65	3 adjacent panels
Wyee LW20	140	180	3.2	N/A	0.4	Isolated panel
Wyee LW21	140	175	3.2	N/A	0.45	Isolated panel
Wyee LW22	150	185	3.2	45	N/A	2 adjacent panels
Wyee LW23	150	195	3.2		0.50	2 adjacent panels
CVC MW4	97	196	3.4	40	0.22	3 adjacent panels
CVC MW5	97	200	3.4	30.6	0.46	3 adjacent panels
CVC MW5a	97	200	3.4		0.46	3 adjacent panels
CVC MW1	72	200	3.4	30.6	0.20	10 adjacent panels
CVC MW2	72	200	3.4	30.4	0.40	10 adjacent panels
CVC MW3	97	200	3.4	32.6	0.70	10 adjacent panels
CVC MW6	97	198	3.4		0.80	10 adjacent panels
CVC MW7	97	195	3.4		0.90	10 adjacent panels
CVC MW8	97	193	3.5		1.00	10 adjacent panels
CVC MW9	97	191	3.5		1.20	10 adjacent panels
CVC MW10	97	183	3.5		0.90	10 adjacent panels
CVC MW11	97	178	3.5		0.60	10 adjacent panels
CVC MW12	97	173	3.5	36.1	0.30	10 adjacent panels
CVC CVB1	97	225	3.5	N/A	0.45	Multi-seam workings
CVC MW S1	97	195	3.5	N/A	0.1	Isolated panel
CVC MW N1	97	170	3.5	N/A	<0.1	Isolated panel
CVC MW S2	97	176	3.5	N/A	<0.1	First panel
CVC MW S3	97	170	3.5	N/A	<0.15	2 adjacent panels

The following comments are made regarding this local database:

i) The panel void width range of 72m to 216m is large.

ii) The depth range of 162m to 225m is quite narrow. MW S5 is at the bottom of this range (i.e. depths of 162m to 171m). The herringbone panels extend into shallower areas, warranting the conservative design approach (i.e., reduced span).

iii) The extraction height range of 3.2m to 3.5m is narrow and consistent with the proposed workings (i.e., 3-3.5m).

iv) The Wyee panels were the subject of detailed geotechnical investigation, focusing on subsidence and the development and extent of sub-surface fracturing (**Holla, 1989; Li *et al*, 2006**).

v) The 45m (solid width) Wyee chain pillars all meet the criteria for long-term stability with limited subsidence discussed in **Section 3.1** (i.e. Factors of Safety of >2.11).

vi) The 40m chain pillar between CVC MWs 4 and 5 is long-term stable (FoS of 2.66) and a controlling influence with regard to the very limited subsidence over MW4 (i.e., 0.22m).

vii) The historical 30.4m to 32.6m wide CVC chain pillars (up to MG10) for did not meet the stipulated criteria for long-term pillar stability under double abutment loading (i.e. Factors of Safety of <2.11 with pillar stresses of >15MPa). Even then, subsidence only increases to >0.5m when >3 adjacent panels are mined and spanning / bridging of the overburden reduces.

viii) The chain pillar width was increased from 32.6m to 36.1m for MG11. This is considered to have been the major factor in the reduced subsidence experienced over MW12 (0.15-0.30m, at a pillar FoS of ~2.3).

ix) Multi-seam workings at both mines have been associated with increased subsidence magnitudes (Wyee LW1 and CVC CVB1).

x) No appreciable subsidence has been measured by bathometric survey above CVC MWs S1 and N1 to-date, and subsidence in the MW S2-S3 area is <0.15m, noting that individual survey accuracy is considered to be approximately 100mm (such that the error band for two surveys is 200mm).

Table 7 overleaf summarises the local database in the context of the theoretical outcomes of the **Ditton and Merrick (2014)** and **Tammetta (2013)** equations. Also included are the results for the planned MW S5 and herringbone panels.

The following comments are made regarding the outcomes:

i) **Tammetta's** equation is much less sensitive to depth than that of **Ditton and Merrick**.

ii) **Tammetta's** average values correlate very closely to the void width.

iii) The Wyee LW1 data point was the subject of detailed research **(Holla, 1989; Holla and Buizen, 1990)**, from which a Fractured Zone height of 126m was derived. **Ditton and Merrick** used this a calibration point for their model. The **Tammetta** equation suggests a CHGD of 208m to 245m (average and U95%CL), which is effectively to surface (i.e. H = 212m).

iv) The Wyee LW1 data point is also interesting in that it represents a multi-seam case, with remnant pillars in the overlying Great Northern Seam.

v) The **Tammetta** U95%CL results for Wyee LWs 17 to 23 range from 149m to 169m and would have been a cause for concern if they had been available at the time of mining, given that they suggest only 17m to 26m of super-incumbent cover to the lake floor (including <10m of rock). This was the area investigated by **Li *et al* (2006)**; no inflow / seepage issues were reported.

vi) It is concluded, on the basis of the local experience, that:

- the **Ditton and Merrick** values (average and U95%CL) are credible and
- the **Tammetta** average values are credible at panel widths of ≤ 150m.

Table 7: Theoretical Fractured Zone Heights for the Local Database

Case	Void Width (m)	Depth (m)	Mining Height (m)	Ditton & Merrick 'A' Zone Height		Tametta 'CHGD'	
				Average (m)	U95%CL (m)	Average (m)	U95%CL (m)
Wyee LW1	216	212	3.44	125	158	208	245
Wyee LW17	130	174	3.2	89	108	113	150
Wyee LW18	130	172	3.2	88	108	112	149
Wyee LW19	130	170	3.2	88	107	112	149
Wyee LW20	140	180	3.2	93	114	122	159
Wyee LW21	140	175	3.2	92	113	121	158
Wyee LW22	150	185	3.2	97	120	131	168
Wyee LW23	150	195	3.2	100	123	132	169
CVC MW1	72	200	3.4	78	89	71	108
CVC MW2	72	200	3.4	78	89	71	108
CVC MW3	97	200	3.4	88	102	95	132
CVC MW4	97	196	3.4	87	101	94	131
CVC MW5	97	200	3.4	88	102	95	132
CVC MW5a	97	200	3.4	88	102	95	132
CVC MW6	97	198	3.4	87	102	94	131
CVC MW7	97	195	3.4	86	101	94	131
CVC MW8	97	193	3.5	87	102	98	135
CVC MW9	97	191	3.5	87	101	97	134
CVC MW10	97	183	3.5	85	99	97	134
CVC MW11	97	178	3.5	83	98	96	133
CVC MW12	97	173	3.5	82	97	96	133
CVC MW CVB1	97	225	3.5	94	109	101	138
CVC MW S1	97	195	3.5	88	102	98	135
CVC MW N1	97	170	3.5	81	96	95	132
CVC S2	97	176	3.5	83	98	96	133
CVC S3	97	170	3.5	81	96	95	132
CVC S4 Inbye	97	178	3.5	83	98	96	132
CVC S4 Outbye	97	156	3.5	78	92	94	131
CVC S5 Inbye	97	178	3.5	83	98	96	132
CVC S5 Outbye	97	154	3.5	77	92	93	131
Herringbone Workings	85	180	3.0 (effective)	74	87	69	106
		140		65	78	65	102

4.3 SCT Surface Tensile Strain Approach

SCT (2008) used two-dimensional numerical (FLAC) modelling and field studies of overburden strata conductivity to compliment the historical database. They studied the relationships between surface tensile strain, subsidence, depth and groundwater inflow (consistent with the concept put forward by **Whittaker and Reddish, 1989**). SCT stated that no issues were associated with systematic strains of <4mm/m and that inflow became problematical at strains of >10mm/m (consistent with UK experience).

Table 8 summarises the tensile strain results for the Wyee / Mannering and CVC database, including the planned MW S5 and herringbone panels, based on the standard equation:

Strain, E = 1000k(Subsidence/Depth)

Where:

k is a constant dependent on coalfield geology (k = 0.4 for the Newcastle Coalfield).

Table 8: Systematic Tensile Strain Results for the Local Database

Panel	Subsidence Smax (m)	Depth, H (m)	Tensile Strain (mm/m)	
			E/k	E (k = 0.4)
Wyee LW1	2.20	212	10.4	4.2
Wyee LW17	0.45	175	2.6	1.0
Wyee LW18	0.55	175	3.1	1.3
Wyee LW19	0.65	175	3.7	1.5
Wyee LW20	0.40	180	2.2	0.9
Wyee LW21	0.45	175	2.6	1.0
Wyee LW23	0.50	185	2.7	1.1
CVC MW7-12	1.20	190	6.3	2.5
CVC MW4-5	0.22	200	1.1	0.4
CVC MW5-5A	0.46	210	2.2	0.9
CVC MW CVB1	0.45	225	2.0	0.8
CVC MW N1	0.00	160	0.0	0.0
CVC MW S1	0.10	190	0.5	0.2
CVC MW S2	0.15	176	0.9	0.3
CVC MW S3	0.15	170	0.9	0.4
CVC MW S4	0.30	162	1.9	0.7
CVC MW S5 (Inbye)	0.36	178	2.0	0.8
CVC MW S5 (Outbye)	0.36	154	2.3	0.9
CVC Herringbone	0.40	140	2.9	1.1
	0.50	180	2.8	1.1

Note that the S_{max} value for MWs S4 and S5, as well as the planned herringbone workings are the estimates derived from numerical modelling, as detailed in **Section 5**.

For the purpose of simple local comparison, it is not necessary to know the 'k' value; it is enough to compare E/k ratios, viz:

- Wyee LW1: 10.4
- Wyee LWs 17 to 23: 2.2 to 3.7
- Previous CVC Miniwalls: 0.0 to 6.3
- Planned CVC MW S5: 2.0-2.3
- Planned CVC Herringbone Workings: 2.8-2.9

Figure 16 is adapted from the **SCT ACARP** report; with respect to strain, it is noted that the local values generally plot in the range indicated as benign by **SCT**, with CVC MWs 7-12 plotting just below the "No Observed Water Inflow Issues" line. In particular, the planned MW S5 and herringbone workings plot well inside the "No Issues" zone. Also shown in the figure is the 7.5mm/m strain limit derived from the **Wardell Guidelines (1975)** and **Holla's** k value of 0.4 for the Newcastle Coalfield. This limit line is practically the same as the SCT 10mm/m line, which is based on a k value of 0.6.

4.4 Spanning of the Karingal and Teralba Conglomerates

A two-dimensional analytical beam model has been utilised to assess the spanning ability of both the Karingal and Teralba Conglomerates. Traditionally, such beam analyses have focussed primarily on the spanning ability of the latter, but in this case the significant thickening of the Karingal Conglomerate to the north means this unit is also of interest.

For the purpose of this study, there are four key units of interest, namely:

- the 12-30m thick Teralba Conglomerate above the Great Northern Seam,
- the approximately 47-65m of interburden from the Fassifern Seam working section to the base of the Teralba Conglomerate (i.e. including the GN Seam),
- the 6-39m thick Karingal Conglomerate below the Great Northern Seam and

- the approximately 23-44m of interburden from the Fassifern Seam working section to the base of the Karingal Conglomerate.

The model assesses potential modes of beam failure involving both linear elastic and voussoir arch (i.e. jointed rock mass) properties. A major advantage is that it allows the sensitivity of an outcome to various input parameters to be rapidly tested; this parametric analysis provides insight of roof behaviour. The model has been applied by Strata² geotechnical engineers in a variety of mining environments and situations for over 20 years.

A review of previous Chain Valley studies, laboratory tests, rock mass characterisation and *in situ* stress testing results indicates that the properties summarised in **Table 9** are appropriate inputs.

Table 9: Beam Analysis Inputs for MW S5 and the Herringbone Panels

Parameter	Interburden	Teralba Conglomerate	Karingal Conglomerate
Depth to Base (m)	144 - 180	100 - 130	126 - 142
$\sigma_1 : \sigma_V$ Ratio	2:1		
UCS (MPa)	30	50	
E (GPa)	5	12	
Beam Thickness (m)	2	12 - 30	6 – 39
Joint Friction Angle (°)	35	45	
Joint Dip Angle (°)	70 to 90 (70 conservatively selected)		

The important feature of the interburden is that it is expected to cave readily. For the purposes of this analysis, the main function of the interburden is to form a caving arch that reduces the effective span at the base of the overlying conglomerate units.

For example, assuming a moderately conservative 20° caving angle from the working horizon, it can be shown that over a minimum of:

- 47m of interburden to the Teralba Conglomerate, the span reduces by ~34m and
- 23m of interburden to the Karingal Conglomerate, the span reduces by ~17m.

It can also be shown that the probable initial mode of beam failure would be abutment crushing, with the roof sagging and overstressing the rock material at its margins. This would tend to be manifested by guttering, accompanied by buckling. In the analysis, “failure” (i.e. caving) is expected to initiate at a Factor of Safety (FoS) of 1, whereas long-term stability would be expected at FoS values of ≥ 2.

For this analysis, the simplest representation of the results takes the form of a schematic NW-SE cross-section, see **Figure 17**.

The results are summarised as follows:

i) In spite of thinning to the NW, the Teralba Conglomerate is long-term stable across the entire area of interest (i.e. FoS values of >2).

ii) The Karingal Conglomerate becomes long-term stable in the NW, but fails elsewhere.

4.5 Conclusions Regarding the Theoretical Height of Connective Cracking

The following conclusions are drawn from the preceding analysis:

i) **Forster’s** approach is for super-critical longwalls and is not applicable to the sub-critical MW S5 or the herringbone panels.

ii) The **Tammetta** equation is inconsistent with local experience at panel widths of >150m.

iii) The values derived using the **Ditton and Merrick (2014)** geology equation are consistent with local experience and this equation has been successfully applied at CVC in recent years. This approach suggests heights of connective fracturing of ≤ 81m for MW S5 and ≤ 74m for the herringbone panels.

iv) The **SCT (2008)** approach is considered the most rational, as it relates to the expected maximum values of strain, the latter being a key parameter for permeability. The approach suggests that the MW S5 and herringbone designs are conservative, from a "potential inflow" perspective.

v) In practice, the height of connective cracking would almost certainly be capped at the base of the Teralba Conglomerate, only around 47-65m above the workings.

4.6 Geological Structure

Most of the panels in the local database encountered geological structures, see **Table 10**.

Table 10: Major Structures Encountered by Wyee and CVC Panels

Case	Void Width (m)	Depth (m)	Mining Height (m)	Subsidence Smax (m)	Major Geological Structure
Wyee LW1	216	212	3.44	2.20	Dyke parallel with T/G; 35-55m disturbance zone
Wyee LW17	130	174	3.2	0.45	0.3m fault at inbye end of M/G
Wyee LW18	130	172	3.2	0.55	No major geological structure
Wyee LW19	130	170	3.2	0.65	Fault zone with 0.6-1.4m throw, inbye half of block
Wyee LW20	140	180	3.2	0.4	Minor 0.1-0.4m faults in block
Wyee LW21	140	175	3.2	0.45	0.8m fault in block; 3m fault in T/G
Wyee LW22	150	185	3.2	N/A	4m normal fault zone at inbye end of panel
Wyee LW23	150	195	3.2	0.50	4m normal fault zone at inbye end of panel
CVC MW4	97	196	3.4	0.22	1-2m normal fault through the entire block
CVC MW5	97	200	3.4	0.46	Locallised 0.1-0.2m normal faults in block; normal faults up to 2.7m in chain pillars
CVC MW5a	97	200	3.4	0.46	Normal faults up to 2.7m throughout the block and chain pillars
CVC MW1	72	200	3.4	0.20	0.4m normal fault in inbye quarter of TG1
CVC MW2	72	200	3.4	0.40	No major geological structure
CVC MW3	97	200	3.4	0.70	No major geological structure
CVC MW6	97	198	3.4	0.80	Dyke ~3m thick in outbye half of block; 2m normal fault zone in inbye half of M/G and extending into block
CVC MW7	97	195	3.4	0.90	0.25m dyke in outbye half of block; 2m normal fault in inbye half of block
CVC MW8	97	193	3.5	1.00	0.25m dyke mid-block
CVC MW9	97	191	3.5	1.20	1.8m normal fault, inbye quarter of block, trending into M/G chain pillar
CVC MW10	97	183	3.5	0.90	1-1.5m normal faults through three-quarters of the block
CVC MW11	97	178	3.5	0.60	1-1.5m normal faults through outbye half of the block
CVC MW12	97	173	3.5	0.30	No major geological structure
CVC CVB1	97	225	3.5	0.45	inbye third of the block
CVC MW S1	97	195	3.5	0.1	Minor 0.1-0.4m faults in block and gate roads
CVC MW N1	97	170	3.5	<0.1	Minor 0.1-0.3m faults in block and gate roads
CVC MW S2	97	176	3.5	<0.1	Minor 0.2m fault in block and tailgate
CVC MW S3	97	170	3.5	<0.15	1.5m fault in the inbye half of the block

The following comments are made regarding **Table 10**:

i) Two-thirds of the panels in the local database were directly impacted by significant geological structures (defined for this purpose as faults with throws of >0.5m or dykes).

ii) There is no obvious relationship between the subsidence magnitude and the presence or absence of major geological structure.

iii) One of the reasons why the faults do not impact on subsidence is that they are normal faults dipping at moderate to high angles (60° to 90°). As such, they have a reduced impact on beam stability and the spanning ability of the overburden, in comparison to low angle thrust faults, which have been associated with increased subsidence magnitudes elsewhere, such as Mandalong.

iv) However, there is local evidence that structures can be associated with strain concentrations at surface. Over Wyee LW1, measured maximum strain values varied between 2.5mm/m on the MG side and 8.1mm/m on the TG side, versus the predicted maximum tensile strain of 4.2mm/m. The maximum measured value coincided with the dyke zone adjacent to the tailgate. This is consistent with the findings of **Ditton and Frith (2003)**, who suggested that surface strain concentrations of 2 to 3 times the systematic strain could be associated with fracturing. However, the surface strain concentration does not seem to have translated into a height of fracturing increase over Wyee LW1.

v) Localised strain concentrations, due to geological structure (or any other factor) are implicit within empirical strain limit guidelines based on "systematic" strains (i.e. empirical limits / impact guidelines are an outcome of actual experiences that incorporate and reflect the vagaries of geology). Further, the presence of major geological structures is also implicit in the empirical models and equations for heights of fracturing, such as that of **Ditton and Merrick (2014)**.

vi) Nonetheless, even a strain multiple of 2 to 3 would have no material consequences for MW S5 or the herringbone panels.

vii) **Figure 18** shows the major structural features, based on in-seam drilling, mapping in adjacent areas / seams and exploration drilling results. The MW S2 to S5 panels are orientated at 119°, rather than the 134° of earlier CVC panels. This orientation is much more favourable, with respect to the dominant 131° structural direction. Similarly, the sub-mains and run-outs of the herringbone panels are orientated at favourably moderate angles to the major structural direction.

Given that:

- voussoir beam analysis suggests that the prevalent features would not appreciably impact on the spanning ability of the Teralba Conglomerate and
- the favourable experiences from previous extraction panels with exposure to major structures,

faults and dykes in the area of interest are considered to be of no material consequence.

Overall, the structural environment is considered to have no significant adverse implications for post-extraction subsidence and sub-surface fracturing.

4.7 Rock Cover Requirement

Figure 19 shows rock cover contours for the area of interest, based on the latest detailed survey results. Rock cover varies from 118m in the NE, to 130m in the NW and 166m in the SE. Rock cover therefore significantly exceeds the Fractured Zone height (≤ 96m at the SE / inbye end of MW S5 and <85m for the northern herringbone panels in the area of minimum rock cover).

5.0 SUBSIDENCE ESTIMATION

It was concluded in **Section 3 (Pillar Design)** that subsidence due to MW S5 extraction was expected to be limited in the long-term (<0.5m) due to the high final FoS of the MG S5 chain pillars, even under double abutment loading related to subsequent herringbone extraction to the north (FoS ≥ 2.2). To compliment this empirical subsidence estimate, numerical modelling has been conducted using the three-dimensional, displacement discontinuity code "LaModel" (**Heasley and Chekan, 1999**), which has been successfully applied by the author to a variety of situations at a number of NSW mines over the last decade.

5.1 Material Property Inputs and Assumptions

LaModel incorporates yielding elements in the coal seam properties enabling the yield zone, which is manifested in practice by rib spall and fracturing, to be simulated. The results of numerical codes are sensitive to the material parameters inputted and require calibration. In LaModel, the following material input parameters are important:

- Young's Modulus of the coal and overburden,
- Poisson's Ratio of the coal and overburden,
- overburden lamination thickness,
- goaf loading height and
- mass strength of coal at a width to height (w/h) ratio of 1.

LaModel incorporates default values for material properties, developed from simulations of a large number of case histories. However, the adoption of site-specific values determined via a calibration process is recommended, where the data is available. Calibration involves adjusting the modelled, site-specific mechanical properties to provide the best correlation between predicted and measured values of pillar stress and surface subsidence (**White and Hill, 2017**). For this study, the calibration developed for MW S5 has again been applied to the subsequent herringbone extraction operations (**Strata² 2020**). This primarily involved reference to geotechnical and subsidence data from Chain Valley and the adjacent Mannering Colliery. However, it has also drawn on the findings of equivalent miniwall / partial extraction studies, applying LaModel in other coalfields.

The model outcomes are relatively insensitive to the Poissons Ratio of the coal and overburden. The default values of 0.33 for coal and 0.25 for the overburden have been applied, noting that these are consistent with earlier studies for the mine **(DGS, 2017)**.

The default value for the overburden Young's Modulus is 20.7GPa, noting that modelled subsidence results are sensitive to this input value. Early studies for the mine applied this default value **(DGS, 2017)**, which is generally consistent with expected values of 15-20GPa for conglomerate material. However, experience indicates that lower values tend to calibrate better to actual subsidence behaviour. This is considered to reflect the influence of the weaker units within the overburden, as well as the role of discontinuities and the strength reduction associated with full-scale "rock mass" versus laboratory-scale "rock-material" mechanical behaviour.

Subsidence estimation with LaModel is also sensitive to the overburden lamination thickness. Earlier studies for the mine have varied the lamination thickness from 20m to 46m **(DGS, 2017)**. However, for sub-critical panels, experience indicates that the most accurate subsidence predictions are attained by adopting lamination thicknesses of 10m to 15m for mining operations involving caving (e.g. miniwall systems). These more conservative input values are considered to implicitly reflect the weakening effect of major discontinuities, such as faults and dykes, on overburden behaviour.

A sensitivity analysis was conducted, involving progressive reductions in the overburden modulus and lamination thickness and associated increases in the calculated subsidence values, until the results most closely matched the measured subsidence behaviour over the previous CVC miniwall panels and the Wyee (Mannering) longwall panels. The overburden properties that provided the most accurate calibration were:

- a Youngs Modulus of 10GPa,
- a lamination thickness of 15m for the first panel situation and
- a lamination thickness of 10m for multi-panel situations.

The default value at a w/h ratio of 1.0 for coal mass strength is 6.2MPa. Geomechanical testing of the Fassifern Seam at Chain Valley indicates a moderate uniaxial compressive strength (UCS) of typically 25 to 40MPa for laboratory sized specimens, with an average of 34MPa. Empirical methods and rock mass classification schemes suggest a coal mass strength of 6 to 8MPa and, in particular, a value of 7MPa derived using the approach of **Protodiakanov (1964)**. **Gale (1999)** suggested that coal mass strength varies between 5MPa, for weak coal with weak coal / strata contacts, to 9MPa for strong coal with strong coal / strata contacts. The Fassifern Seam contacts are considered weak. The specific issue

is the role of the claystone units in the floor, which has an average long-term strength of <5MPa. A second sensitivity analysis was therefore conducted, involving progressive reductions in the strength and stiffness properties of the seam and associated increases in the calculated subsidence magnitudes, until the results most closely matched long-term, measured subsidence behaviour. The seam properties that provided the most accurate calibration were:

- a seam strength of 3.5MPa and
- a Youngs Modulus of 1.05GPa.

Goaf properties are calculated using LaModel's "Gob Wizard" by inputting the maximum estimated goaf stress. In this case, the goaf stress is considered to be largely limited to the load due to the height of the caved material below the Teralba Conglomerate, with the majority of the load transferring to the chain pillars and adjacent abutments, refer to **Section 4.3**. Given a caving height of 50m from the Fassifern Seam working section to the base of the conglomerate, this suggests an average goaf stress of around 1.25 MPa.

For this study, an important consideration is the progressive increase in the overall mined-out area from sub-critical to super-critical. This reduces the overburden stiffness, resulting in increased final pillar loads and associated subsidence. The width (W) to depth (H) trend for MWs S2 to S5 is as follows:

- MW S2: W/H = 97/170 = 0.57 (sub-critical)
- MWs S2 and 3: W/H = 234/170 = 1.38 (close to super-critical)
- MWs S2 to 4: W/H = 371/170 = 2.18 (super-critical)
- MWs S2 to 5: W/H = 508/170 = 2.99 (super-critical)

Ordinarily, it would be assumed that the combined MW S2 and 3 span is super-critical, with maximum pillar loading. However, local experience and previous studies suggest that a W/H ratio of >2 is required to generate full loading and subsidence in this environment (i.e. a minimum of three consecutive MW panels). This is due to the significant spanning ability of the conglomerate beds. Therefore, this situation is only regarded as truly super-critical from MW S4 onwards.

At this stage, the subsequent herringbone panels are also considered to contribute to the overall super-critical extent of the extraction area, although this is likely to prove a very conservative assumption, given the panel configuration.

In LaModel, the change from sub- to super-critical is addressed using the "Free Surface" feature; switching Free Surface "on" increases the subsidence magnitude. By iteration, the following inputs provided the best calibration:

- MW S2: Lamination thickness = 15m and Free Surface "off"
- MWs S2 and 3: Lamination thickness = 10m and Free Surface "off"
- MW S4 onwards: Lamination thickness = 10m and Free Surface "on"

The outcomes of the LaModel calibration exercises are summarised in **Figure 20**, which plots modelled (i.e. predicted) versus measured subsidence. The correlation coefficient of 0.8 is a favourable outcome.

The material inputs are accordingly summarised in **Table 11**.

Table 11: Modelling Parameters for MW S5 and the NMA Herringbone Panels

Material Parameter	Values Modelled
Young's Modulus of Coal (GPa)	1.05
Poisson's Ratio of Coal	0.33
Young's Modulus of Overburden (GPa)	10
Poisson's Ratio of Overburden	0.25
Mass Strength of Coal (MPa)	3.5
Lamination Thickness (m)	10 and 15
Depth (m)	170
Mining Height (m)	3.5

5.2 Modelling Steps

The model was simulated in five steps, as follows:

- **Mining Step 1**: Miniwall Panel S2 extracted.
- **Mining Step 2**: Miniwall Panel S3 extracted.
- **Mining Step 3**: Miniwall Panel S4 extracted.
- **Mining Step 4**: Miniwall Panel S5 extracted.
- **Mining Step 5:** Herringbone Panels north and north-east of MW S5 extracted.

Mining Step 2 facilitates a comparison of the LaModel subsidence estimates with previous estimates of MW S2 and S3 subsidence obtained by MSEC using their Incremental Profile Method or "IPM" (**MSEC, 2018**), as well as actual subsidence to-date.

5.3 Grid Geometry

Examples of the LaModel grid are shown in **Figures 21** and **22**. Modelled element widths of 1m and 2m were applied, so that the geometry approximated very closely to the actual at both the first workings and secondary extraction stages.

5.4 Modelling Results

5.4.1 Miniwalls S2 to S5, plus Adjacent Herringbone Panel HB-E1B

The following comments are made regarding Step 1, following the extraction of MW S2, see **Figure 23**:

i) Maximum modelled subsidence is 0.12m. Measured subsidence following the completion of MW S2 was negligible. Given the estimated ±0.1m accuracy of the bathymetric survey method (such that the subsidence can be measured to within 0.2m), this is considered an acceptable level of agreement.

ii) Modelled angles of draw are <19º. However, measured subsidence at the Pelican Rock Navigation Marker, above Tailgate S2 and only 16m from the goaf edge, was only 10mm following MW S2 extraction. In practice, therefore, the measured AoD was <6º.

The following comments are made regarding Step 2, following the extraction of MWs S2 and S3:

i) Modelled maximum subsidence is 0.16m. This is lower than the **MSEC (2018)** prediction of 0.29m, but highly consistent with the latest bathymetric survey results (≤ 0.15m of subsidence), as well as the previous MW4-5 experience.

ii) Modelled tilt values are <3mm/m, see **Figure 24a**. This is less than the **MSEC** prediction of a maximum of 6mm/m.

iii) Modelled strain values are 1-1.5mm/m, see **Figure 24b**. This is slightly greater than the **MSEC** prediction of a maximum tensile strain of 1mm/m.

iv) Modelled angles of draw remain <19º.

v) Modelled subsidence at the Pelican Rock Navigation Marker is 60-70mm. This is slightly lower than the **MSEC** prediction of 90mm, noting that the actual subsidence, post-MW S3 is only 30mm.

The following comments are made regarding the results for Step 4, following the extraction of MWs S2 to S5 inclusive:

i) Modelled maximum subsidence is 0.36m.

ii) Tilt values remain < 5mm/m, see **Figure 25a**.

iii) Strain values remain < 2mm/m, see **Figure 25b**.

iv) Modelled angles of draw are ≤ 23°, reducing to ≤ 18° at the panel ends.

v) Subsidence at the Pelican Rock Navigation Marker is 145mm.

vi) The minimal change in the subsidence values following the mining of MW S5 reflects the controlling influence of the 40m wide chain pillars, once the overall span becomes super-critical.

The following comments are made regarding the results for final Step 5, following the extraction of the HB-E1B herringbone panel to the north:

i) Modelled maximum subsidence is 0.5m above HB-E1B Panel.

ii) Tilt values remain ≤ 5mm/m, see **Figure 26a**.

iii) Strain values remain ≤ 2mm/m, see **Figure 26b**.

iv) Final angles of draw are ≤ 23°, reducing to ≤ 18° at the panel ends.

v) Subsidence at the Pelican Rock Navigation Marker is 155mm.

5.4.2 Multiple Adjacent Herringbone Panels

A section of the model grid at Mining Step 2 is shown in **Figure 22**. Note that the extraction area is depicted as "clean" with no remnant stooks or fenders modelled. In practice, coal recovery during pillar extraction is typically of the order of 85%. Therefore, although a mining height of 3m has been applied (i.e. the approximate development height), eliminating the stooks when modelling has the effect of mimicking an increase in height to 3.5m in the extraction area (i.e. 3m = 3.5 x 0.85).

The following comments are made regarding the results, following the extraction of multiple herringbone panels:

i) Maximum subsidence (S_{max}) is 0.4m to 0.5m, increasing gradually with depth, see **Figure 27**.

ii) Subsidence reduces to 0.10m to 0.15m above the sub-mains pillars and 0.30m to 0.35m above the barriers, see **Figures 28** and **29a**.

iii) The numerical modelling results are reasonably consistent with the empirical estimates derived from the subsidence database.

iv) Tilt values are ≤ 6mm/m across the depth range, see **Figure 29b**.

v) Strain values are ≤ 2mm/m across the depth range, see **Figure 29c**.

5.5 Conclusions Regarding Subsidence Effects

Regarding MW S5, the empirical pillar database (**Section 3.2**) suggests <0.5m of subsidence following the subsequent herringbone extraction to the north, similar to the numerical modelling outcome (0.36m). Referring again to **Figure 23**, the modelling suggests around 0.2m of final subsidence above the chain pillars (slightly less in the case of MG S5), plus around 0.15m of sag between pillars. Accepting the bathymetric survey accuracy, only around 0.05m to 0.15m of subsidence has been recorded above MWs 2 to 4 to-date.

Apart from the ongoing MW S2 to S4 experience, it is also possible to draw on the previous experience from the MW1-12 area. The situation that corresponds most closely to the planned S2-5 geometry is that of MWs 4 and 5, where two 97m void width panels were also separated by a 40m (solid width) chain pillar, albeit at a greater depth of 196 to 200m. Eight years after mining, measured subsidence is of the order of 220mm, with no sign of ongoing movement / creep.

It is therefore concluded that maximum final subsidence associated with the extraction of MW S5 will be of the order of 0.2m to 0.4m. Given that the resolution of bathymetric survey techniques is understood

to be of the order of 0.2m, it is suggested that planning proceed on the basis of a nominal maximum of 0.4m of long-term subsidence.

With regard to the herringbone workings, the modelling suggests S_{max} values in the range of 0.4-0.5m, which is consistent with the empirical analyses.

6.0 SUBSIDENCE IMPACTS

The potential subsidence impacts on the following natural and built features are considered in turn:

- The lake bed
- Sea grass beds
- The foreshore, including minor cliffs
- Built features

6.1 The Lake Bed

The lake bed contours, derived from bathometric surveys from 2012 onwards, are shown in **Figure 30**. Given the gently sloping lake bed topography, the water depth of ≥ 4m over the extraction workings and the expected subsidence of ≤ 0.5m, it is considered very unlikely that there would be an adverse impact on the lake bed.

Further details on benthic communities are given in the Benthic Communities Management Plan, which is included as part of the Extraction Plan.

6.2 Sea Grass Beds

Sea grass beds exist along the foreshore, below the Low-Water Mark, see **Figures 31** and **32**. The Sea Grass Protection Barrier (SGPB) is defined by a 26.5º angle of draw from the mapped beds. Predicted vertical subsidence at the closest point of any of the extraction workings (i.e., MW S5 or herringbone) to the SGPB is <0.5m and predicted subsidence at the actual sea grass beds is <20mm. It is therefore considered practically impossible that there would be an adverse impact on the sea grass beds.

6.3 The Lake Foreshore

The foreshore and the High-Water Mark, defined by the RL 0.00m Australian Height Datum (AHD) contour, are also shown in **Figures 31** and **32**. The High-Water Mark Protection Barrier (HWMPB) is defined by a 35º angle of draw from the High-Water Mark, as shown in the example along the MW S5 centre-line, **Figure 33**, noting that the commencing end of MW S5 is located typically >50m outside the barrier.

A second cross-section, approximately north-south through the western side of herringbone panel HB-Mains (see **Figure 1** for panel location), is seen in **Figure 34**. Extraction ceases just south of the SGPB and HWMBP, which in this case are almost coincident. As discussed in **Section 5**, predicted subsidence at the HWMPB is <0.5m for all the extraction workings. It is therefore considered practically impossible that there would be any measurable change in the High-Water Mark due to the extraction operations (i.e. predicted subsidence at the High-Water Mark is <20mm).

6.4 Minor Cliffs

Along the southern edge of the Morisset Peninsula is an approximately 200m length of minor (i.e., ~8m high) cliffs formed in the Munmorah Conglomerate, with an overlying steep (typically 20-25º) slope, see **Figures 34** and **35a-b**. These cliffs are at the margin of the herringbone workings (specifically, the first workings associated with HB-Mains and HB-W2 Panels). Subsidence in this area is expected to be 0-20mm, with no impacts on the cliffs or slope.

6.5 Built Features

Built features relevant to the area of interest are shown in **Figures 35a** and **36a-c**.

The Pelican Rock Navigation Marker, **Figure 36b**, is located on a rock outcrop that extends into the lake from Summerland Point. It is evident from **Figure 23** that minor subsidence at the navigation marker is expected to continue until the extraction of herringbone panel HB-E1B is complete (155mm of modelled subsidence). There is a second navigation marker further west at Sugar Bay; given that the herringbone panels do not extend to that point, no subsidence is expected. There are also two low water buoys (063 and 064) in the Morisset Peninsula area; these buoys are located within the SGPB, such that <20mm of subsidence is expected.

The built features along the foreshore, including houses and jetties, do not extend beyond the mapped sea grass beds. Given that <20mm of subsidence is predicted, no measurable impacts are expected on the foreshore features.

Given the limited overburden caving and predicted vertical subsidence of <0.5m, it is unlikely that measurable horizontal movements will be experienced beyond an angle of draw of 26.5° from the extraction limits. However, NSW Spatial Services should be notified, so that any affected survey markers can be managed and re-established if necessary.

7.0 MONITORING

A key feature of the area of interest is that as mining progressively extends to the north, the focus of monitoring will shift from the existing activities centred on the Summerland Point area. The following specific comments are made:

i) Periodic surveying of the Pelican Rock Navigation Marker and bathymetric surveys of the MW S2 to S5 area should be maintained until herringbone Panel HB-E1B is extracted.

ii) Once HB-E1B Panel is extracted, periodic bathymetric surveys should continue from HB-E1B panel to the other herringbone extraction panels in the north and west.

iii) With regard to the minor cliffs along the south side of the Morisset Peninsula, negligible subsidence (i.e. <20mm) is expected. Conventional survey approaches are considered to be no value, noting in particular that cliffs are insensitive to tilt magnitudes of <6mm/m. However, it is considered likely that occasional falls of small, joint-bounded blocks from the cliff faces due to natural weathering processes will continue (note the fallen rocks in **Figures 35b-c**). Therefore, it is suggested that a video record of the cliff faces be created and periodically updated.

iv) Finally, it will almost certainly be considered necessary to confirm the absence of appreciable subsidence in the Fishery Point / Sunshine area and this is likely to necessitate the establishment of a local levelling line.

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Appendix A: Glossary of Key Terms

Angle of Draw

The angle from the vertical of a line drawn between the limit of extraction at seam level (goaf edge) and the 20mm subsidence contour on surface, which is historically regarded as the practical limit of measurable subsidence.

Chain Pillar

The unmined block or pillar of coal left between extracted miniwall panels.

Cover Depth

The depth from surface to the top of the seam.

Critical Panel Width

The minimum width of extraction at which the maximum possible subsidence at a point on surface first occurs.

Far-Field Movements

Horizontal movements well beyond the panel boundaries, over solid unmined coal. Such movements tend to be *en masse* movements towards the extracted area, with very low levels of associated strain.

First Workings

Tunnels, roadways or “bords” driven by a continuous miner to provide access to extraction panels in a mine.

Goaf

The void created by the extraction of coal, into which the immediate roof layers collapse or “cave”.

Horizontal Displacement

The horizontal movement of a point on surface due to underlying coal extraction.

Mining Height

The height at which a coal seam is mined; this may not equal the seam thickness.

Panel

The plan area of coal extraction.

Panel Length

The longitudinal distance along a panel measured in the direction of mining, from the commencing rib to the finishing rib.

Panel Width

The transverse distance across a panel between chain pillars.

Secondary Extraction

The extraction of coal pillars or blocks, resulting in the formation of a goaf as the coal is removed.

Strain

The change in horizontal distance between two points, divided by the original horizontal distance between the points. Strain is dimensionless and can be expressed as a decimal or a percentage, but commonly as mm/m. **Tensile Strains** involve an increase in distance between two points, whereas **Compressive Strains** involve a reduction.

Sub-Critical Width

A panel width less than the critical width.

Subsidence

The difference between the pre and post-mining surface level at a point.

Subsidence Control

Reducing the impact of subsidence on a feature by reducing the amount of coal extracted.

Subsidence Effect

Vertical subsidence due to mining, including related parameters, such as horizontal displacement, tilt and strain.

Subsidence Impact

The change (most commonly damage) to a natural or built feature caused by subsidence effects.

Subsidence Mitigation / Amelioration

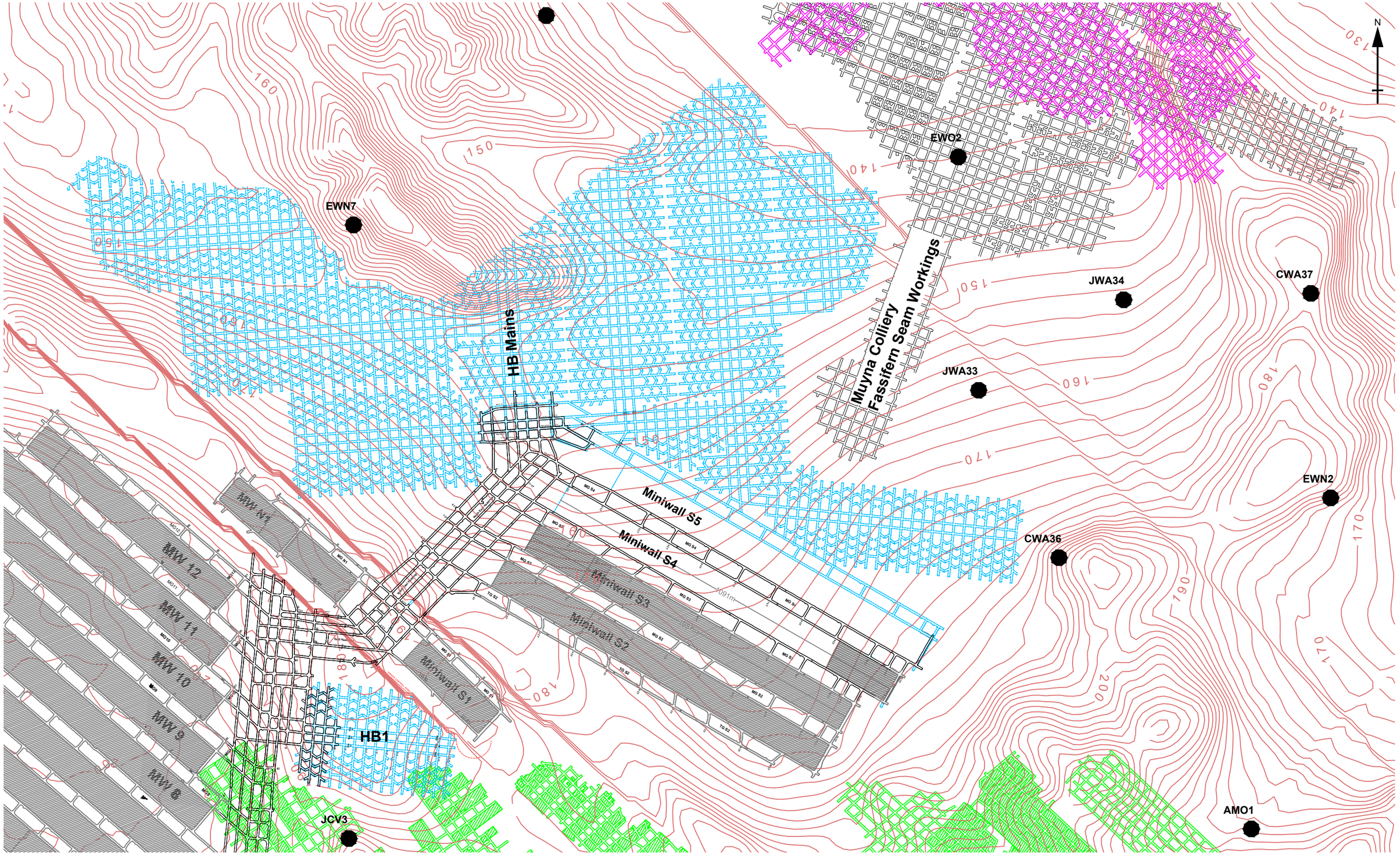
Modifying or reducing the impact of subsidence on a feature to within tolerable limits.

Super-Critical Area

A panel width greater than the critical width.

Tilt

The rate of change of subsidence between two points a known distance apart, plotted at the mid-point and commonly expressed as mm/m.

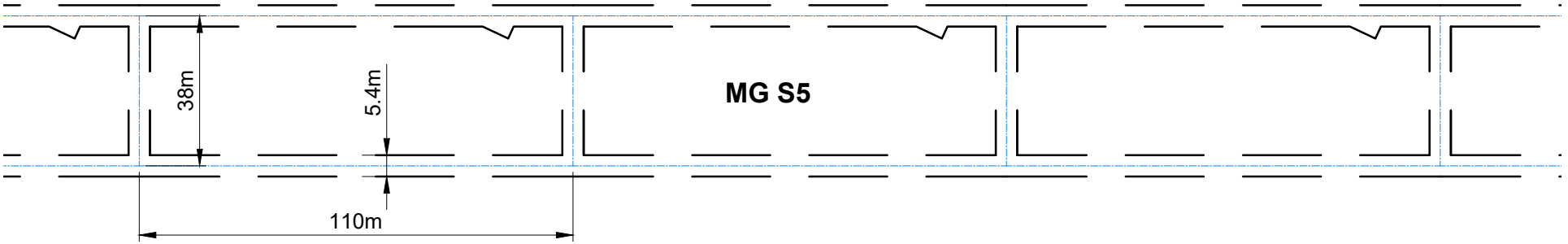


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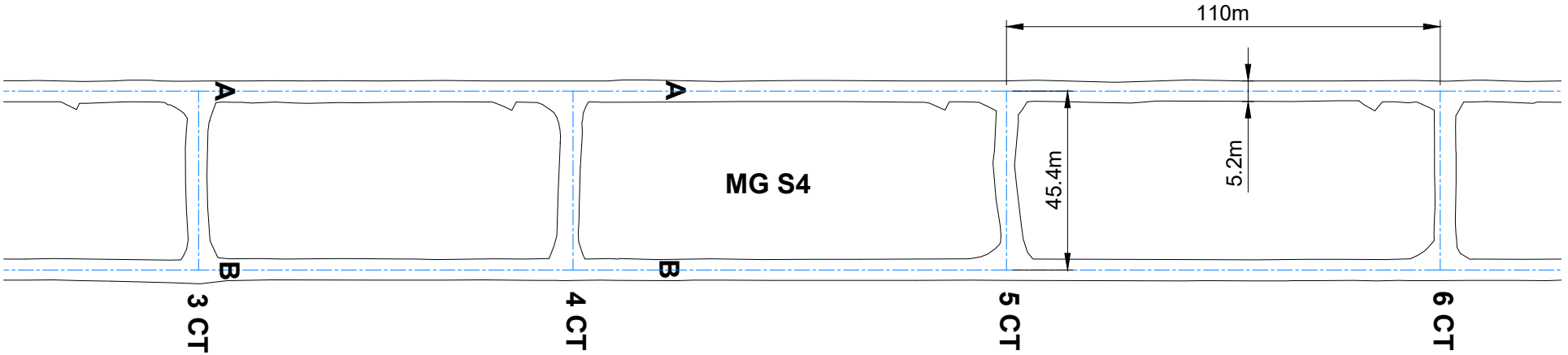
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- CVC Wallarah Seam Workings
- CVC Planed Fassifern Seam Workings
- Muyna Wallarah Seam Workings

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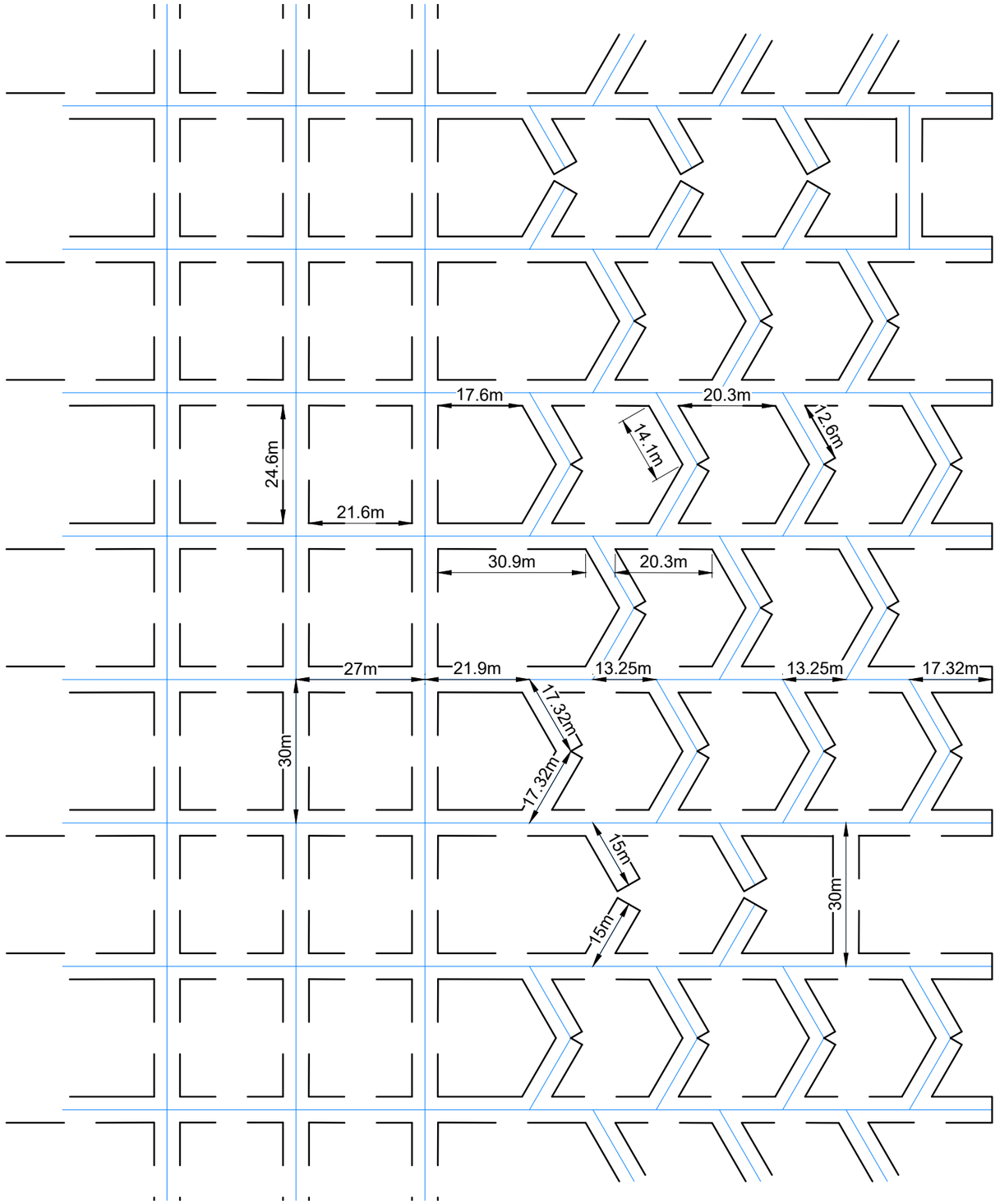
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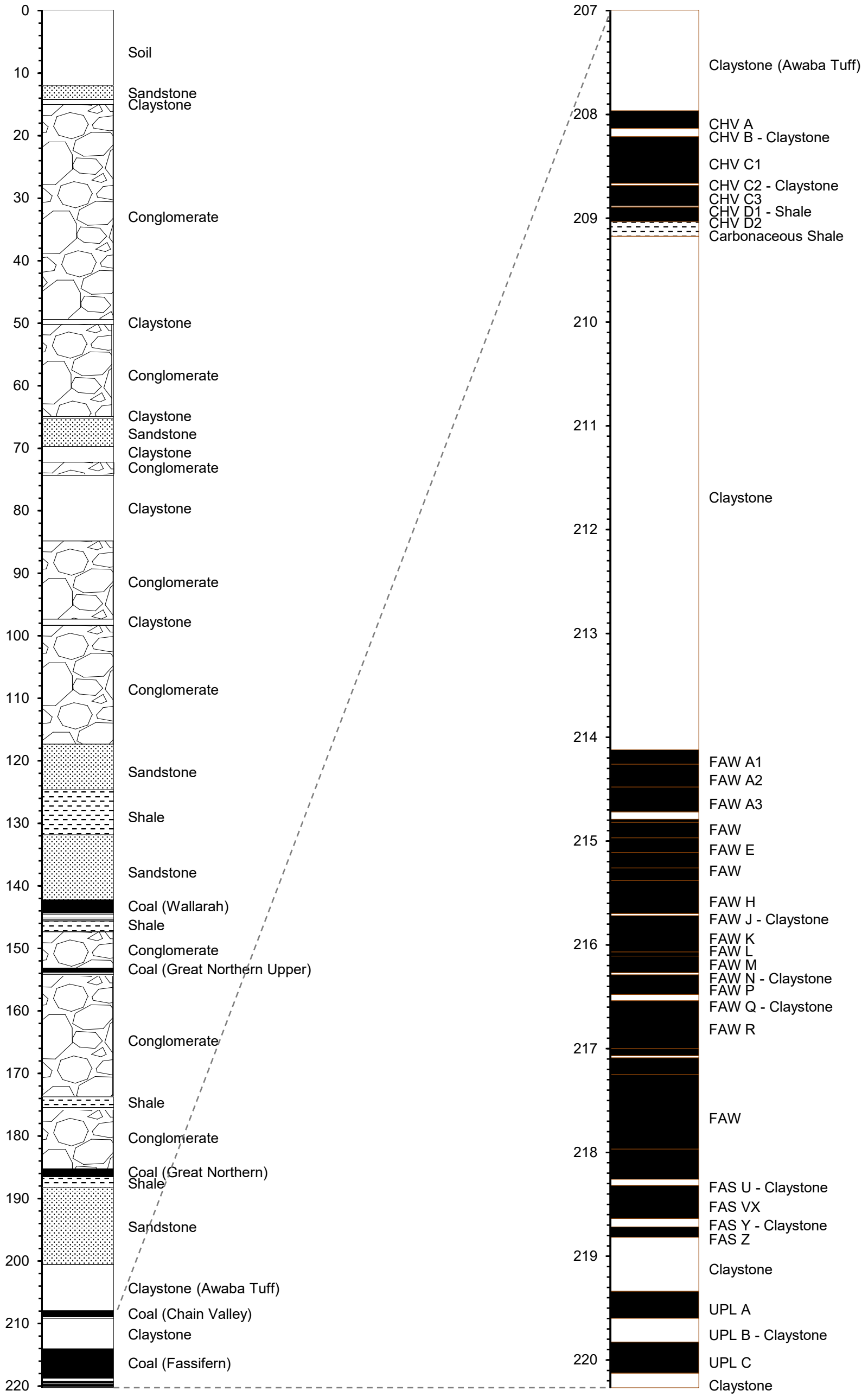
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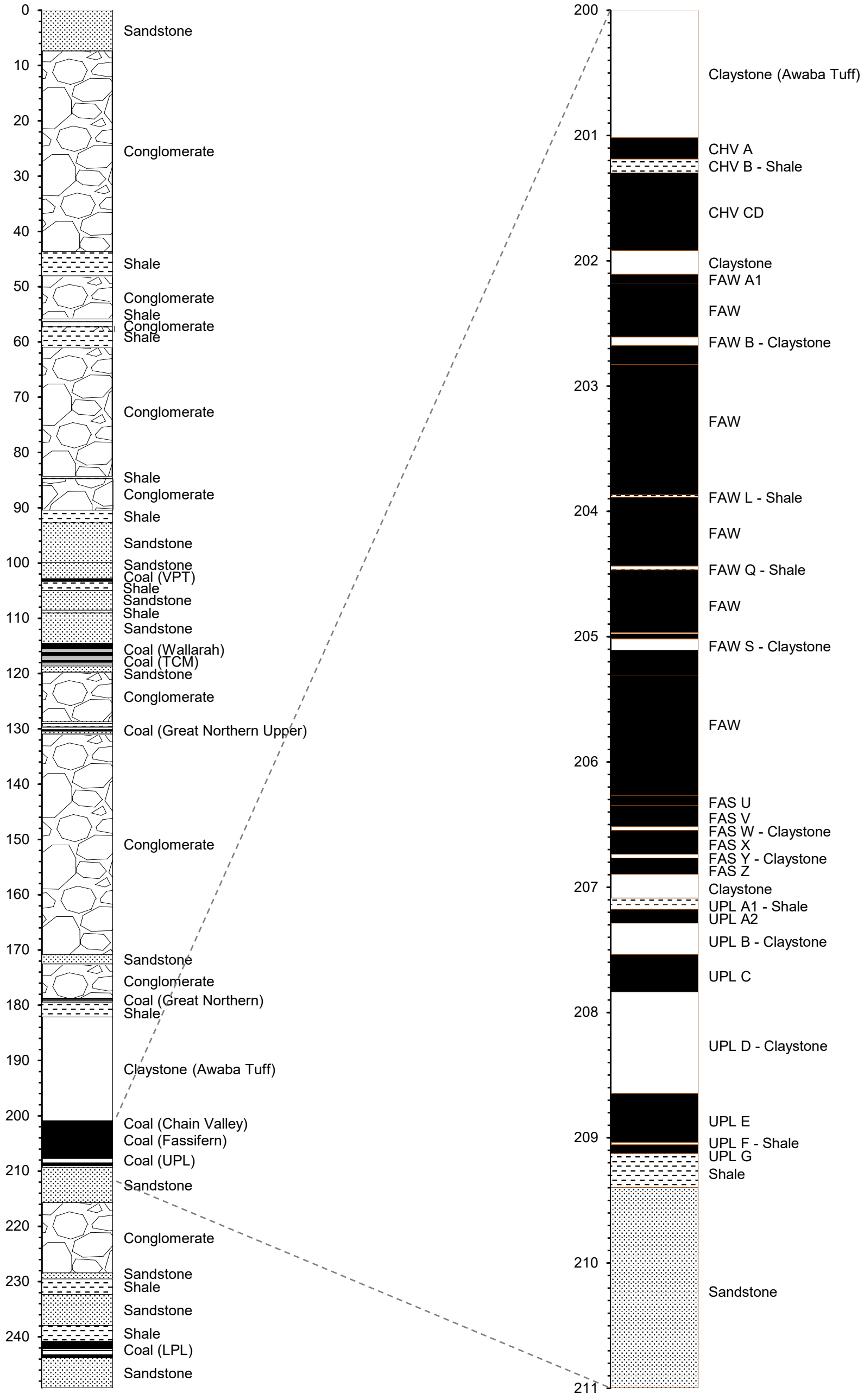
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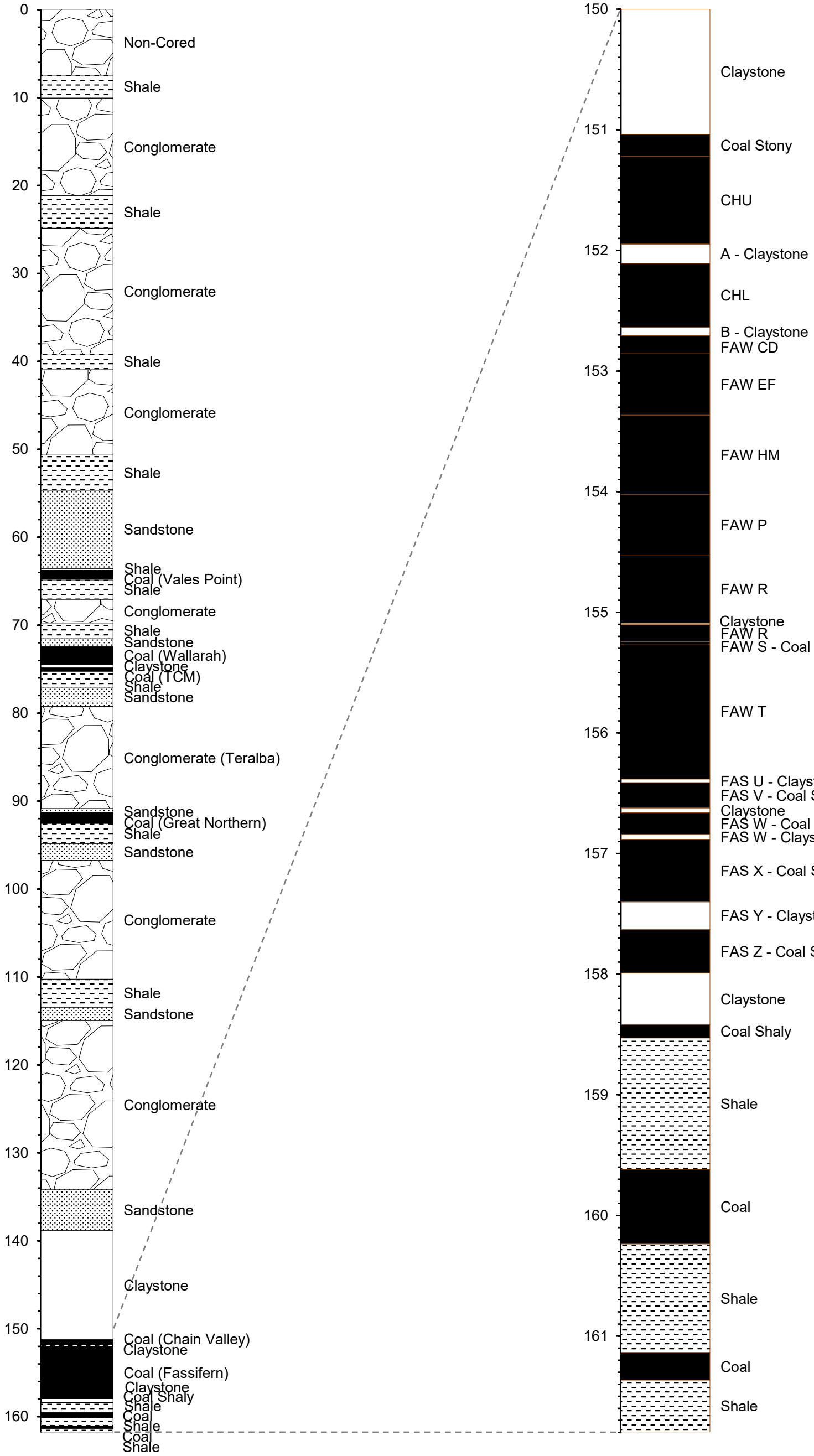
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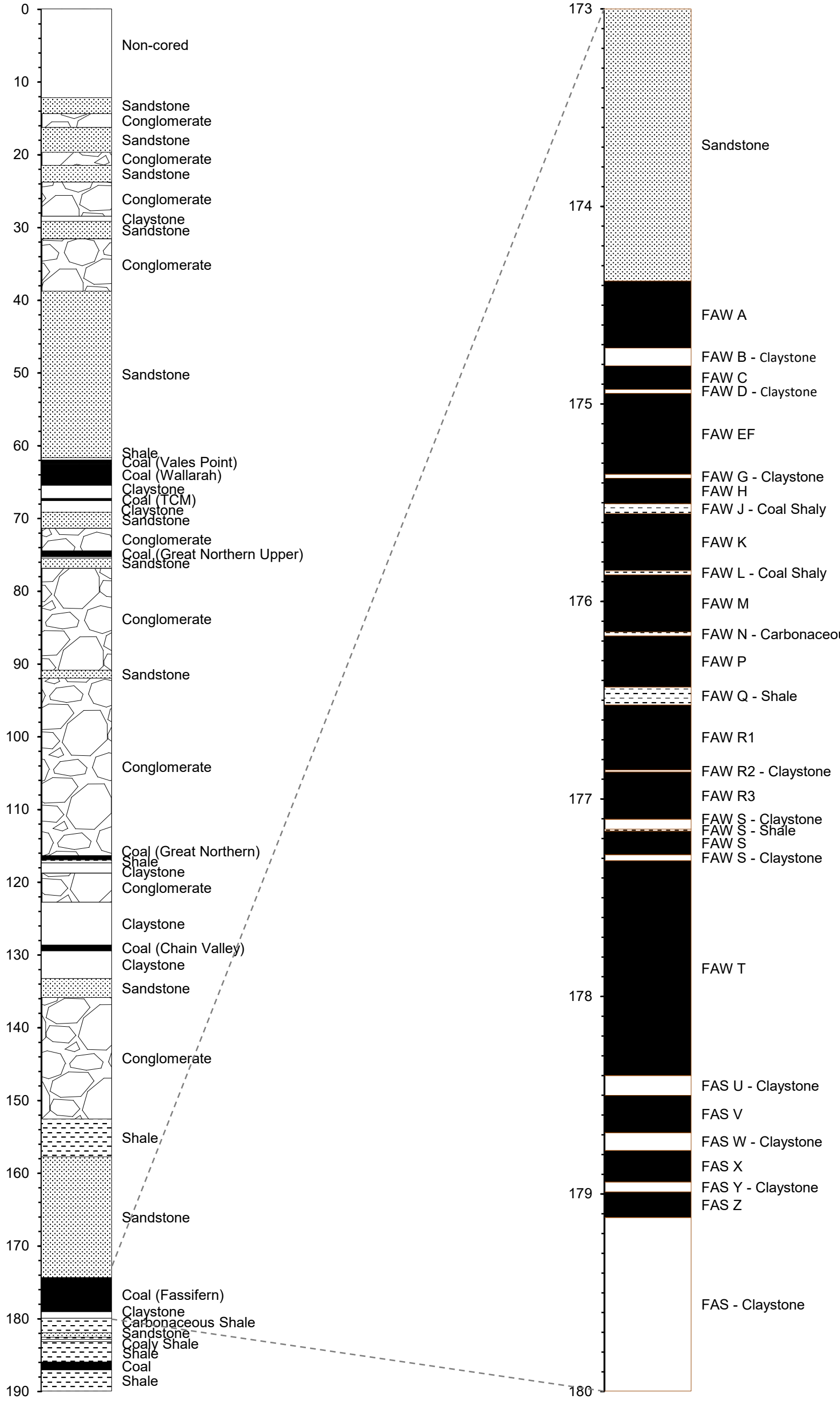
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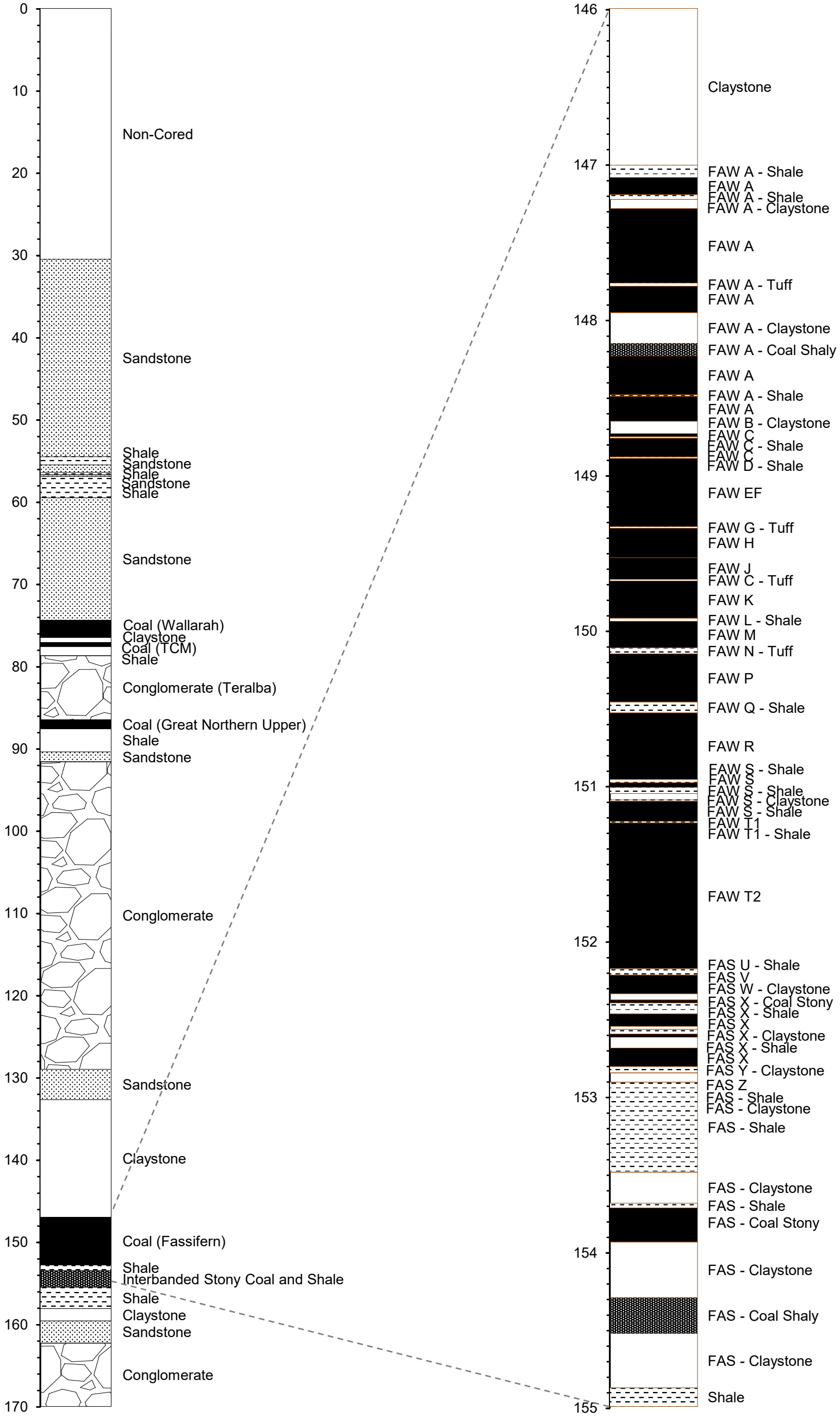
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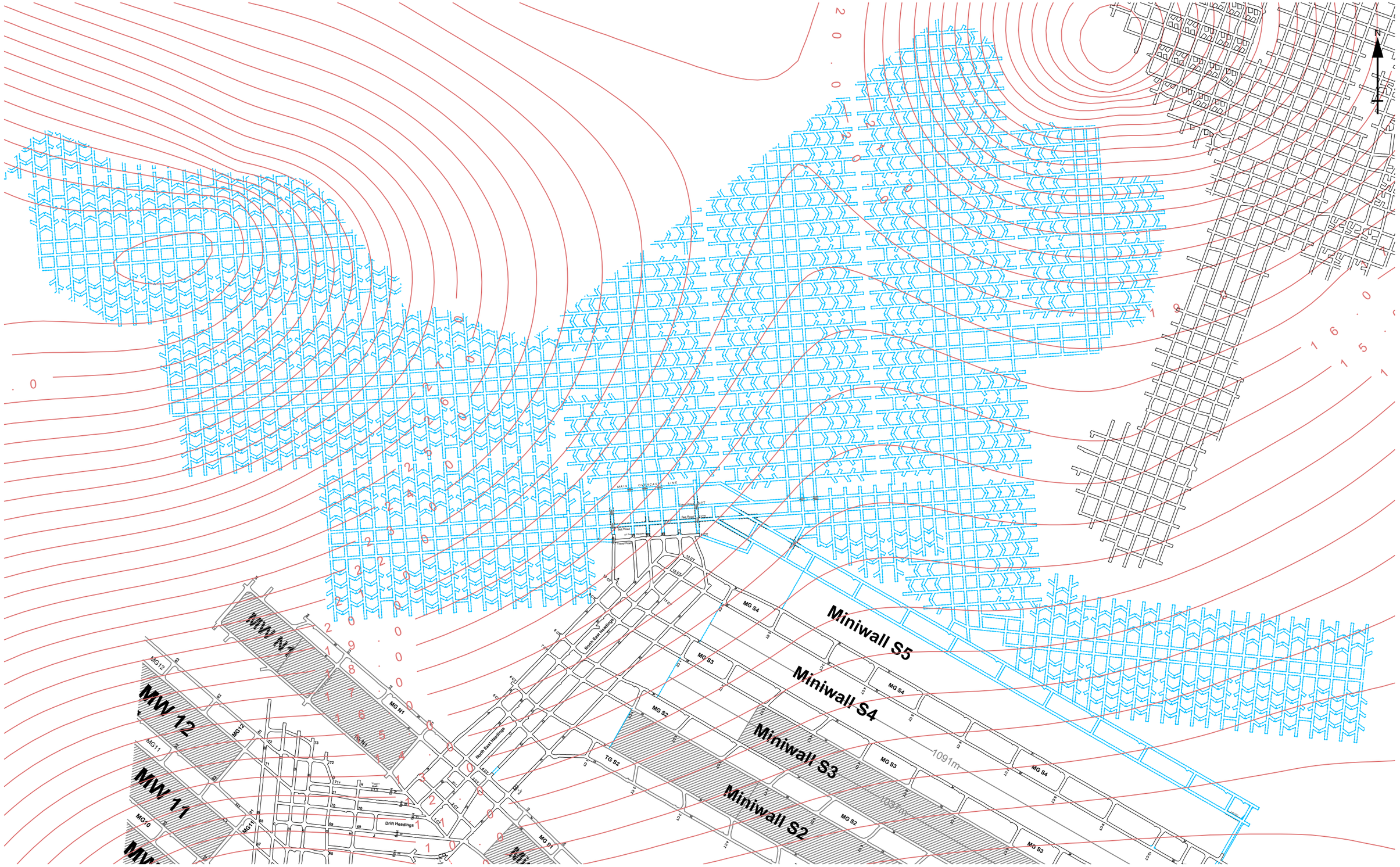
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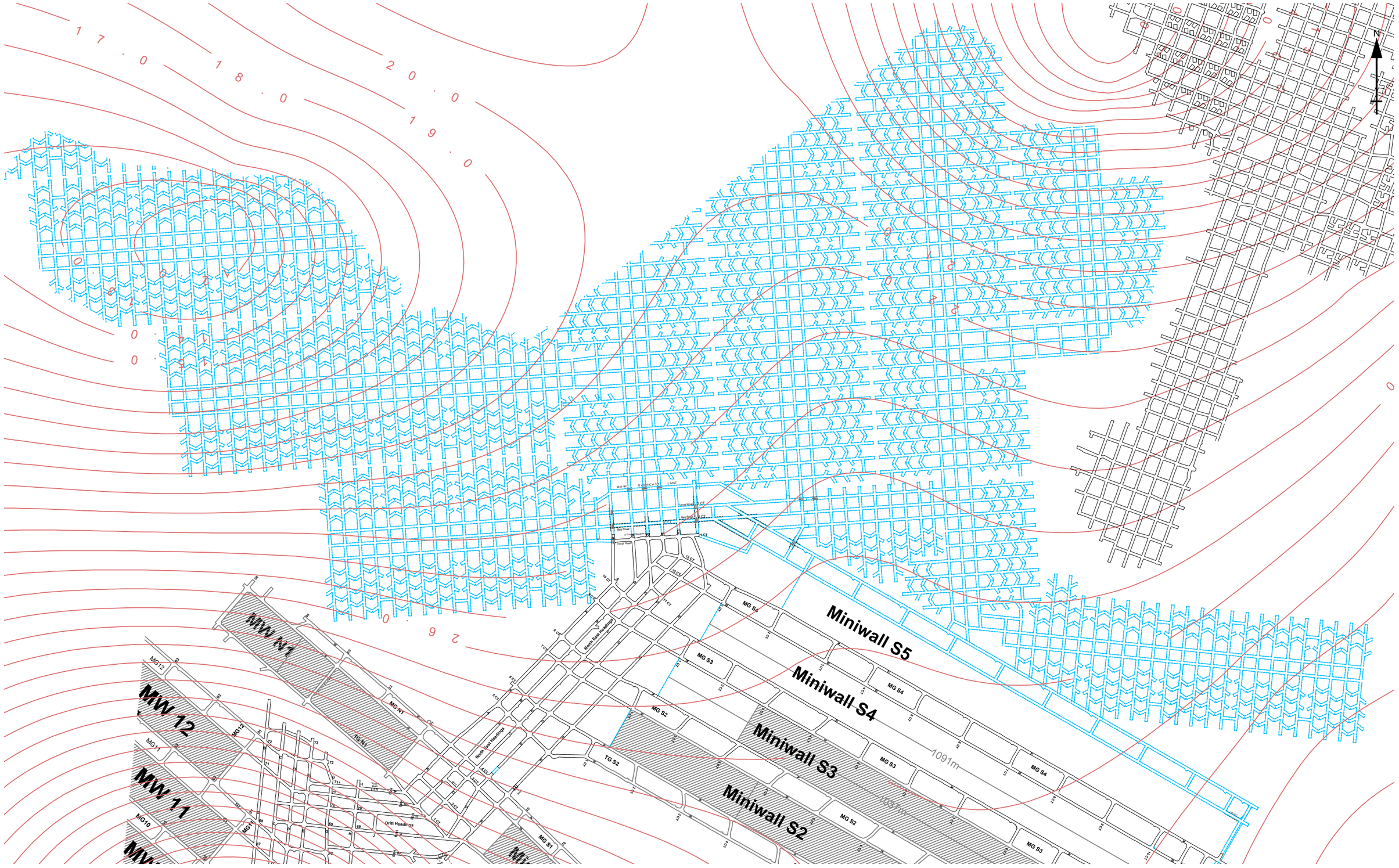


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MW 12
MW 11
MW 10
MW N1
MG N1
MG12
MG11
MG10
TG M1
North East Headings
Drift Headings
MG S1
MG S2
TG S2
MG S3
MG S4
Miniwall S2
Miniwall S3
Miniwall S4
Miniwall S5
1091m
1031m
MAIN CLEARWAY LINE
Bell Road
Head Road
Bell Road 1
Bell Road 2
Bell Road 3
Bell Road 4
Bell Road 5
Bell Road 6
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Bell Road 8
Bell Road 9
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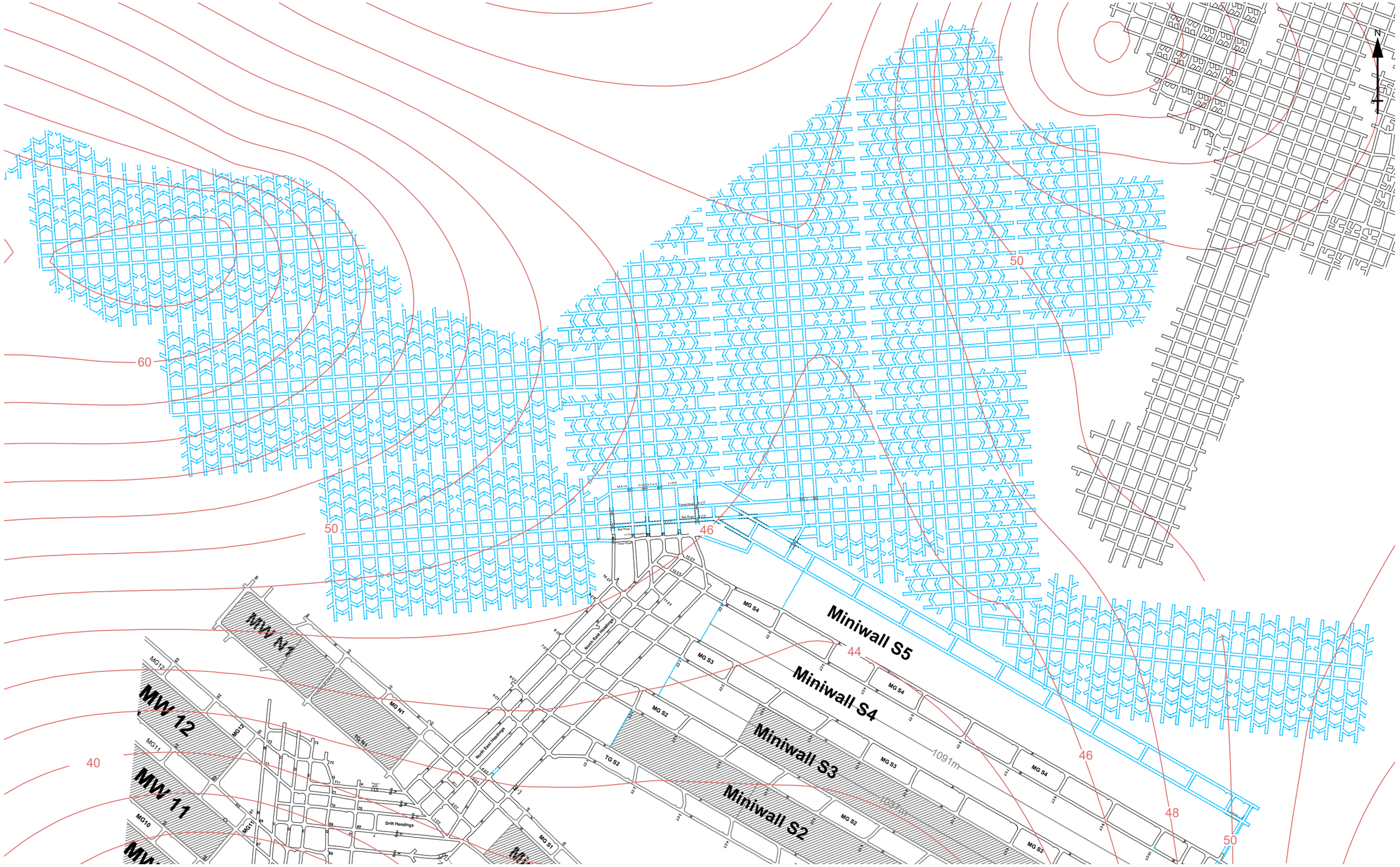


Key:

~ - TER thickness (m)

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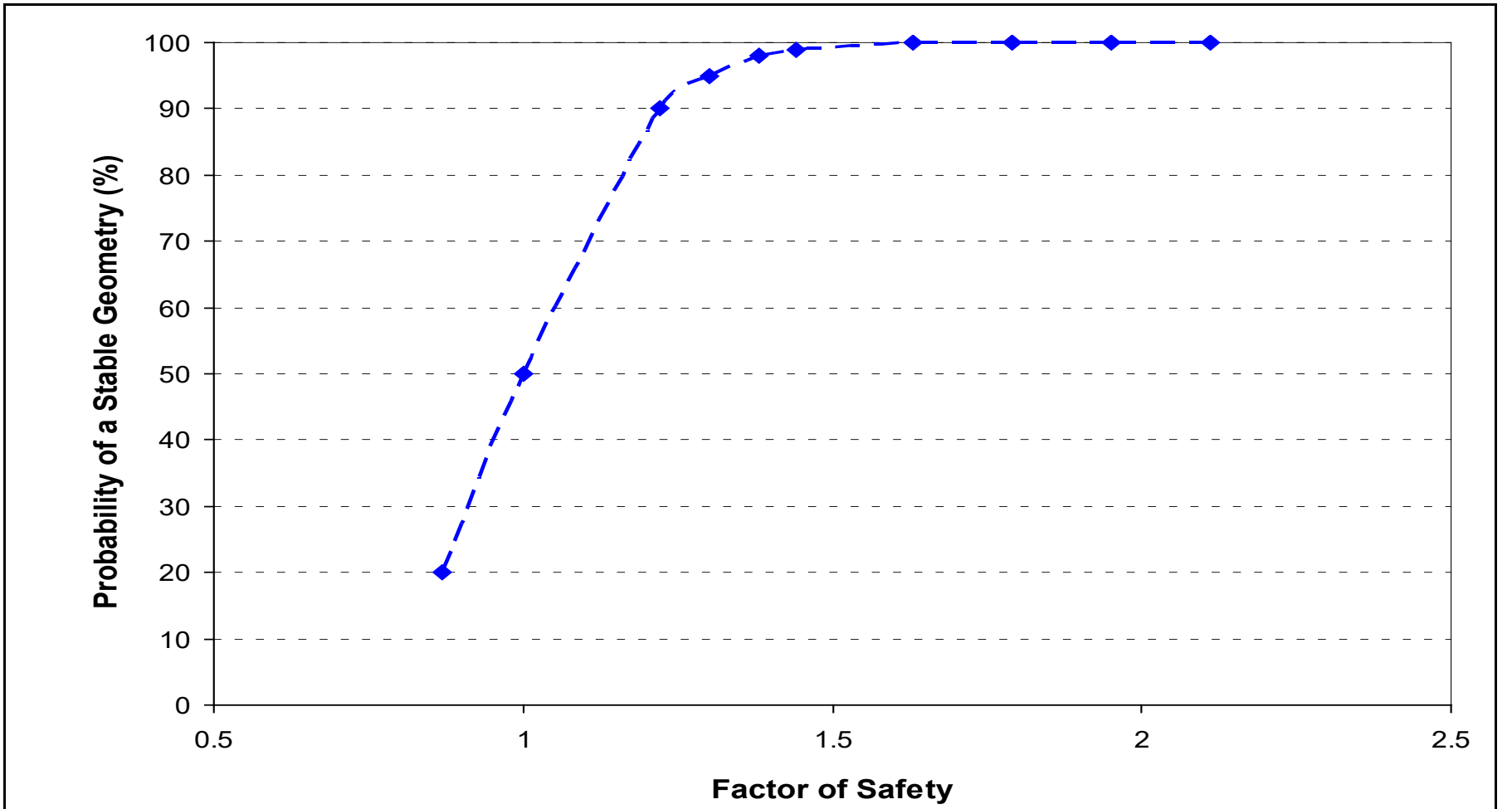
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Key:

~ - GNW / FAS thickness (m)

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Interburden Thickness from Great Northern Floor to Fassifern Roof (GNW/FAS)
Date:	04.12.20		
	STRATA²	**Ref:**	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	7



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Salamon Factor of Safety versus Probability of Stability		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	8

Figure 9a: Successful and Failed Cases (Failure nominally defined by >200mm of Subsidence)

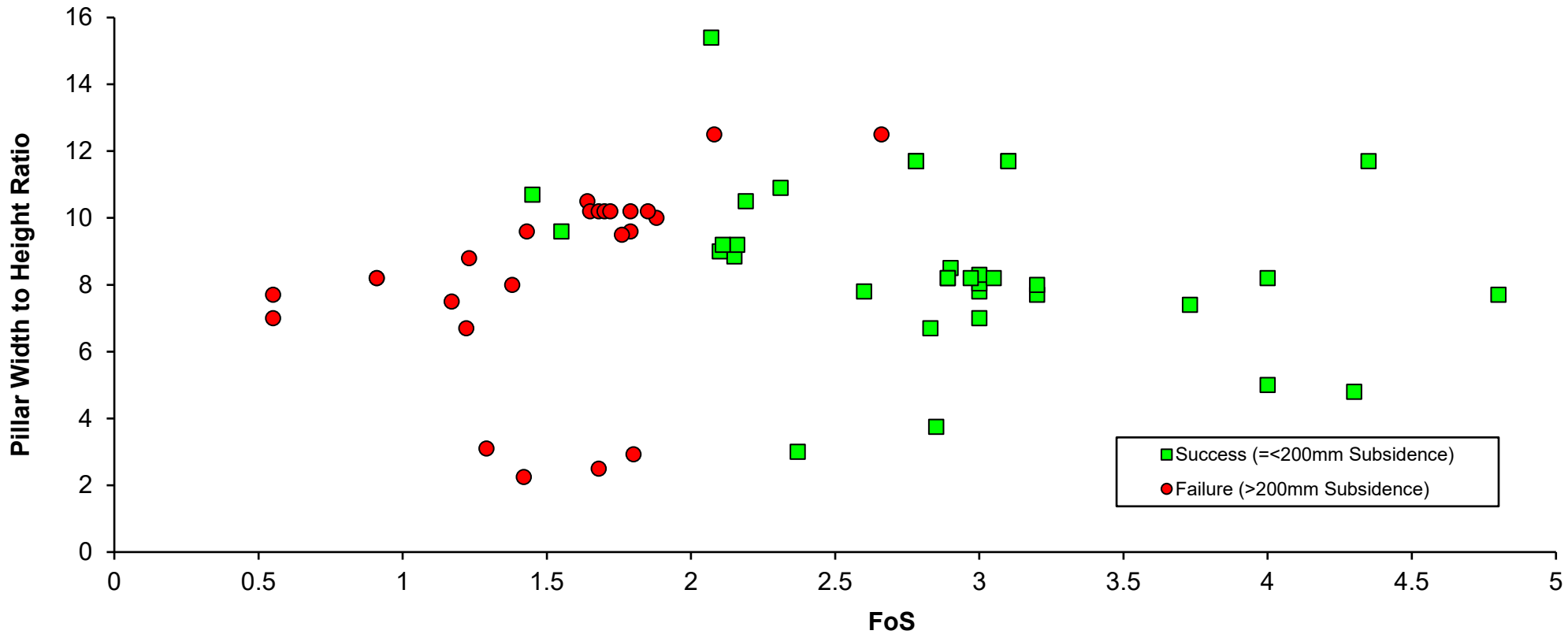


Figure 9b: Successful and Failed Cases (Cases involving Pillar Stresses >15MPa Excluded)

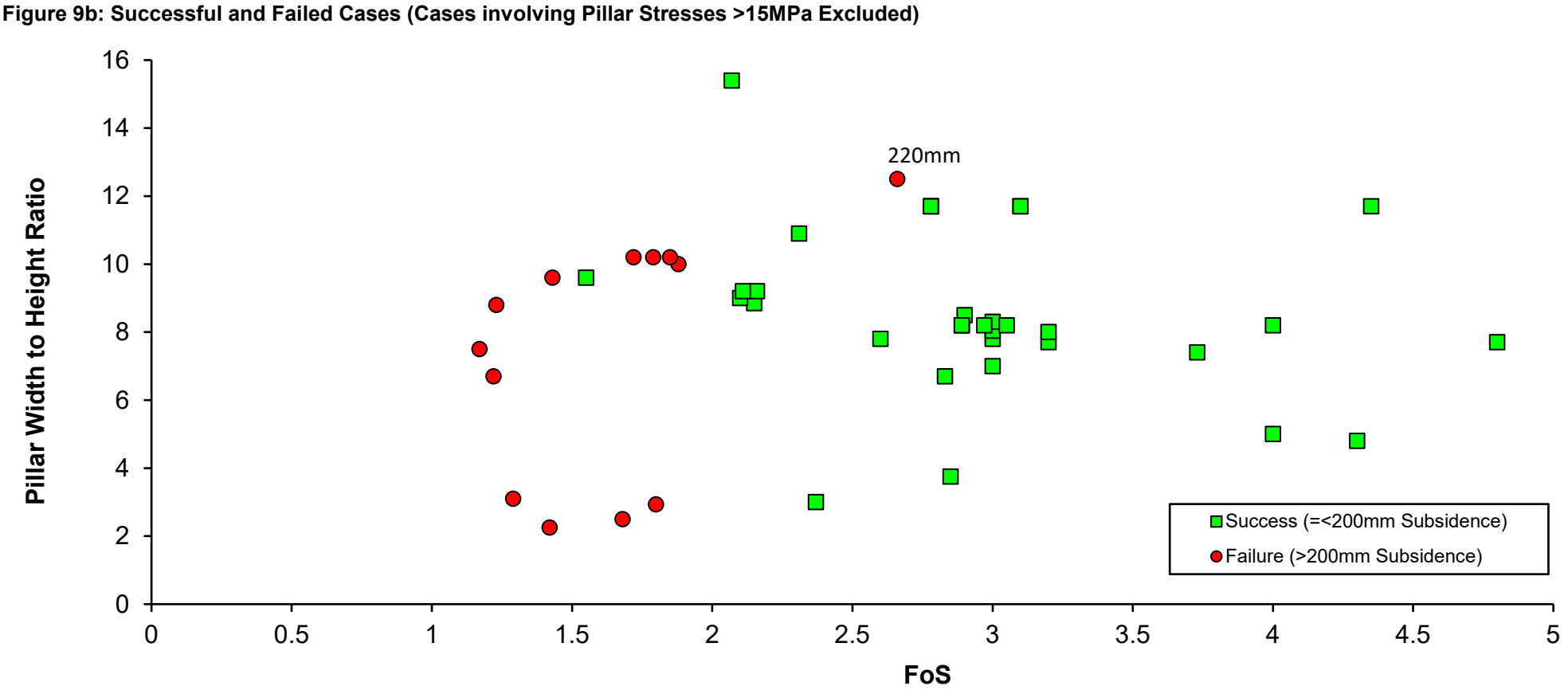
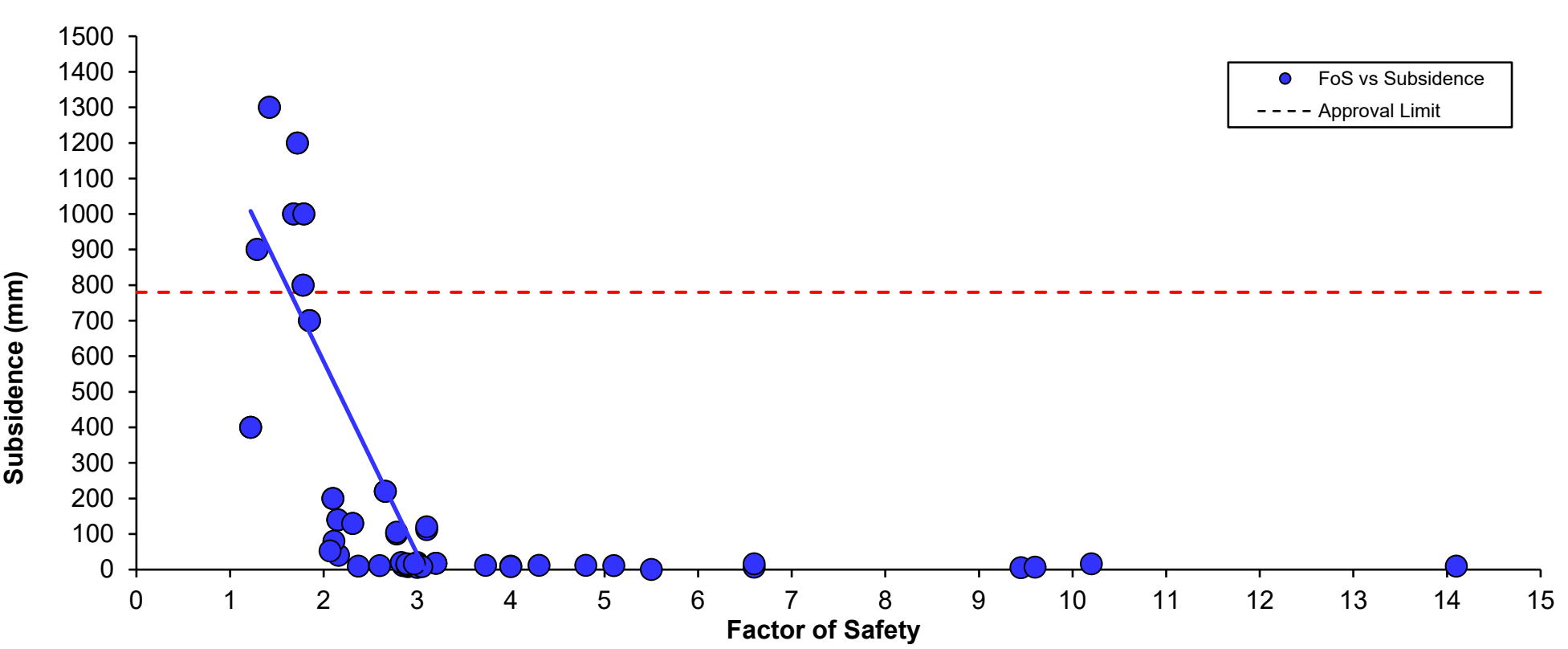


Figure 9c: Subsidence versus FoS, at Pillar Stress Values of <15MPa



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Lake Macquarie Pillar Database		
Date:	04.12.20				
		Ref:	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	9a/b/c

Figure 10a: Subsidence Results - All Data

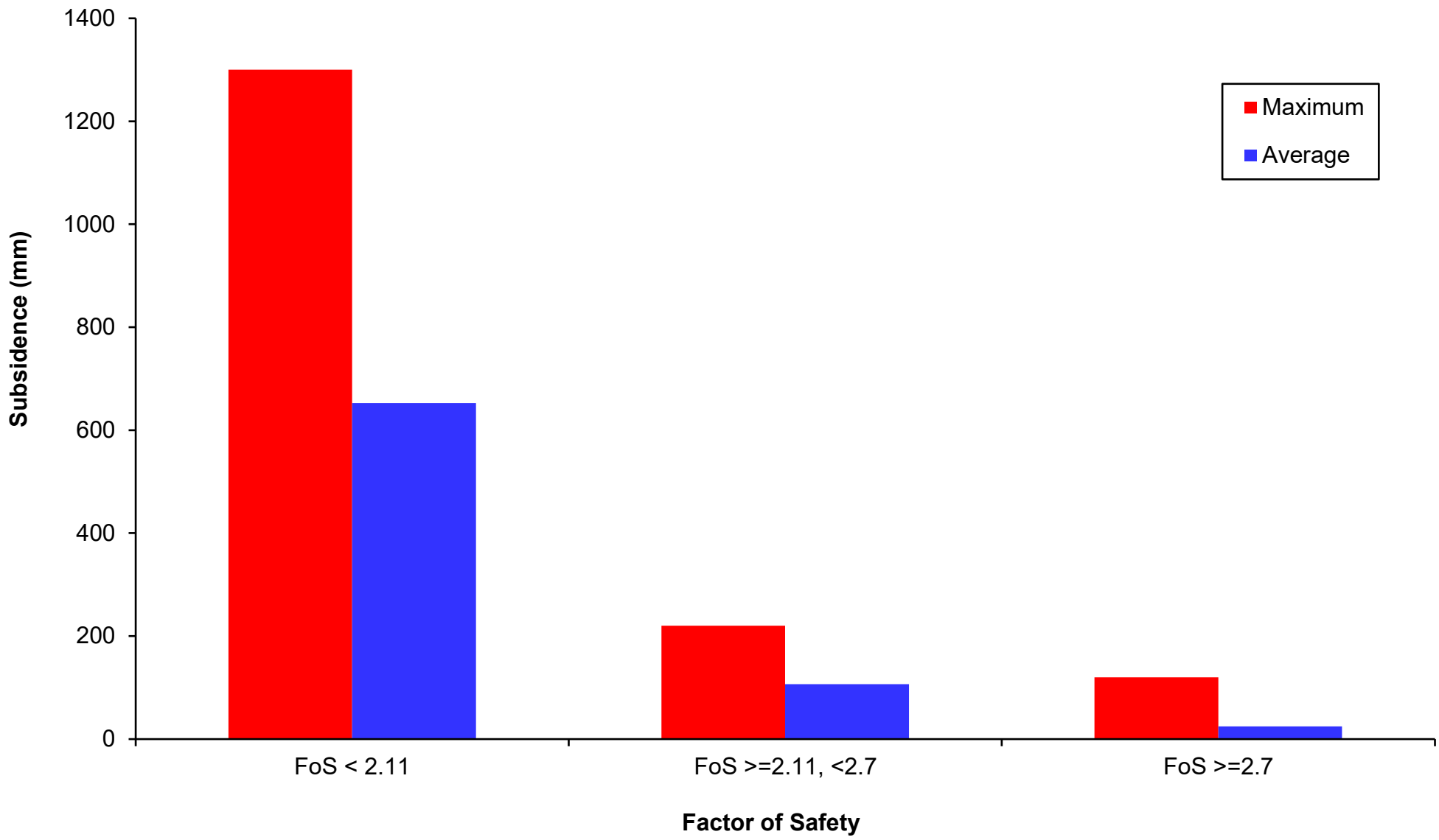
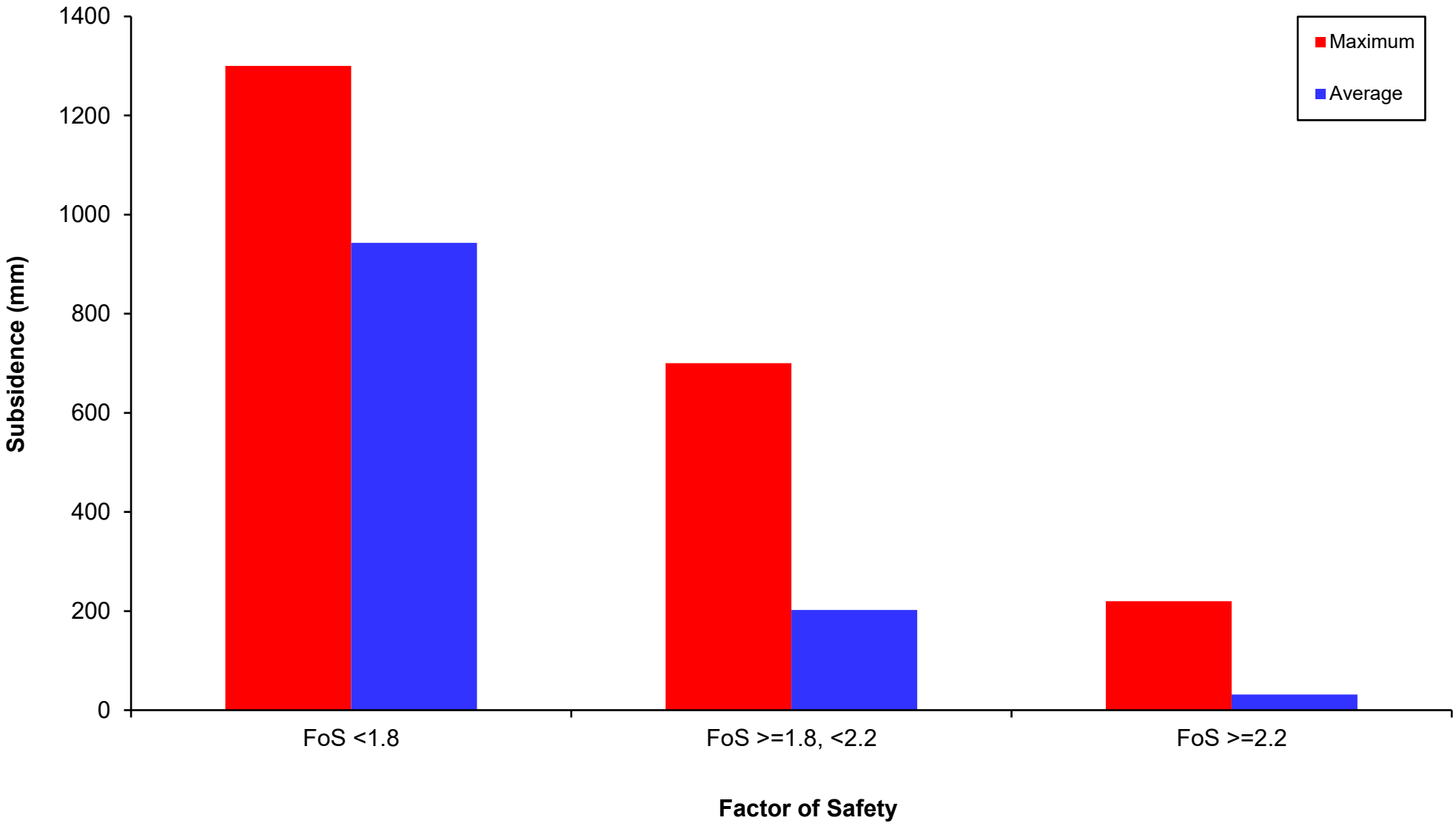
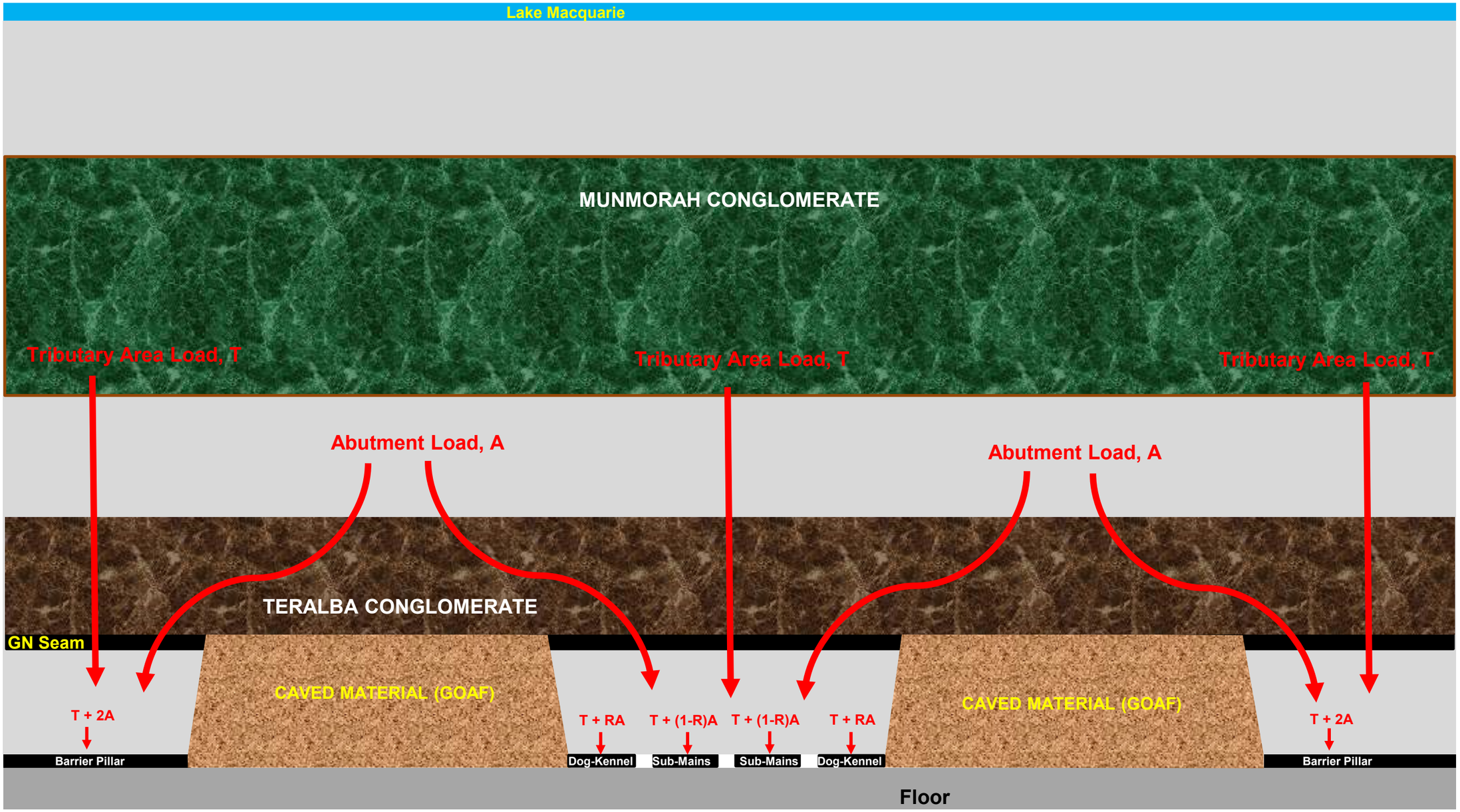


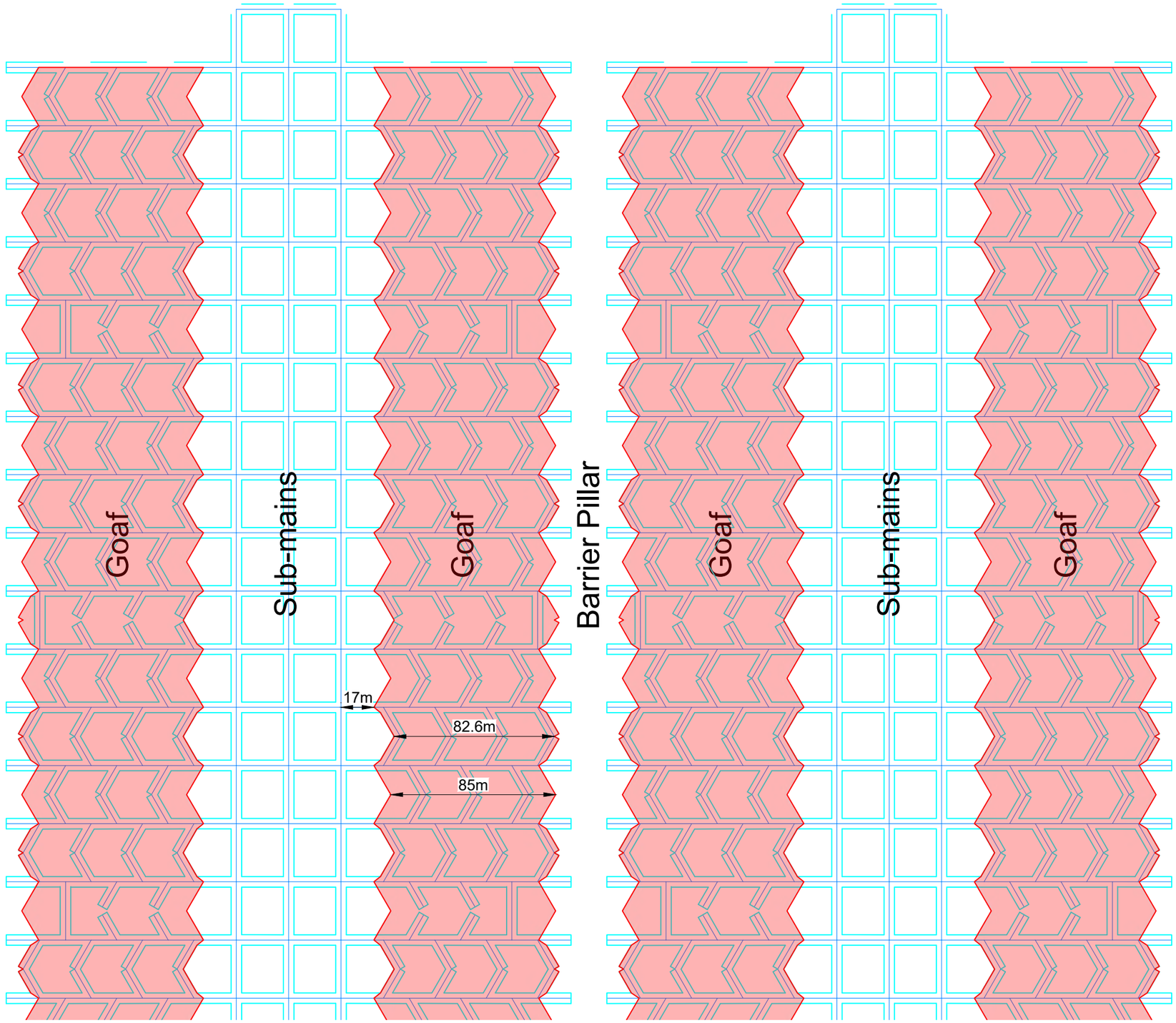
Figure 10b: Subsidence Results - Cases involving Pillar Stresses >15MPa Excluded



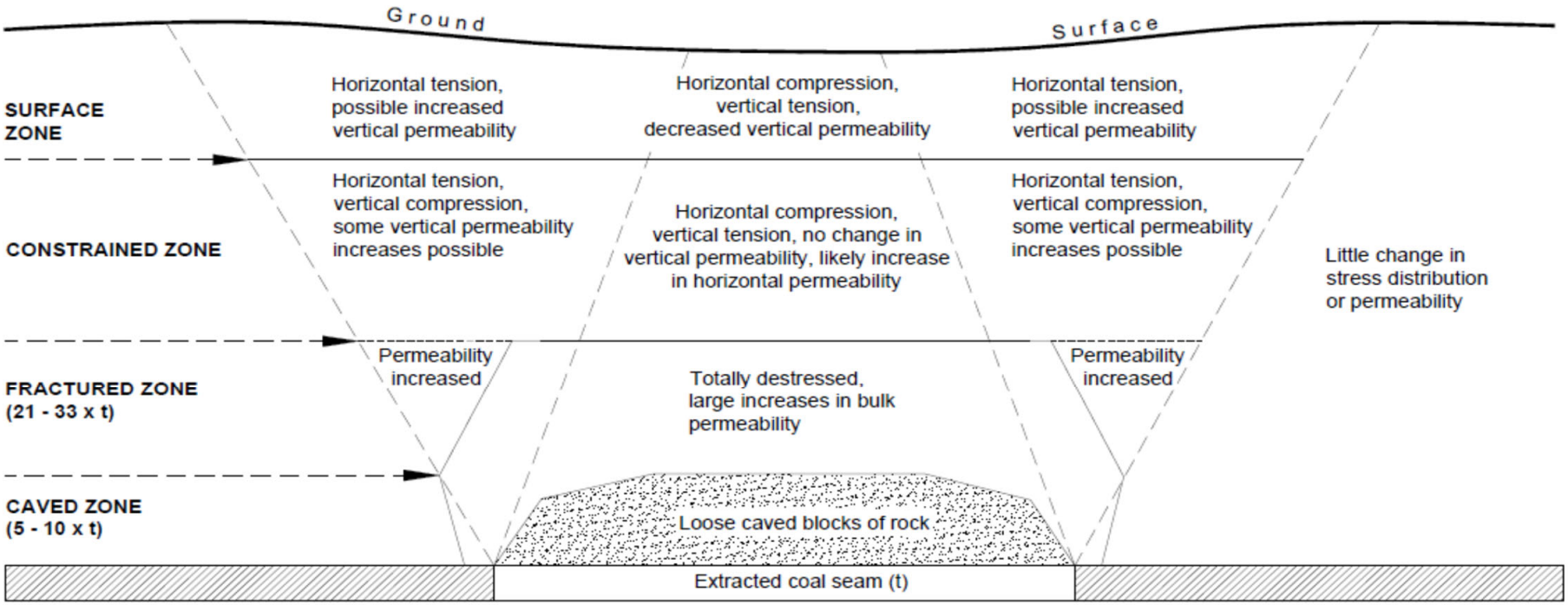
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Lake Macquarie Pillar Database: Subsidence vs FoS		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	10a/b



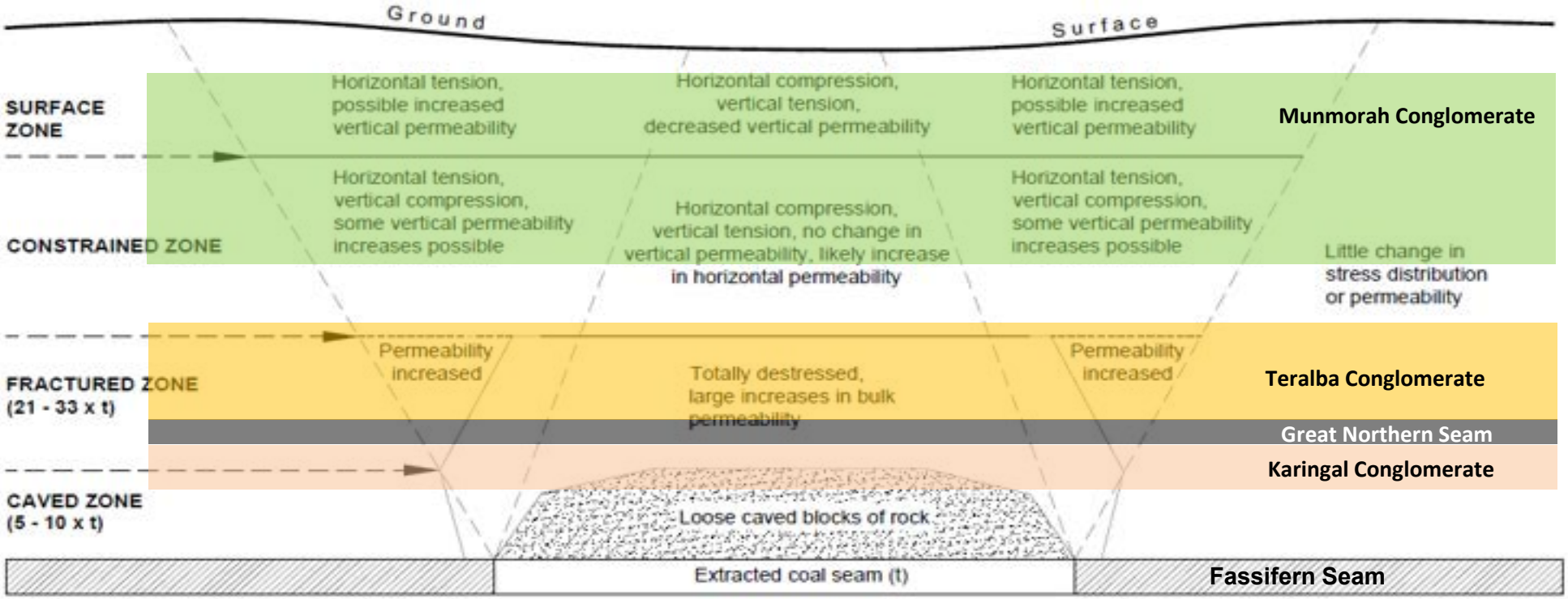
Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	D. Hill	**Title:**	Pillar Loading Schematic for the Herringbone Panel Secondary Extraction Operation
Date:	04.12.20		
STRATA²		**Ref:**	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	11



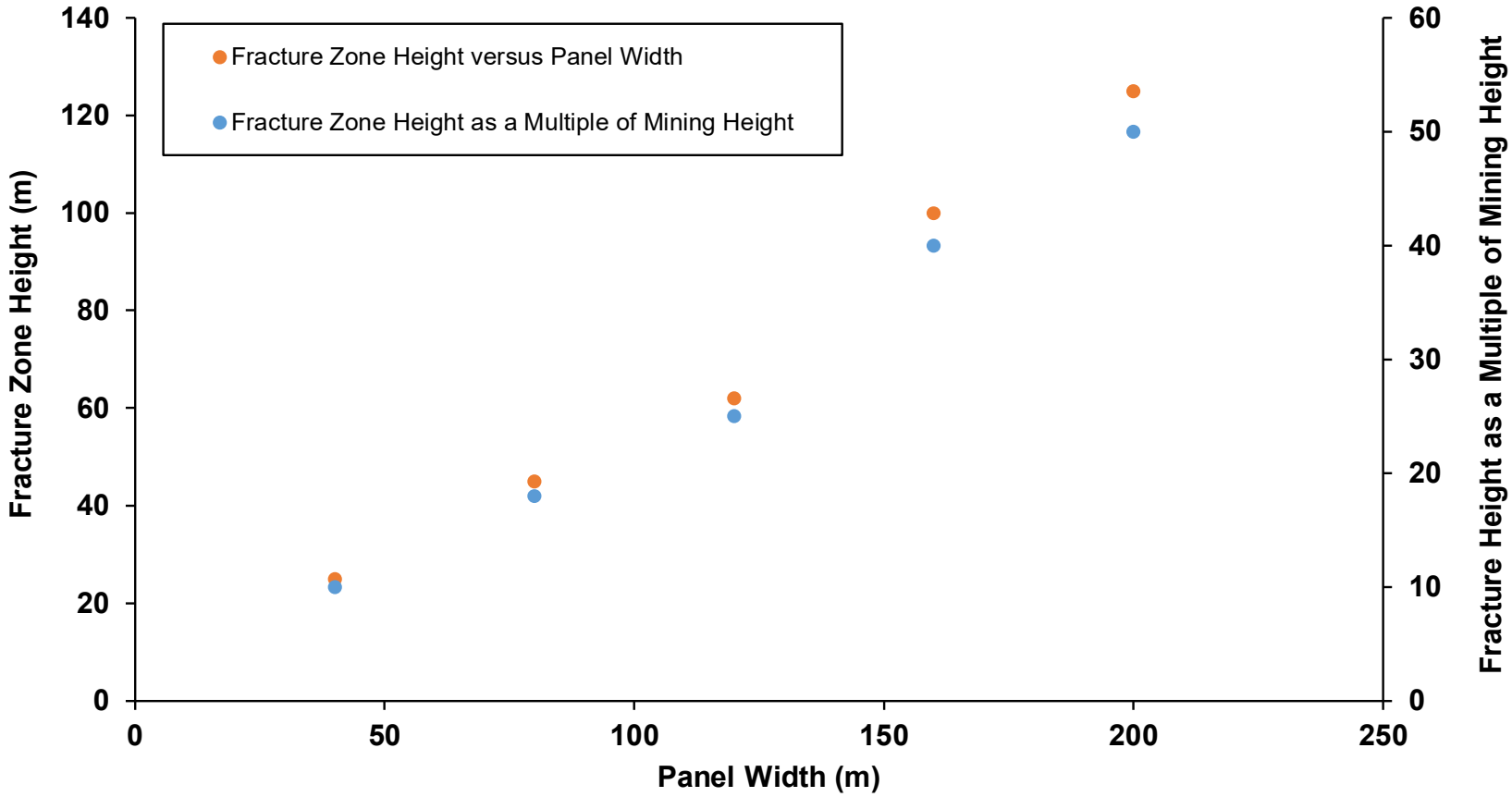
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	R. de Laubadere	**Title:**	Schematic Showing Herringbone Layout Following Secondary Extraction		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	NTS	**Figure No:**	12



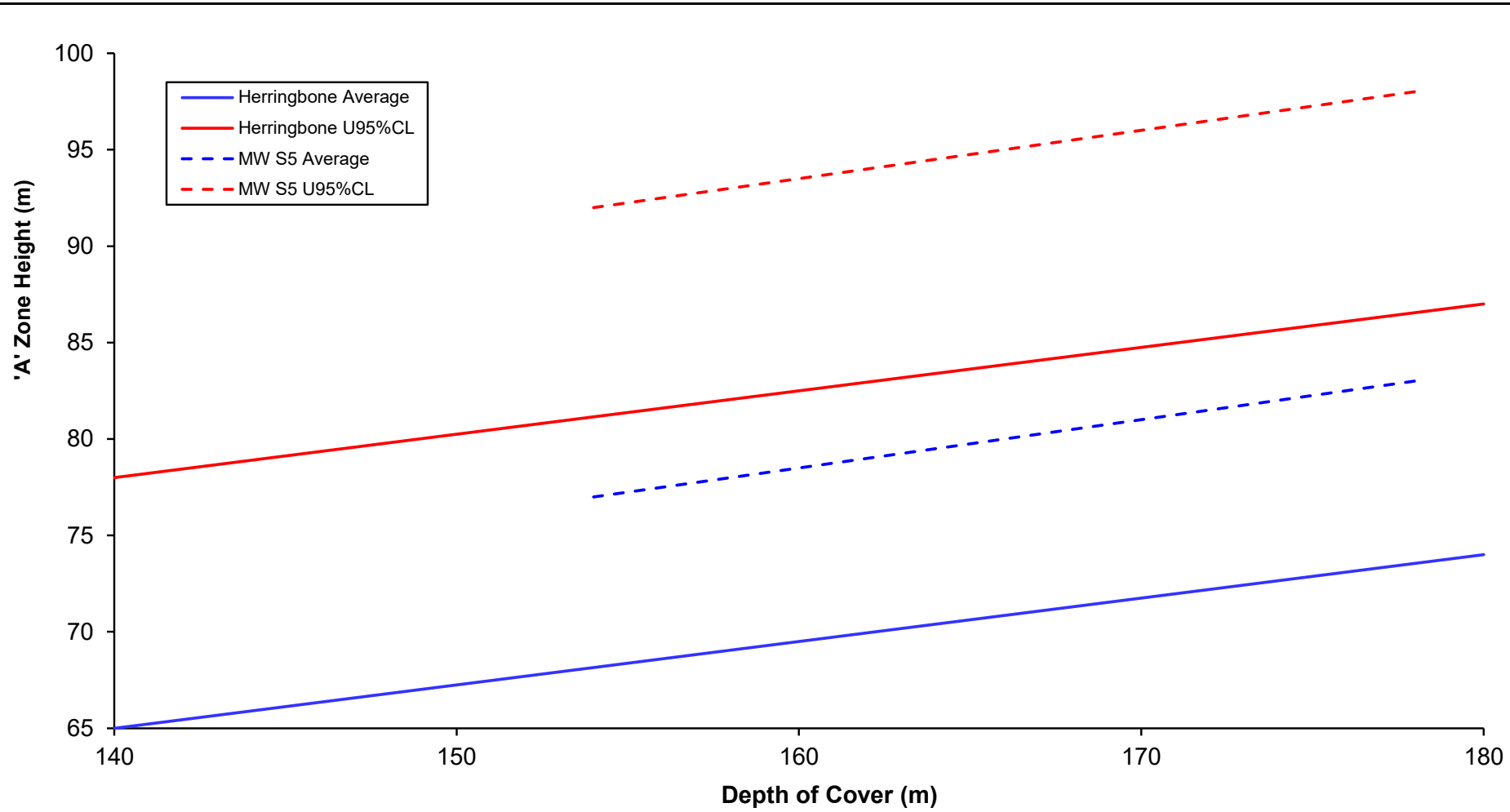
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Hydrogeological Model above a Caved Longwall Panel **(adapted from Forster and Enever, 1992)**		
Date:	03.11.2020				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	13a



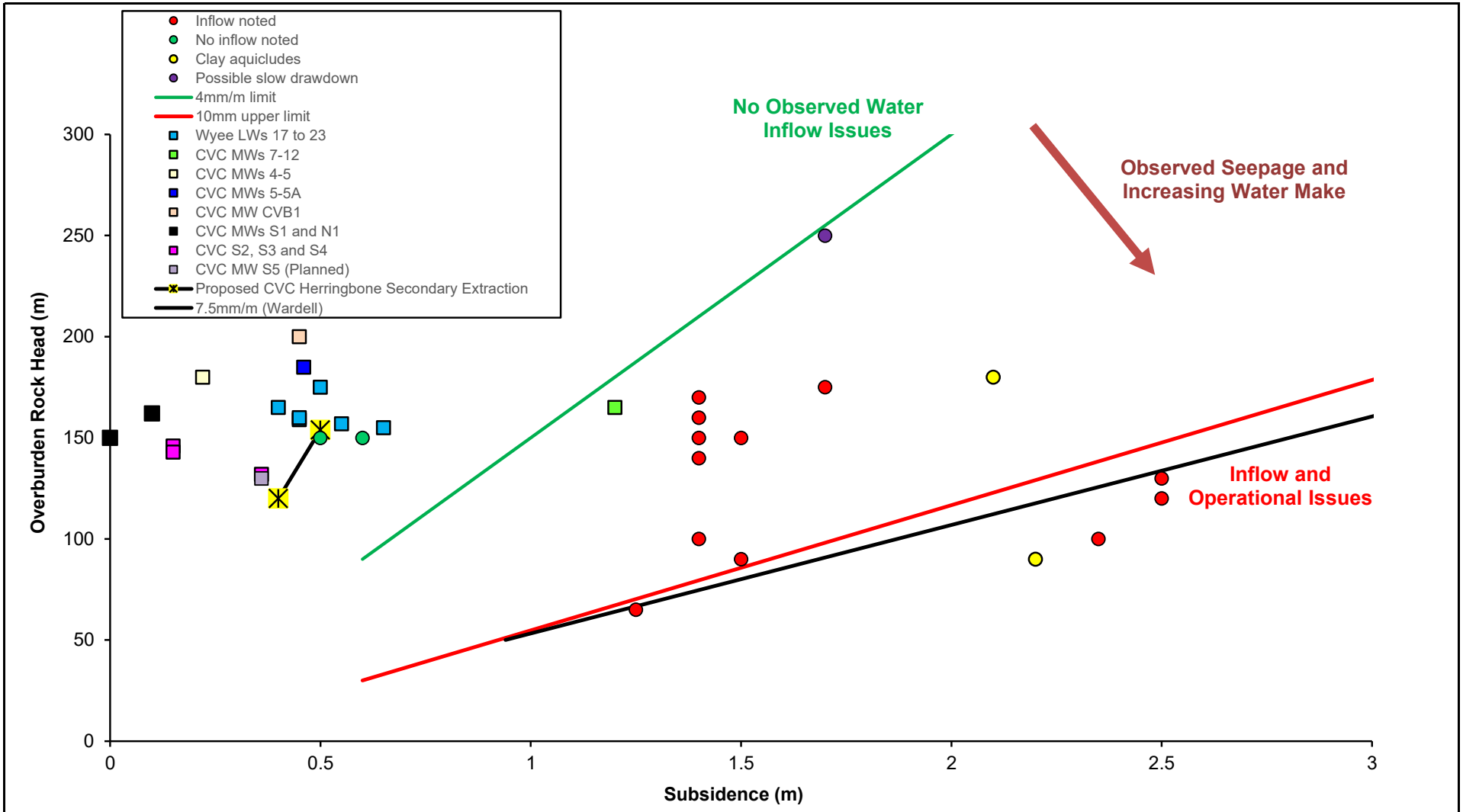
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Hydrogeological Model, showing the GN Seam, Karingal, Teralba and Munmorah Conglomerates in the Overburden (Schematic)		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-019	**Revision No:**	2
		Scale:	N/A	**Figure No:**	13b



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Fracture Zone Heights from Numerical Modelling **(Follington and Isaac, 1990)**		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	14



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Heights of Connective Fracturing for Extracted MW S5 and Herringbone Panels, based on **Ditton and Merrick (2014)**		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	15

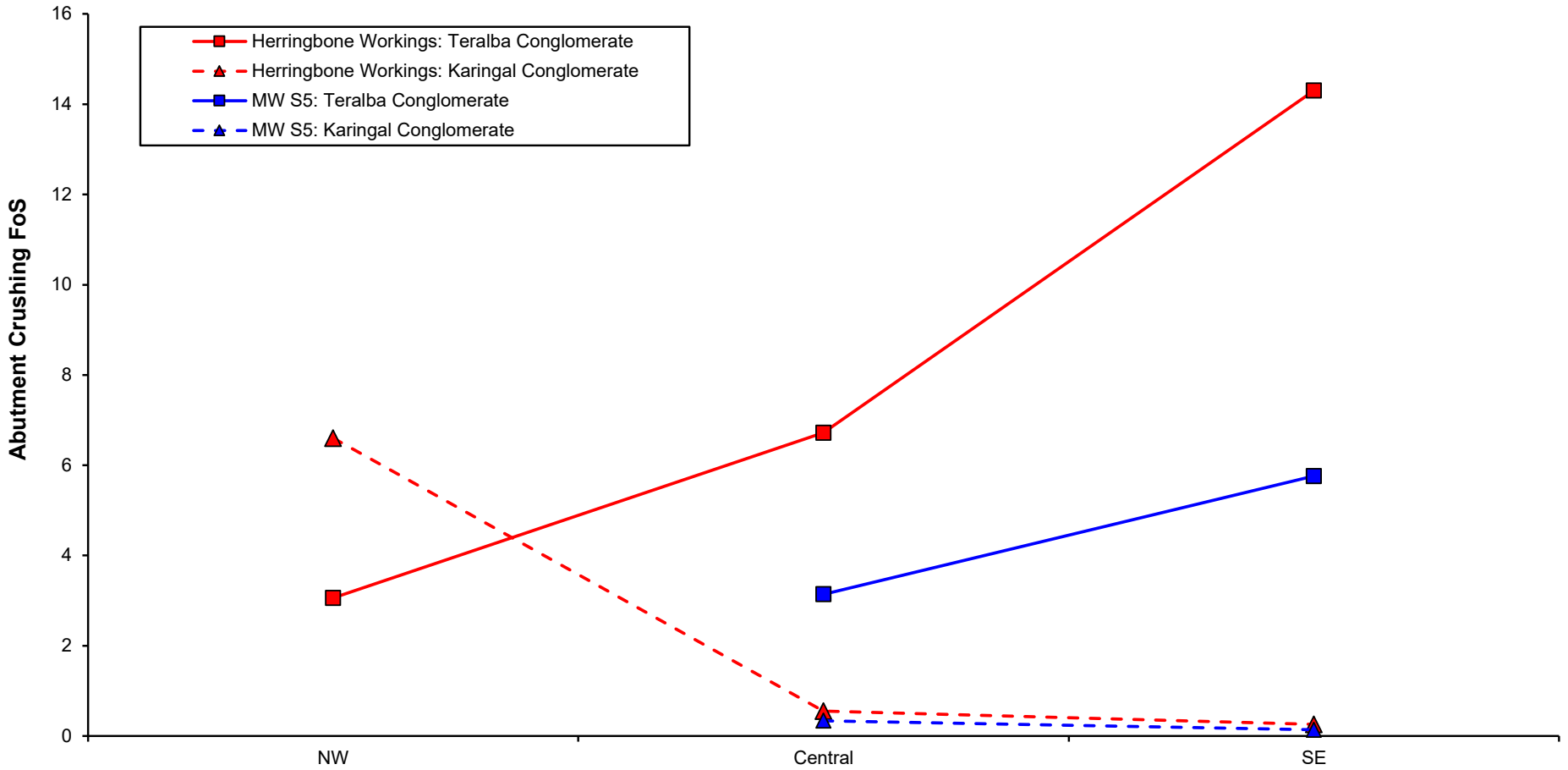


Note: Systematic tensile strain limit lines assume a k value of 0.6, whereas the CVC and Wyee values are based on the local k value of 0.4.

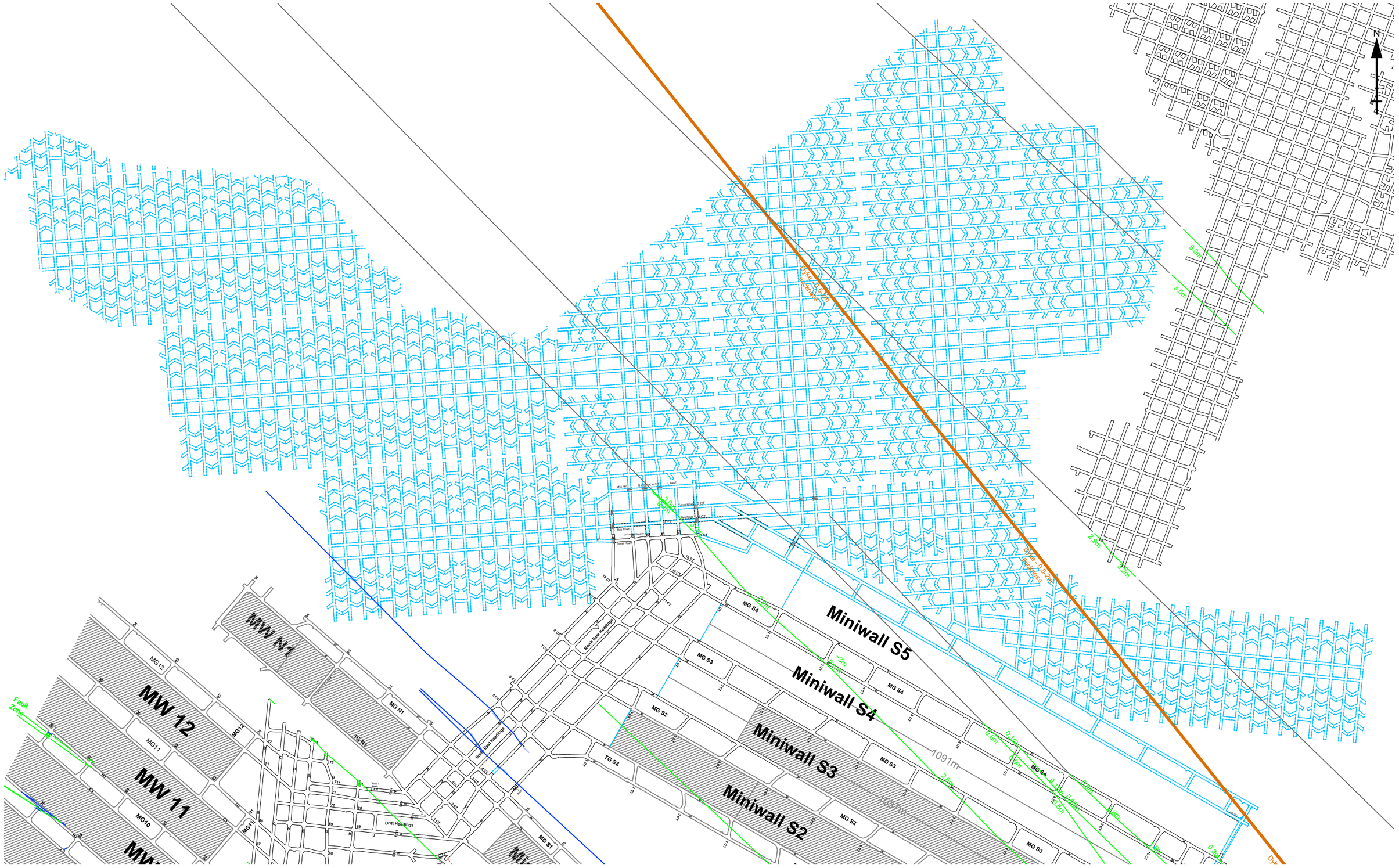
Engineer:	D. Hill
Drawn:	D. Hill
Date:	04.12.20

STRATA²

Client:	Chain Valley Colliery		
Title:	Australian Colliery Inflow Experiences relative to Subsidence and Rock Head Thickness (adapted from **SCT, 2008**), including CVC and Wyee Data		
Ref:	CHV-024	**Revision No:**	2
Scale:	N/A	**Figure No:**	16

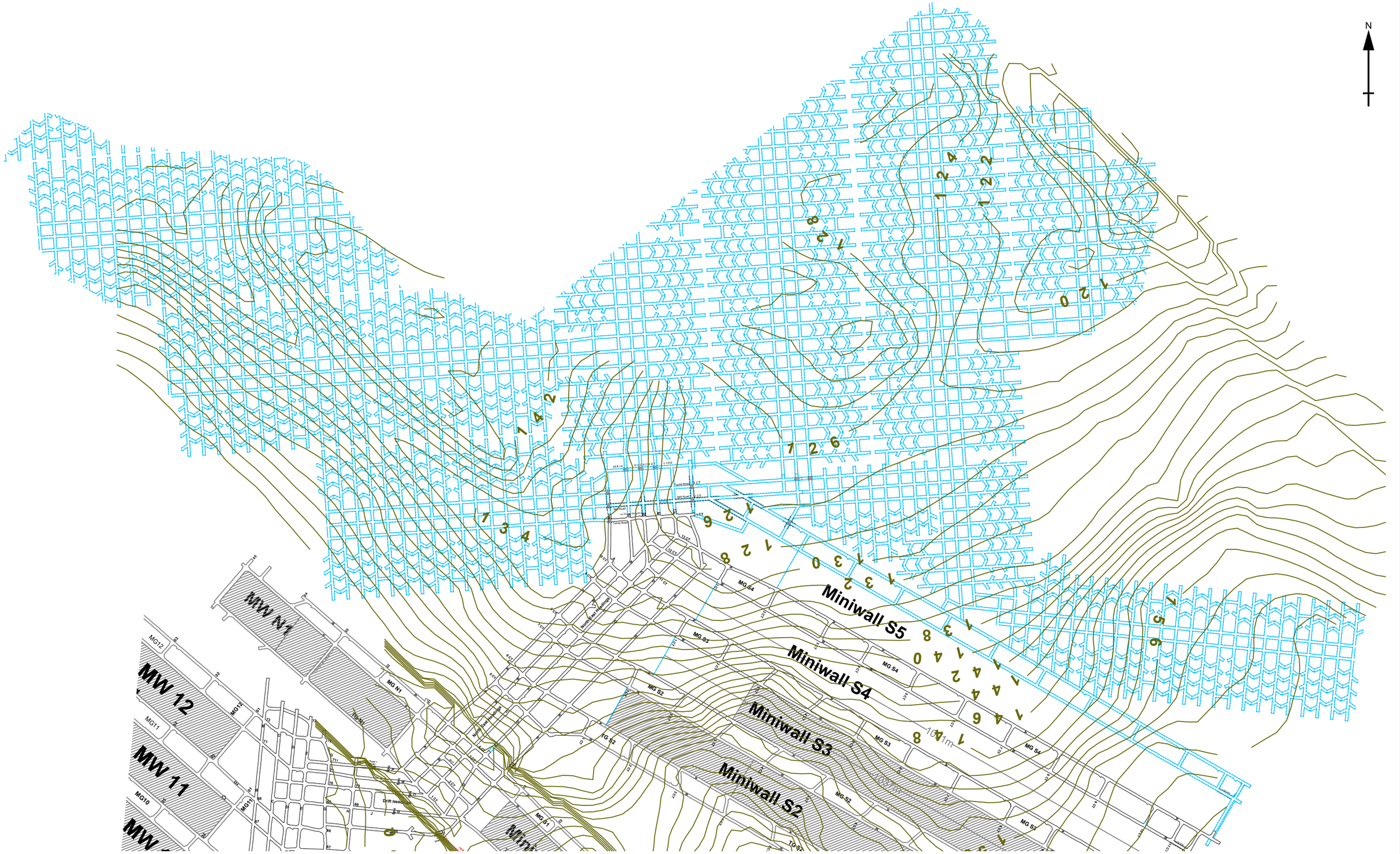


Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Karingal and Teralba Conglomerates: Beam Stability Results for MW S5 and NMA Herringbone Panels		
Date:	04.12.2020				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	17



Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Mine Plan Showing Structural Features
Date:	04.12.20		
		Ref:	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	18

STRATA²

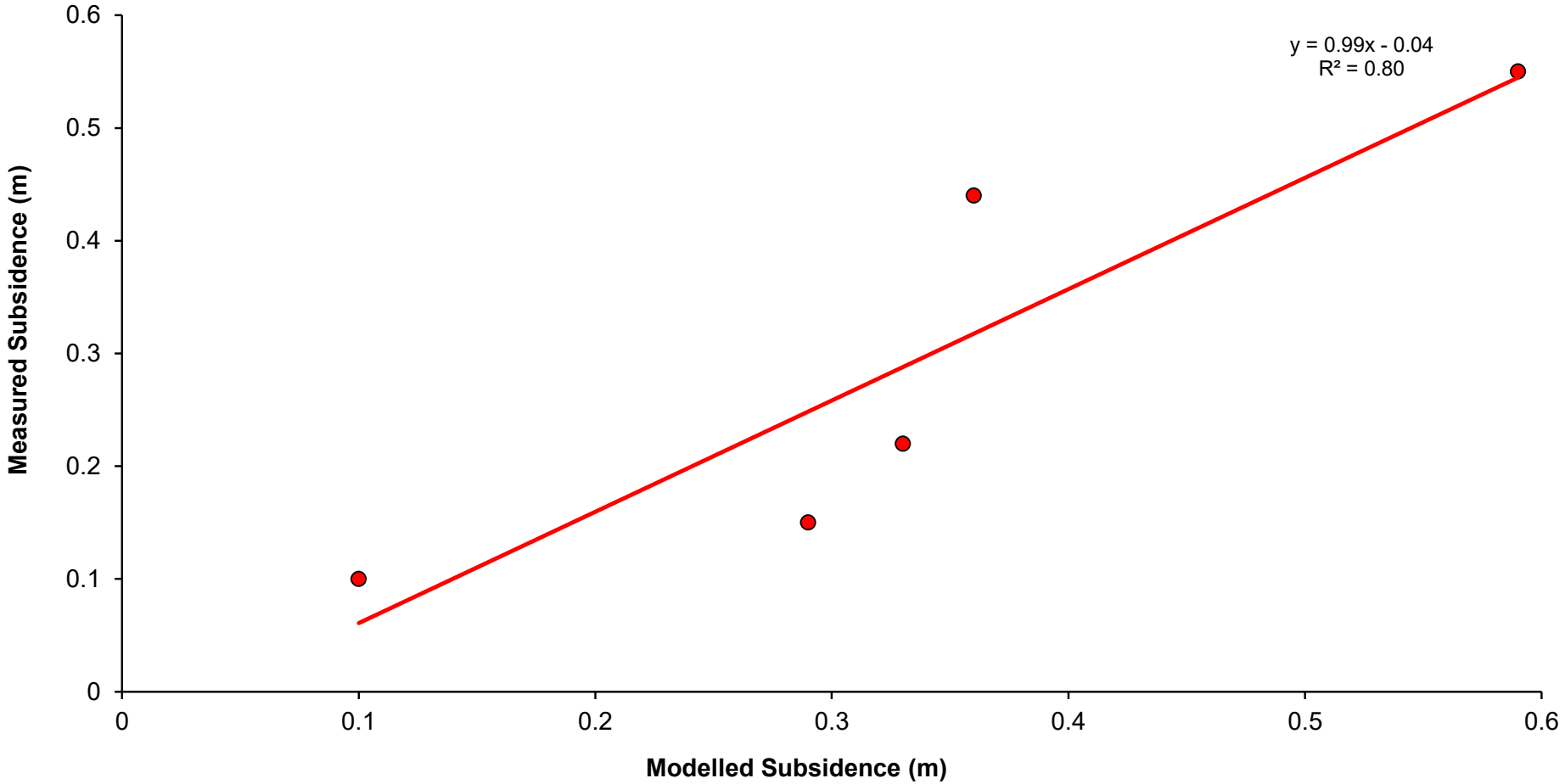


Key:

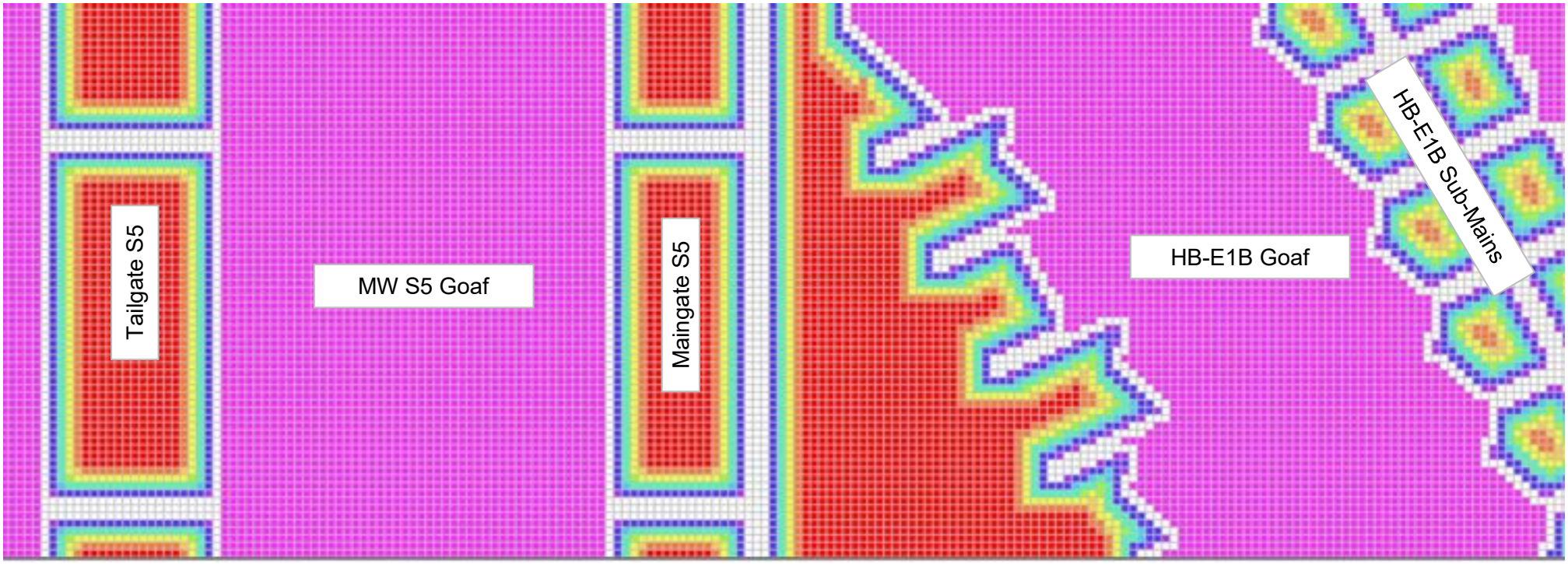
- Rock Head thickness (m)

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	I. Saliamon	**Title:**	Mine Plan Showing Rock Head Contours for Proposed Herringbone Workings
Date:	07.12.20		
		Ref:	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	19

STRATA²

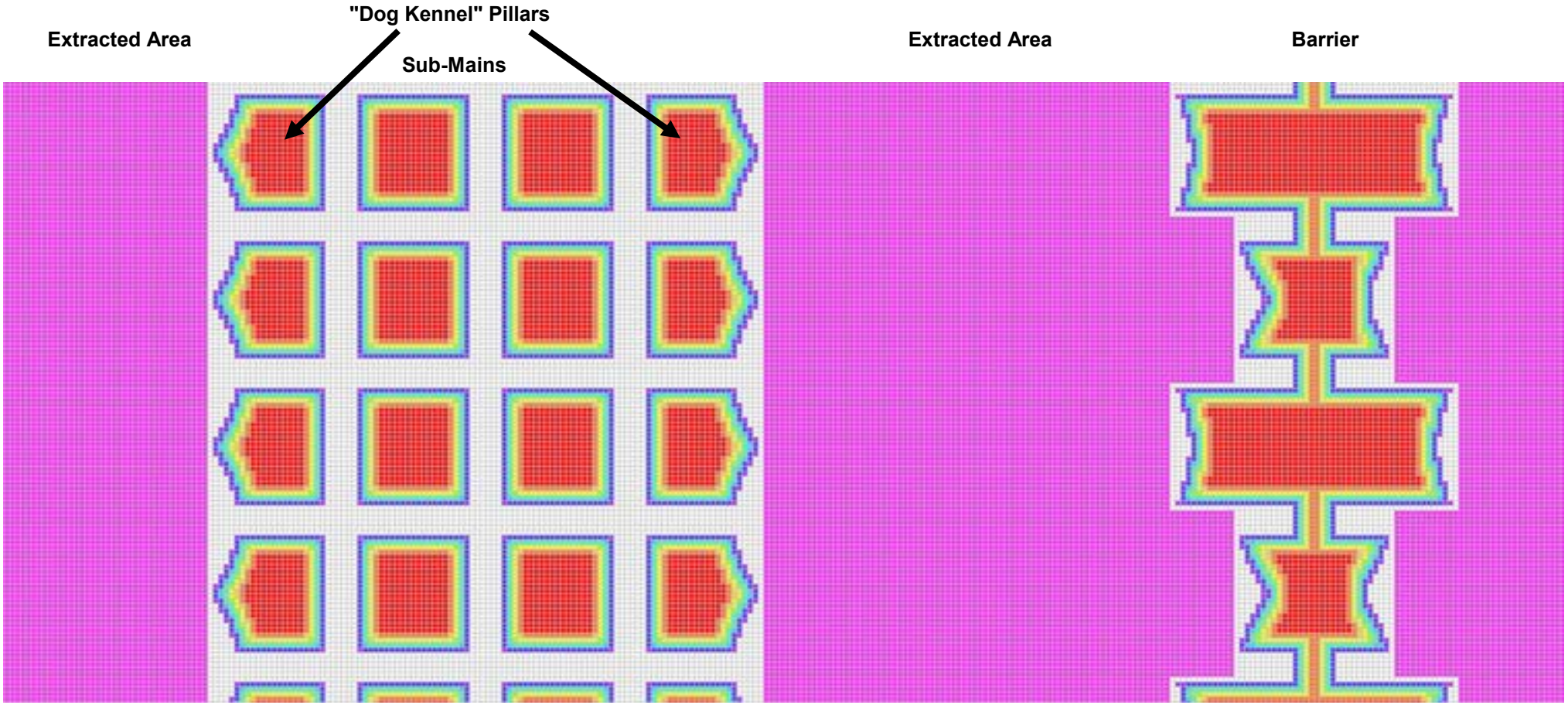


Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	LaModel Calibration Results: Predicted versus Measured Subsidence for Chain Valley Colliery Miniwall Panels and Wyee Colliery Longwall Panels		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	20

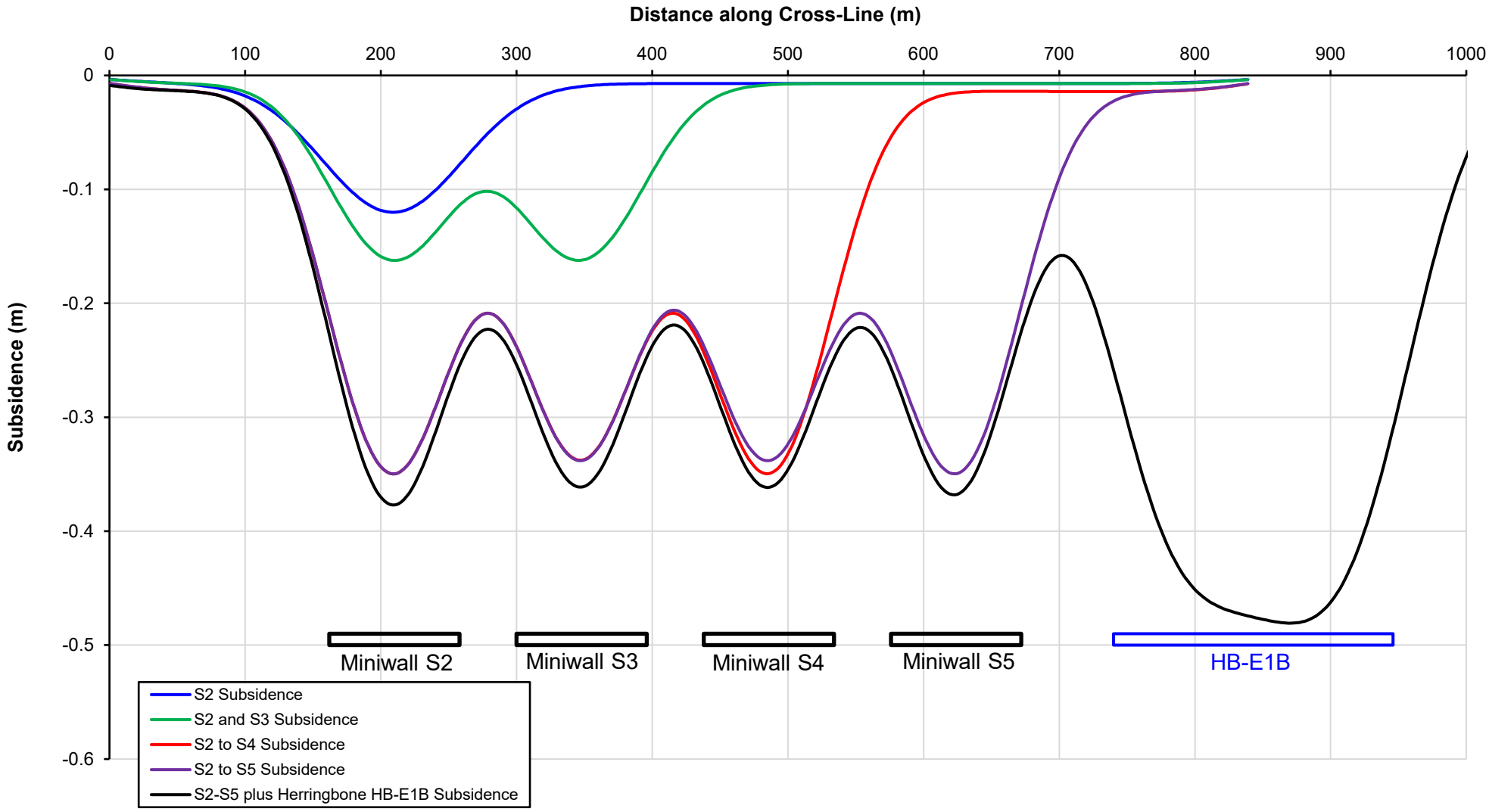


Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	D. Hill	**Title:**	Segment of LaModel Grid, showing MW S5 and Adjacent Area of HB-E1B
Date:	04.12.20		
		Ref:	CHV-024
		Revision No:	2
		Scale:	N/A
		Figure No:	21

STRATA^2



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Section of LaModel Grid for Multiple Herringbone Panels		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	22



Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	D. Hill	**Title:**	LaModel Subsidence Results on a Cross-Line through MWs S2 to S5, plus Adjacent Herringbone HB-E1B Panel
Date:	04.12.20		
		Ref:	CHV-024
		Revision No:	2
		Scale:	N/A
		Figure No:	23

STRATA^2

Figure 24a: Tilt along a Cross-Line through MWs 2 and 3

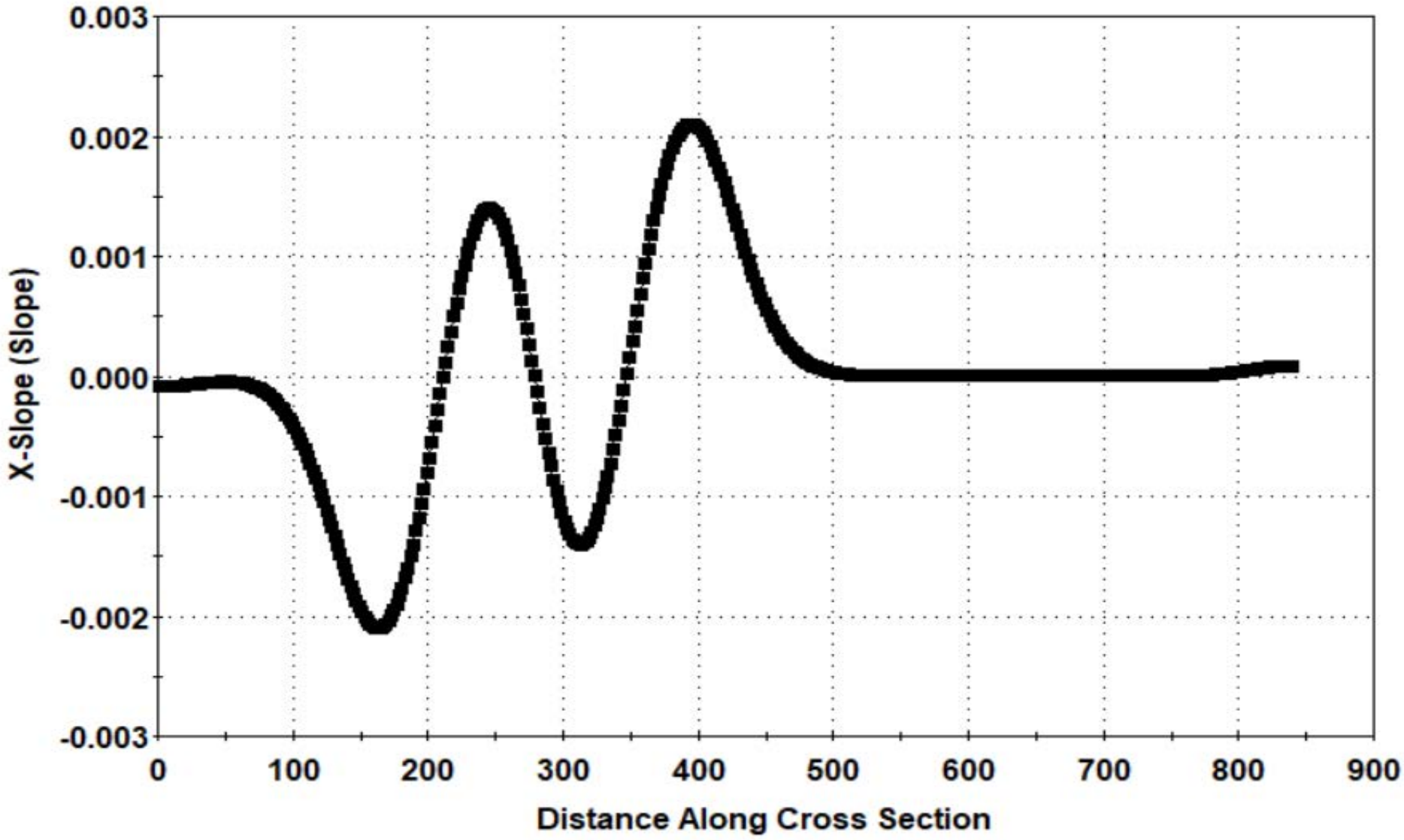
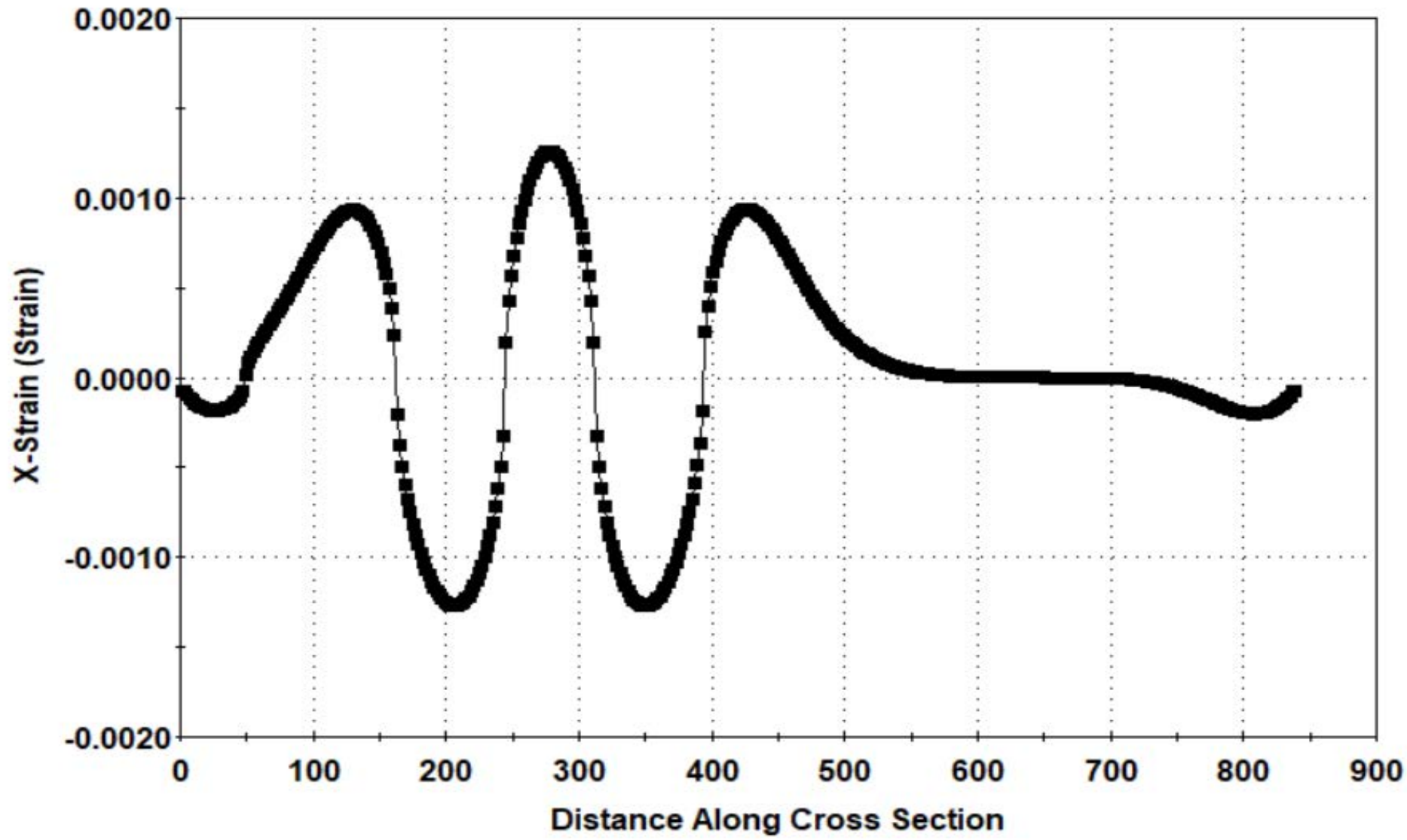


Figure 24b: Strain along a Cross-Line through MWs 2 and 3



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Tilts and Strains following the Extraction of MW S3		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	24a/b

Figure 25a: Tilt along a Cross-Line through MWs 2 to 5

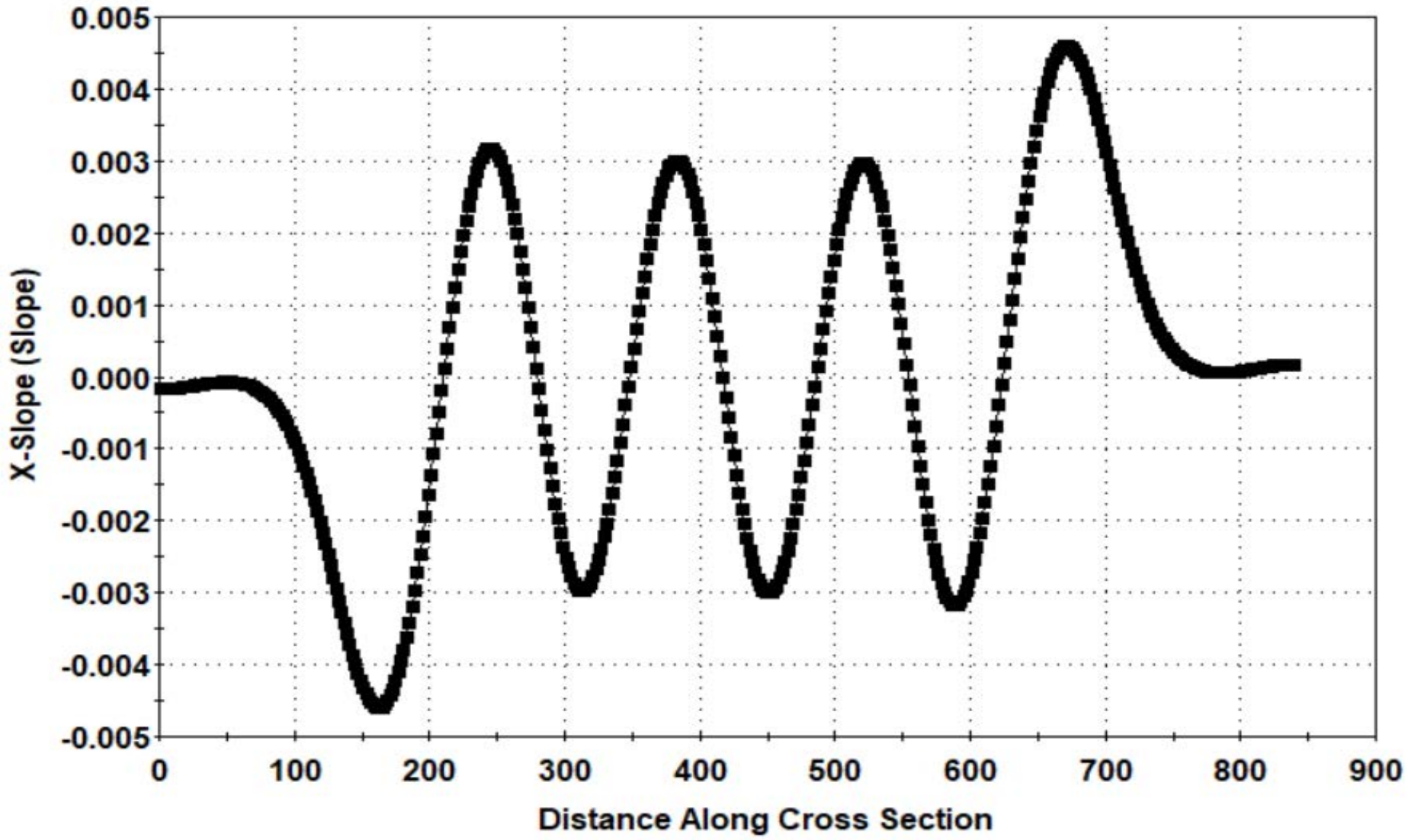
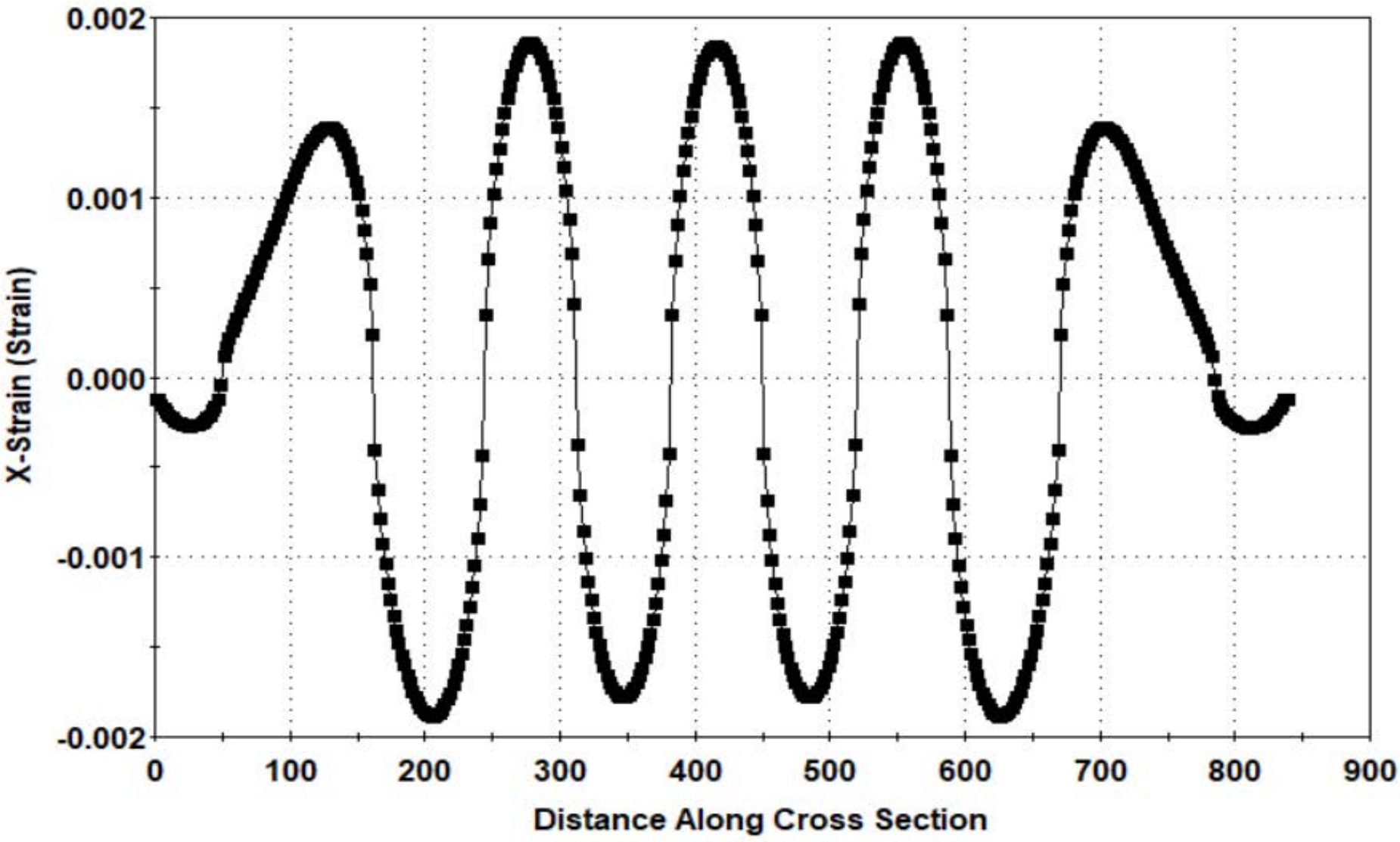


Figure 25b: Strain along a Cross-Line through MWs 2 to 5



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Tilts and Strains following the Extraction of MWs S2 to S5 Inclusive		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	25a/b

Figure 26a: Tilt along a Cross-Line through MWs 2 to 5 and HB-E1B

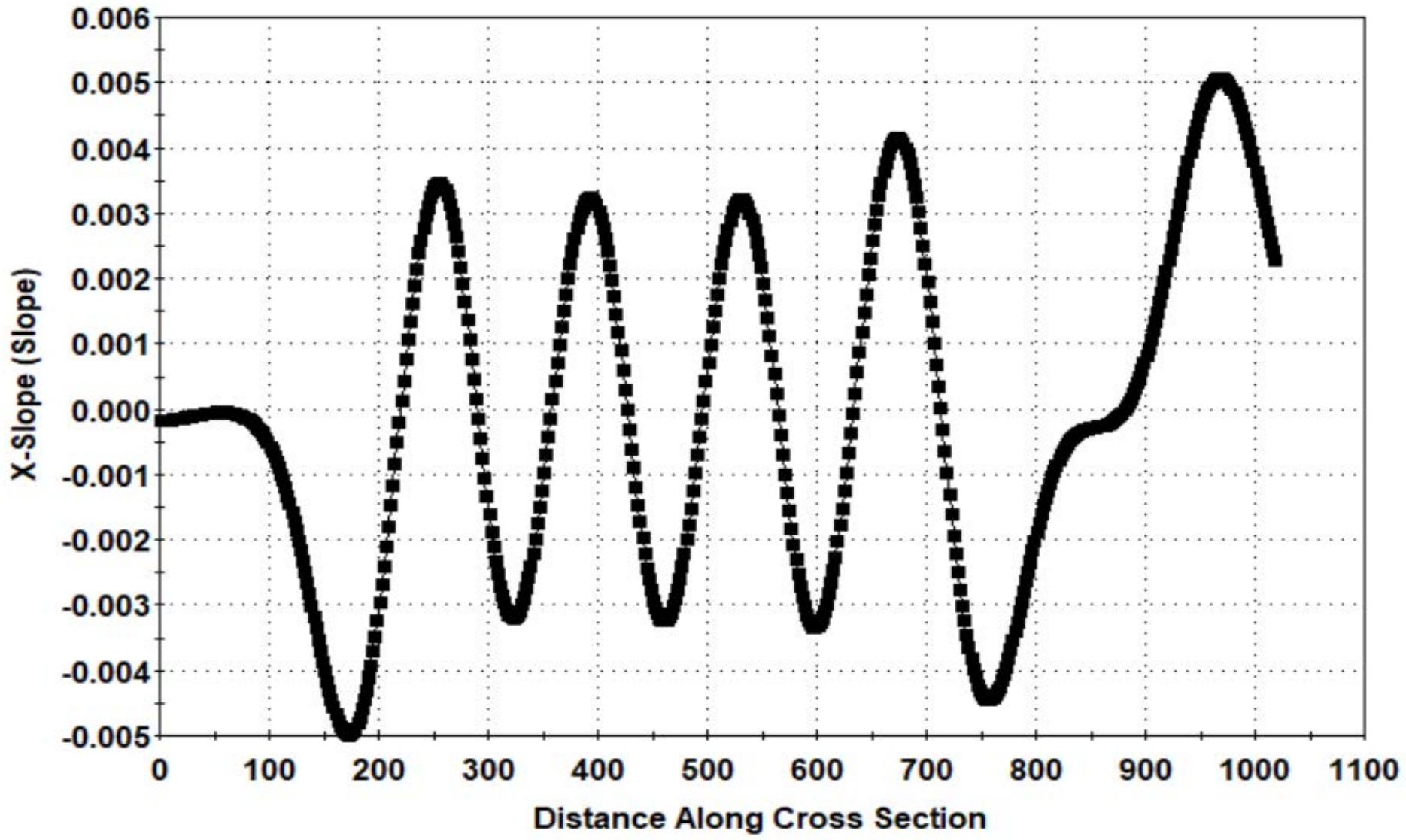
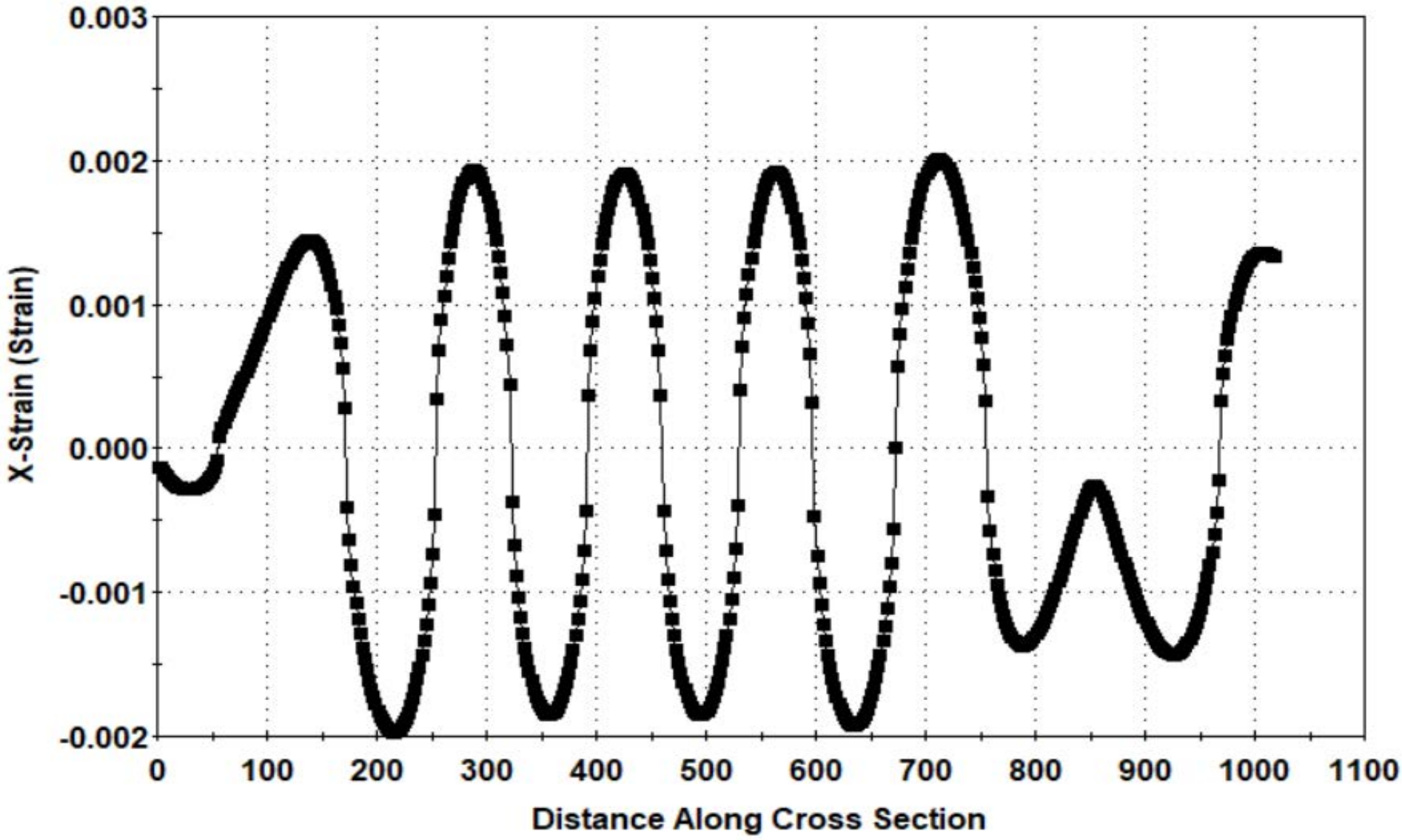
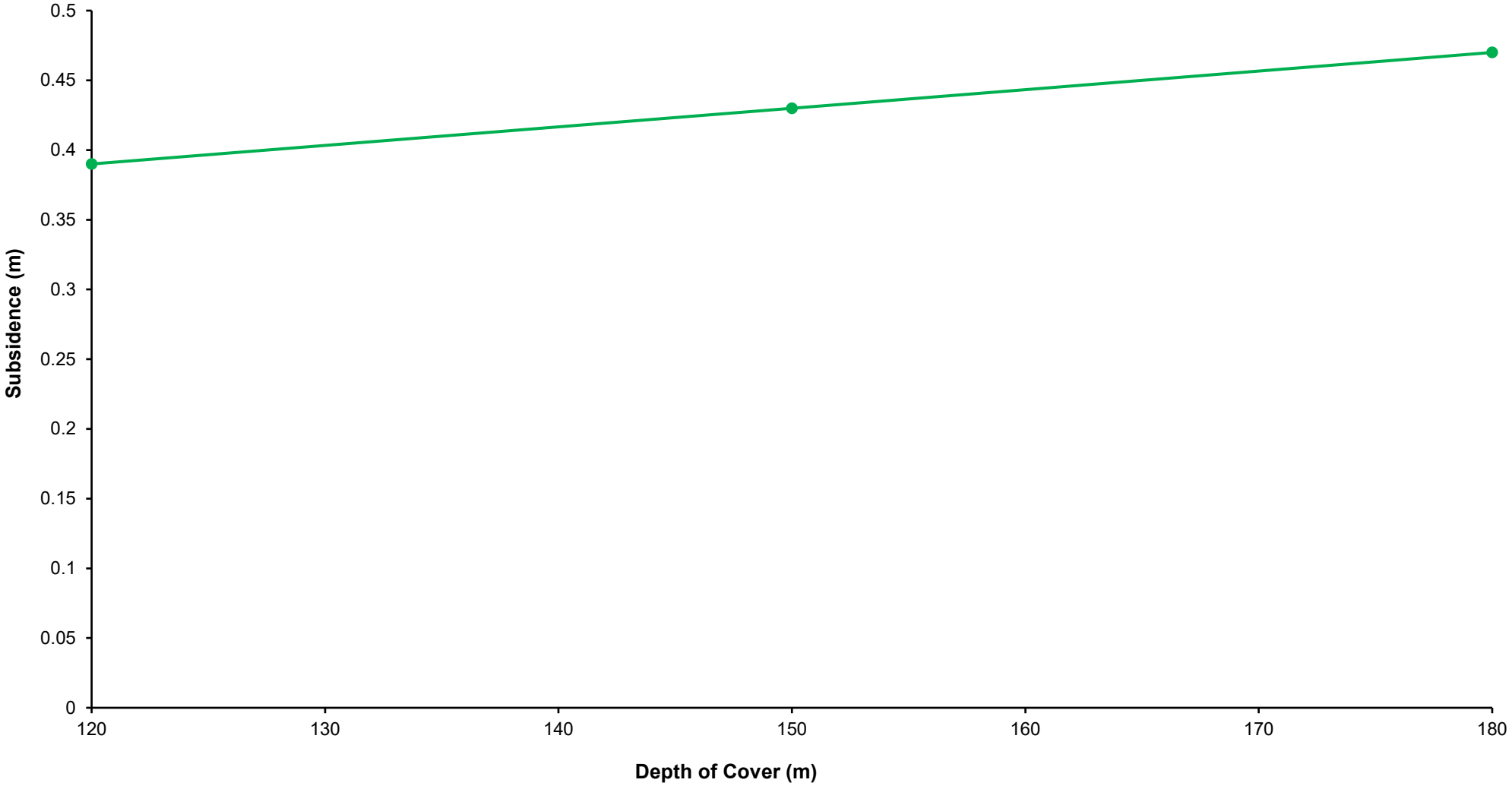


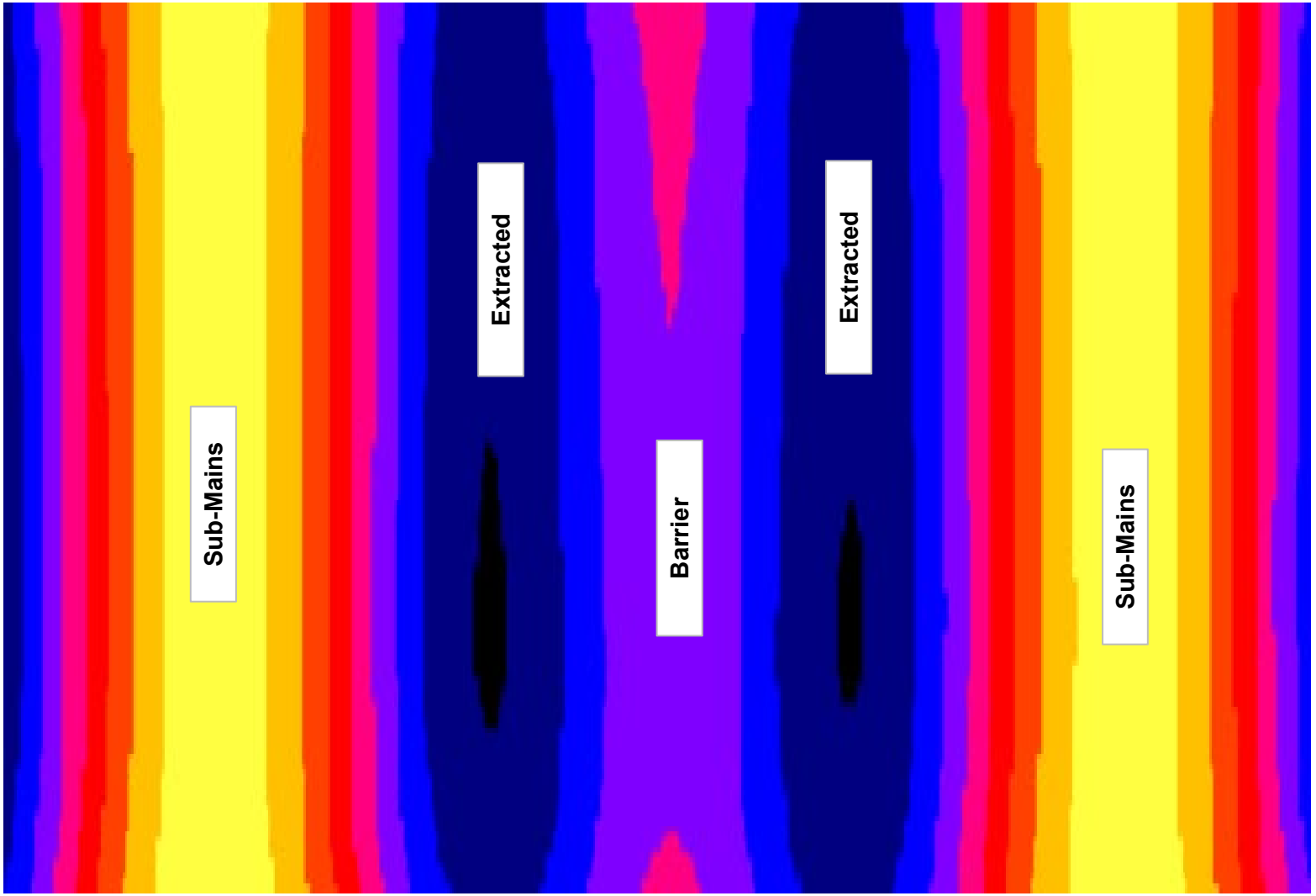
Figure 26b: Strain along a Cross-Line through MWs 2 to 5 and HB-E1B



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Tilts and Strains following the Extraction of MWs S2-S5 plus Herringbone Panel HB-E1B		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	26a/b



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Summary of Subsidence Results (S_{max} values) from LaModel, following Herringbone Pillar Extraction at a Height of 3.5m and at an Extraction Span of 85m		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	27



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Subsidence Heat Map following Herringbone Pillar Extraction at a Height of 3.5m, an Extraction Span of 85m and at the Maximum Depth of 180m		
Date:	04.12.20				
STRATA^2		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	28

Figure 29a: Subsidence on Mid-Panel Cross-Line

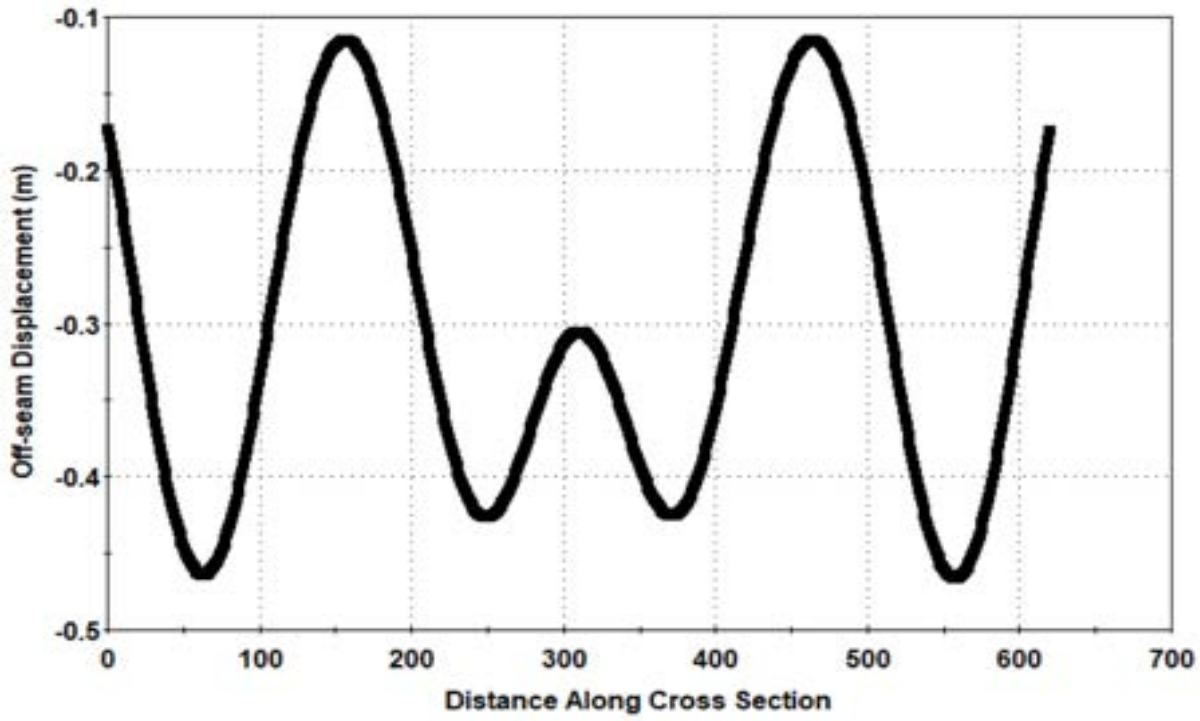


Figure 29b: Tilt on Mid-Panel Cross-Line

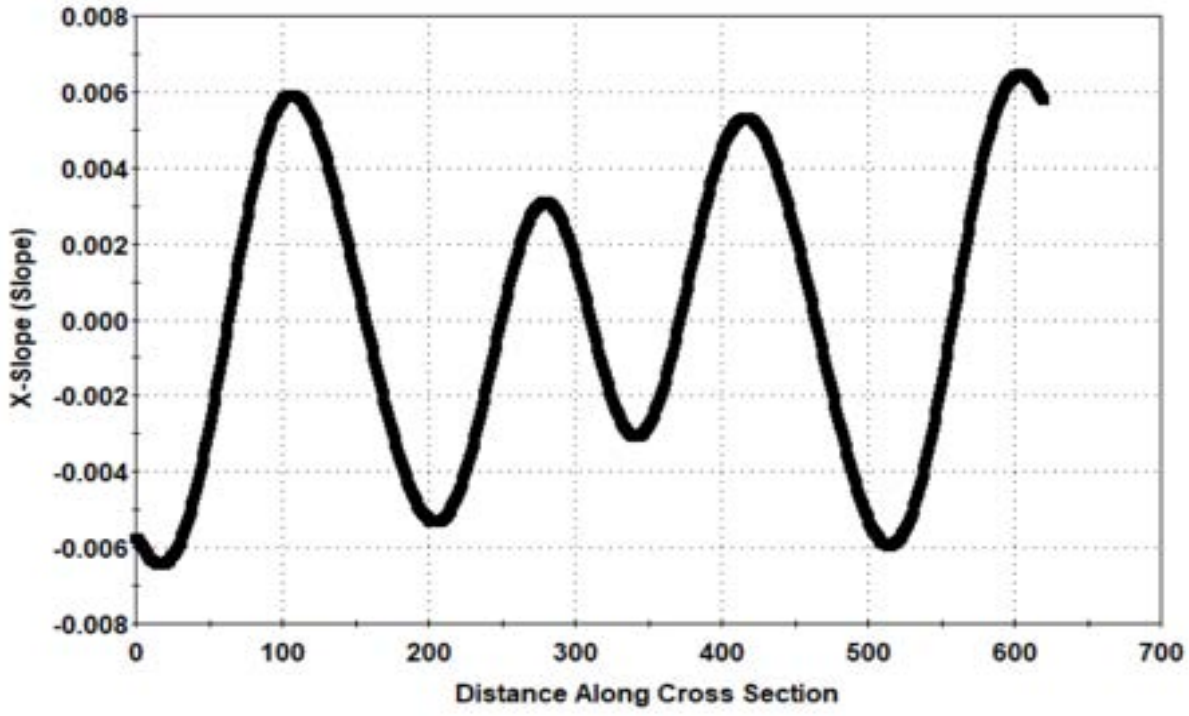
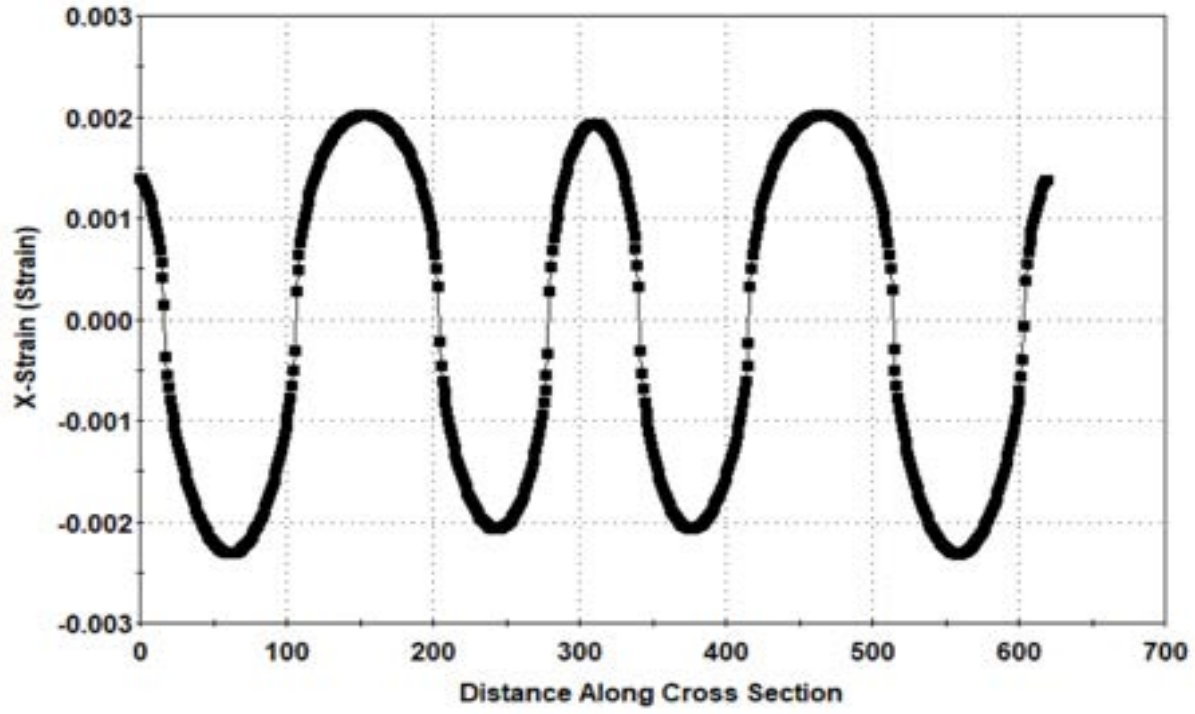
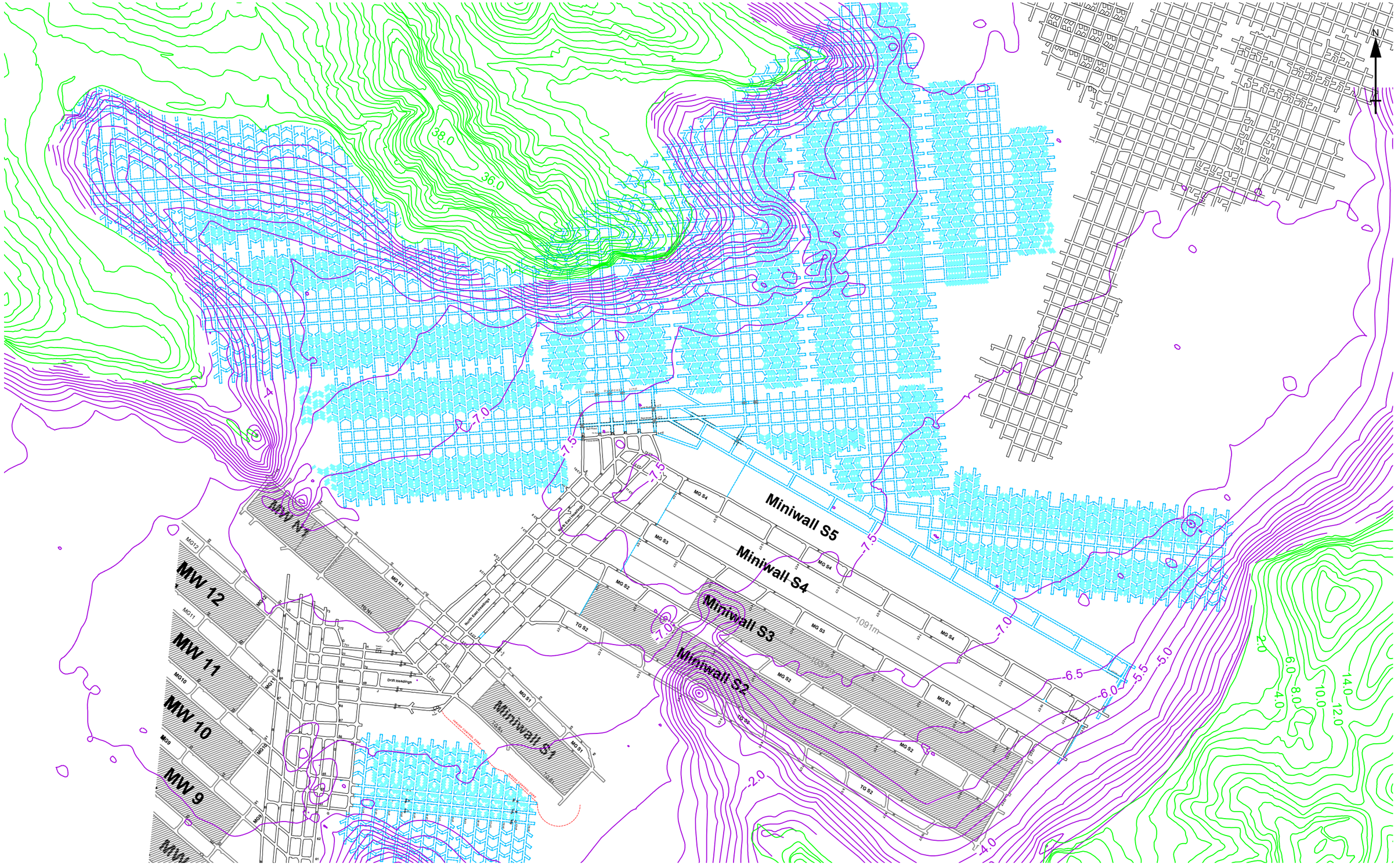


Figure 29c: Strain on Mid-Panel Cross-Line



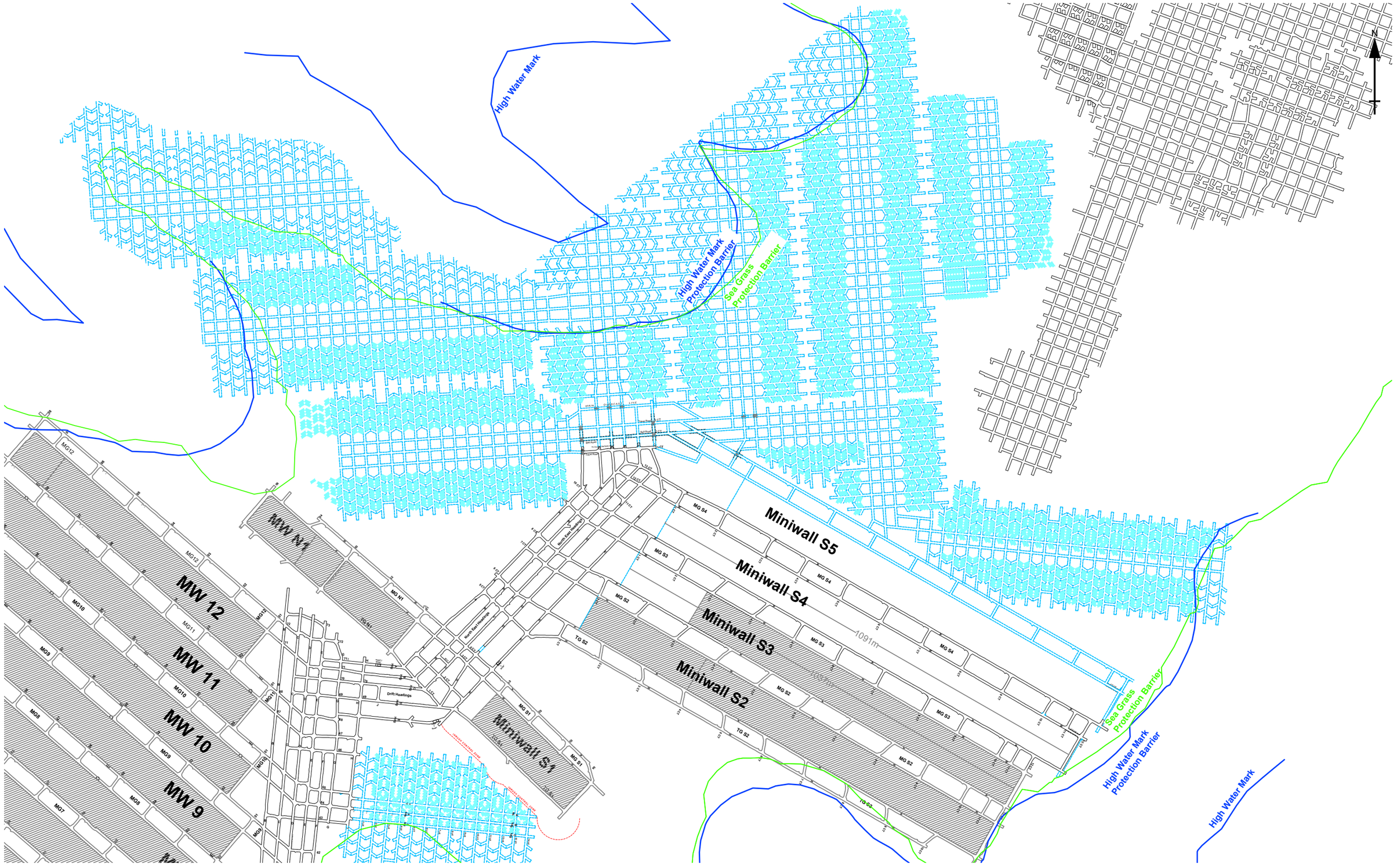
Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Subsidence, Tilts and Strains following the Extraction of Multiple Adjacent Herringbone Panels at a Depth of 180m		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	29a/b/c

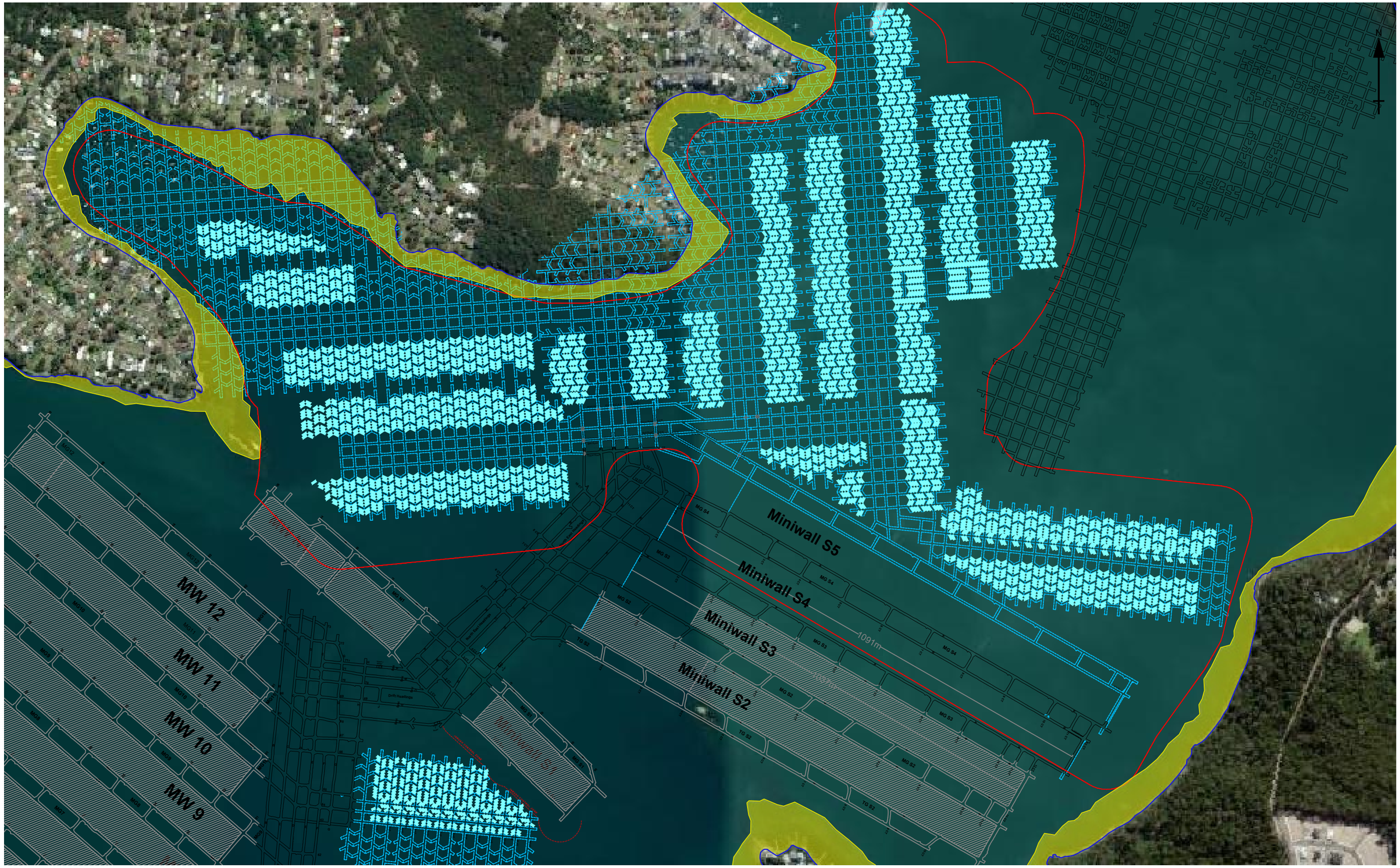


Key:

- Lake bed level contours (m)
- Surface level contours (m)

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	R. de Laubadere	**Title:**	Mine Plan Showing Surface and Lake Bed Level Contours
Date:	04.12.20		
	STRATA²	**Ref:**	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	30


High Water Mark
High Water Mark Protection Barrier
Sea Grass Protection Barrier
N
MW N1
MW 12
MW 11
MW 10
MW 9
Miniwall S5
Miniwall S4
Miniwall S3
Miniwall S2
Miniwall S1
1091m
MG12
MG11
MG10
MG9
MG8
MG7
MG N1
MG S4
MG S3
MG S2
MG S1
TG S2
North East Headings
Drift Headings
RL441
RL442
LR1
LR2
LR3
LR4
LR5
LR6
LR7
LR8
LR9
LR10
LR11
LR12
LR13
LR14
LR15
LR16
LR17
LR18
LR19
LR20
LR21
LR22
LR23
LR24
LR25
LR26
LR27
LR28
LR29
LR30
LR31
LR32
LR33
LR34
LR35
LR36
LR37
LR38
LR39
LR40



Key:

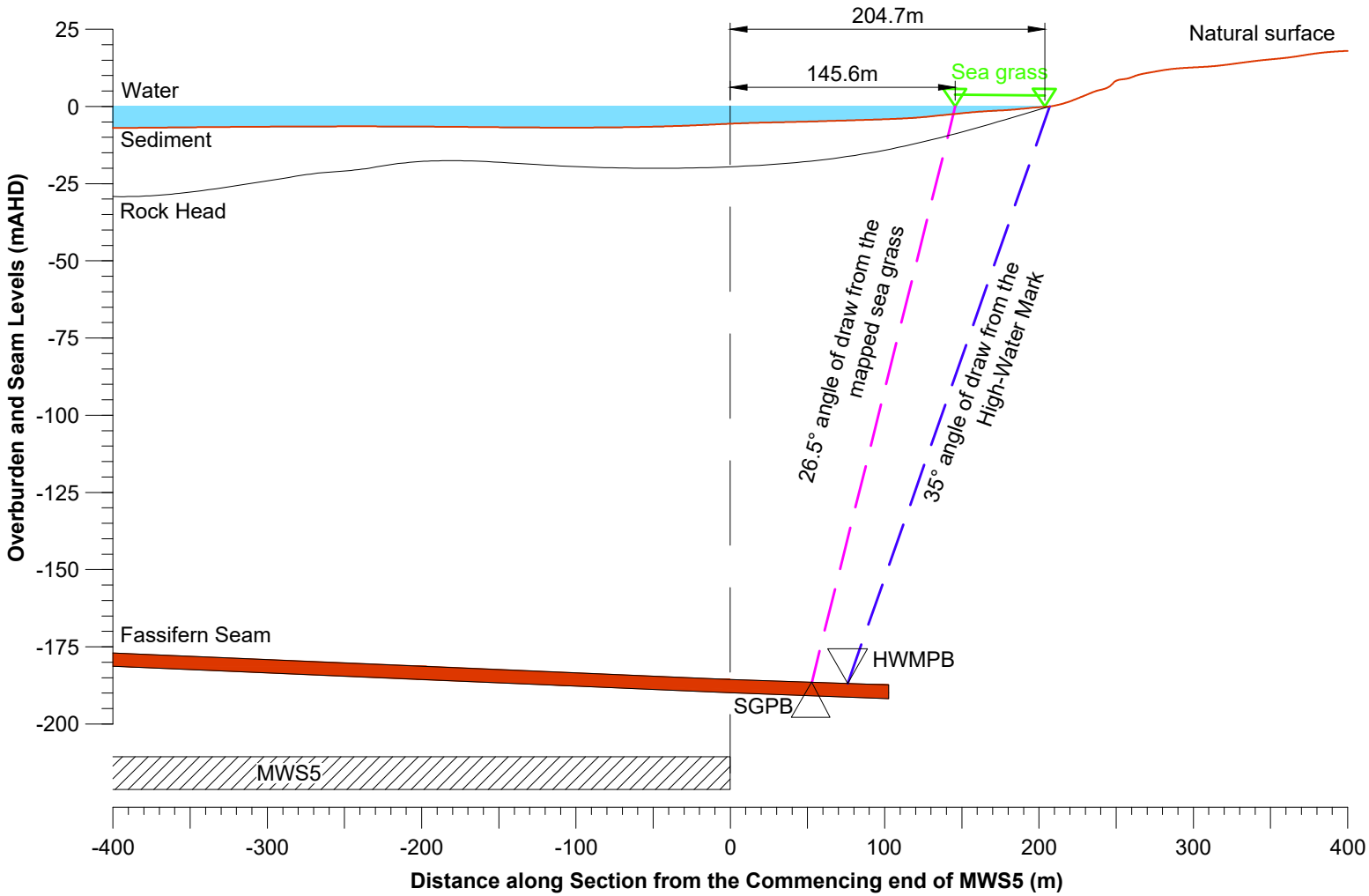
- High water mark
- Mapped sea grass beds
- Limit of Subsidence Based on Nominal Angle of Draw of 26.5°

Engineer:	D. Hill
Drawn:	R. de Laubadere
Date:	04.12.20

STRATA²

Client:	Chain Valley Colliery
Title:	Mine Plan Showing High Water Mark and the Mapped Sea Grass Beds

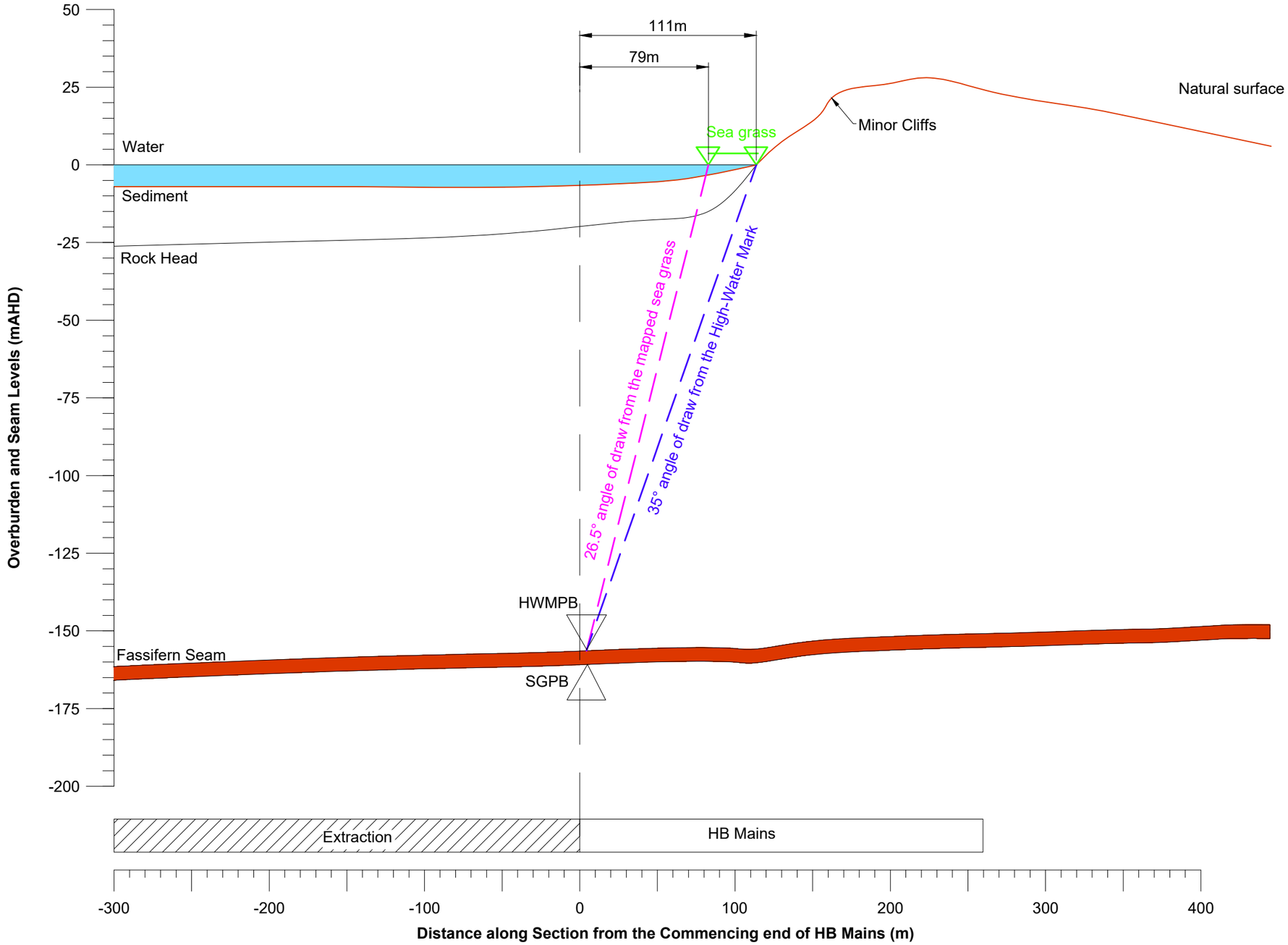
Ref:	CHV-024	**Revision No:**	2
Scale:	NTS	**Figure No:**	32



Notes:

2x vertical exaggeration

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	I. Saliamon	**Title:**	Long-section at the Commencing End of MWS5, along the Panel Centre Line
Date:	07.12.20		
		Ref:	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	33



Notes:

2x vertical exaggeration

Engineer:	D. Hill	**Client:**	Chain Valley Colliery
Drawn:	I. Saliamon	**Title:**	Long-section through Western Flank of HB Mains (Morisset East Side)
Date:	07.12.20		
	STRATA²	**Ref:**	CHV-024
		Revision No:	2
		Scale:	NTS
		Figure No:	34

Figure 35a: Minor Cliffs and Wooded Slope at Mirrabooka / Fishery Point (Morisset East)



Figure 35b: Minor Cliff



Figure 35c: Shoreline



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Minor Cliffs and Steep Slope at Morisset Peninsula		
Date:	04.12.02				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	35a/b/c

Figure 36a: Fishery Point and Sunshine (Morisset East)



Figure 36b: Pelican Rock Navigation Marker



Figure 36c: Shoreline SE of MW S5



Engineer:	D. Hill	**Client:**	Chain Valley Colliery		
Drawn:	D. Hill	**Title:**	Built Features in the Northern Mining Area		
Date:	04.12.20				
STRATA²		**Ref:**	CHV-024	**Revision No:**	2
		Scale:	N/A	**Figure No:**	36a/b

Appendix 15.2 – NPA Subsidence Prediction Report (Amendment 1)

BYRNES GEOTECHNICAL

ACN 633 507 623

Chain Valley Colliery

Subsidence prediction – Northern Mining Area

REPORT: DCV-23

Date: May 2024

Report to: Nigel Birt

Report prepared by:

Ross Seedsman

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Executive Summary

The proposed second workings are located on the lake side of the High Water Mark Subsidence Barrier and involve the stripping of some spine pillars or lifting in some of the runouts resulting in 16.5 m wide voids.

The predicted maximum subsidence at the floor of Lake Macquarie is between 18 mm and 113 mm depending on how the remnant pillars behave. We cannot envisage a situation where the subsidence would exceed 780 mm.

No mining induced impacts are predicted within or on the land side of the High Water Subsidence Barrier.

Over time, the roof may collapse/crack to about 17 m equal to the width of the voids. There is no risk of connected cracking extending from the Fassifern Seam up to the floor of Lake Macquarie.

The roof stability of these voids should be readily manageable with mobile roof supports, as the height of collapse is likely to be no more than about 2 m. Wind blasts are not anticipated. It is possible that the remnant 10.5 m and 13 m wide pillars will punch into the floor and generate floor heave but this will inbye of the stripping. Note that the onset of floor heave deformations requires downward movement of the overburden (i.e. thick conglomerates): it is possible that although the pillars do not provide restraint to the overburden there will be insufficient deformation to induce floor heave.

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1 Introduction

Delta Coal is updating the current Miniwall S5 and Northern Pillar Area Extraction Plan (EP) to amend proposed secondary extraction locations (stripping of Herringbone pillars and single sided lifting option). The proposed secondary extraction is planned in different locations to what was identified within the EP, however remains within the overall proposed subsidence impact area identified within the EP.

This report addresses the geotechnical safety of the proposed extraction, the extent of connective cracking above the extraction, and the likely surface subsidence.

A herringbone layout is currently used with 3.2 m high development in the spine pillars and chevrons and this report specifically addresses two proposed options for secondary extraction (Figure 1):

- Stripping the sides of 3 pillars in the spines without grubbing the floor.
- Single sided lifting of the runouts without grubbing the floor.
- Lift lengths of 11.8m (single miner length).
- Lift widths of 4.3m (single miner head width).

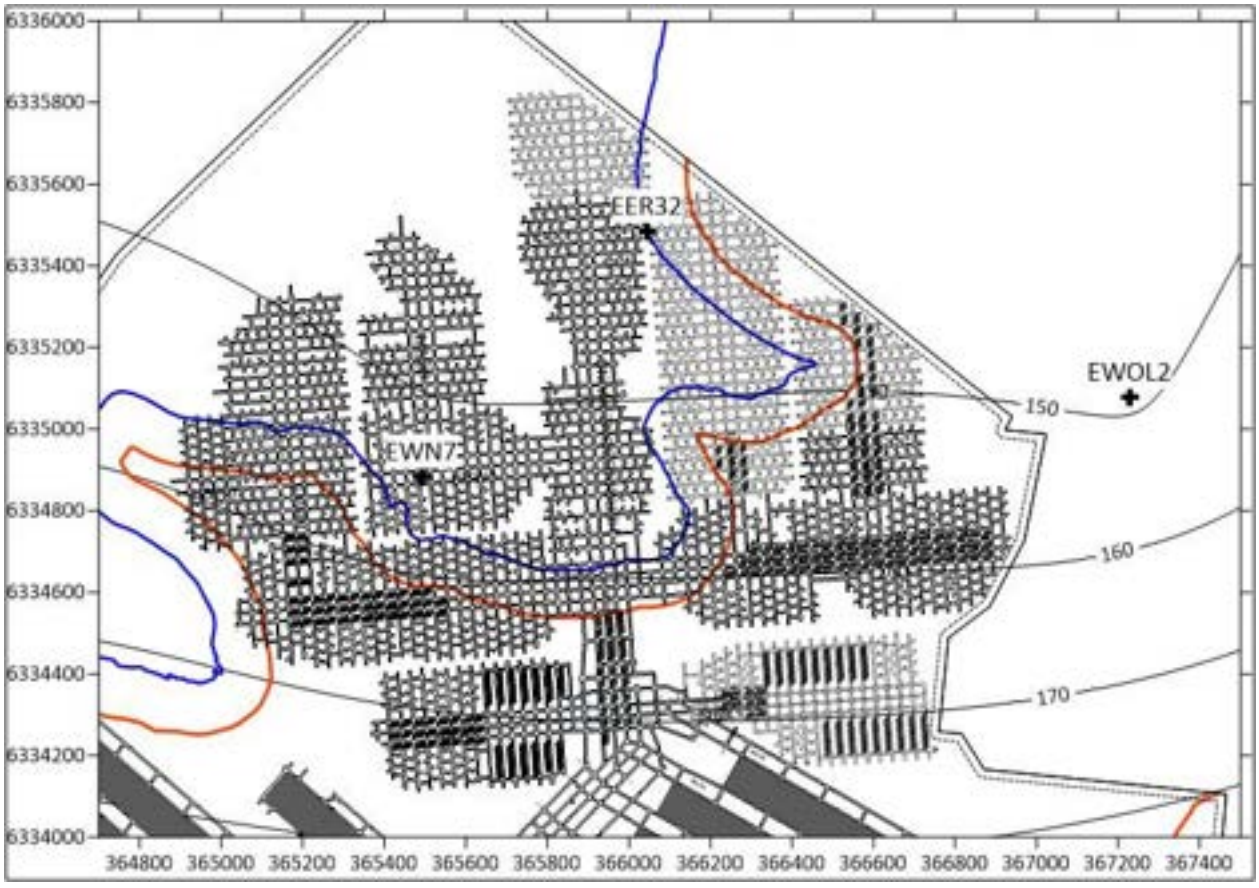


Figure 1 Proposed mine plan showing location of proposed stripping or lifting (black hatched areas), depth of mining, lake edge, seagrass protection barrier, and boreholes

The resulting pillar sizes for 30m x 27m pillars are shown in Figure 2 where the result after extraction will be a line of 10.5 m wide pillars flanked on 2 sides by 5.5m roadways and the other sides by a 16.5 m roadway. The effective extraction pane in this case is 75 m wide.

Single sided lifting in the runouts results in a 100 m wide panel, containing 17 m spans, and 13 m wide pillars. The effective extraction panel width in this case is 83 m in width.

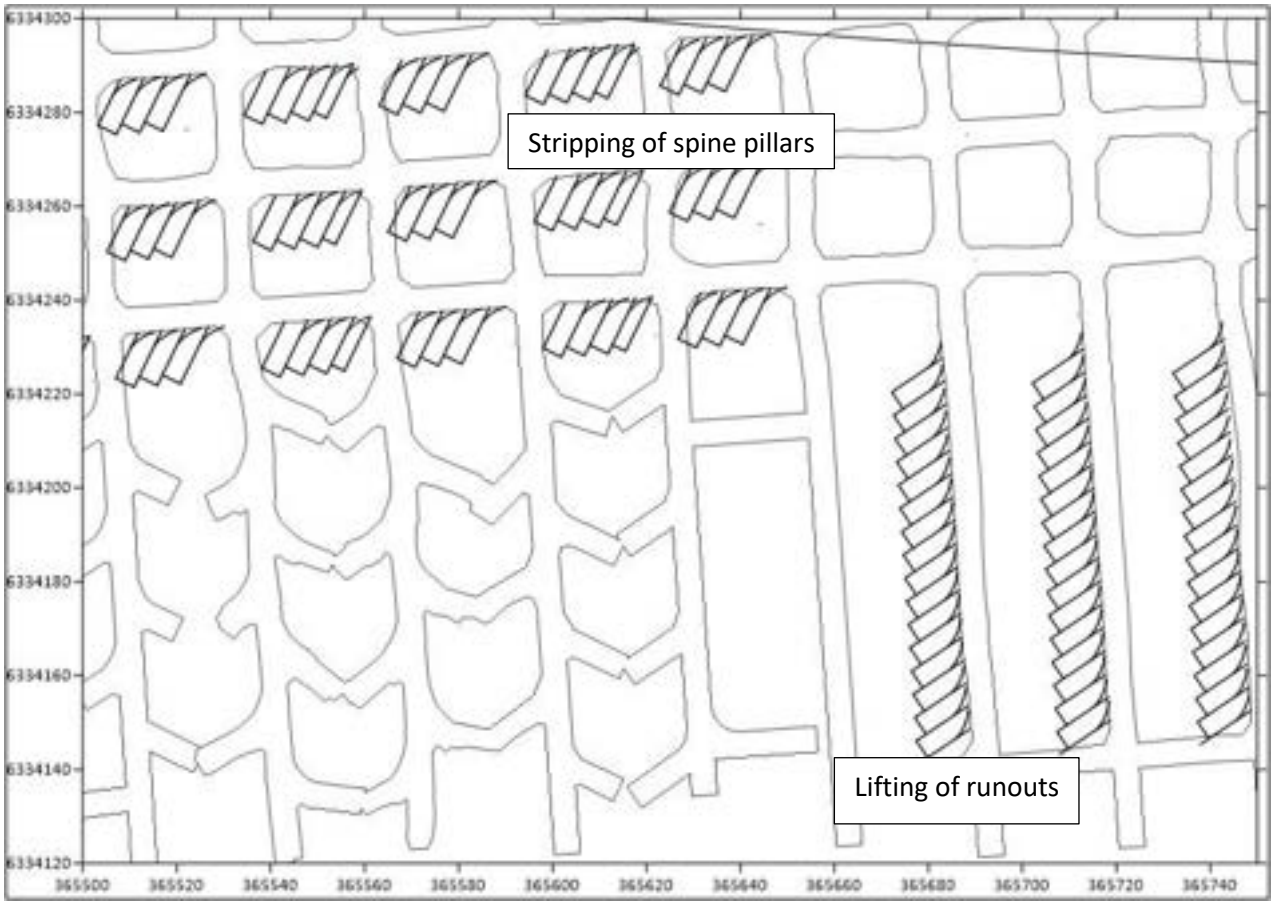


Figure 2 Stripping of spine pillars and lifting of runouts.

2 Geological/Geotechnic environment

The Fassifern Seam in the area of interest is the similar to that currently being mined at Chain Valley Colliery and the seam and the overlying stratigraphic units are similar over Chain Valley and the previously operated Mannering and Wyee Collieries.

2.1 Drillholes

The available drill logs for the area are based on holes drilled by the Joint Coal Board from 1956 onwards. These are good quality geological logs but do not provide geotechnical data except for some general comments regarding strength. The locations of the boreholes are shown in Figure 1.

2.2 Overburden

The overburden of the Fassifern seam comprises the Awaba Tuff, the Warnervale Conglomerate, poorly developed Wallarah and Great Northern Seams, and several massive conglomerate units (Figure 3). There has been no mining of the Wallarah or Great Northern Seams in this area.

The Fassifern - Great Northern Seam interburden typically consists of claystone (tuff) and conglomerate. This interburden is typically around 30 m to 60 m thick. The Awaba Tuff sits within this interval (typically immediately above the Fassifern Seam). There are 1 or 2 conglomerate layers between the Fassifern Seam and the Great Northern Seam – the Warnervale Conglomerate – with maximum layer thickness of at least 10 m.

The Teralba Conglomerate unit, which is present between the Wallarah and Great Northern Seam is about 10 m thick across the area and thicker where the Warnervale Conglomerate is thinner. Some of the logs include reference to thin layers of sandstone – these are typically medium to coarse-grained and our experience is that they are contiguous with the conglomerate without bedding partings separating the layers.

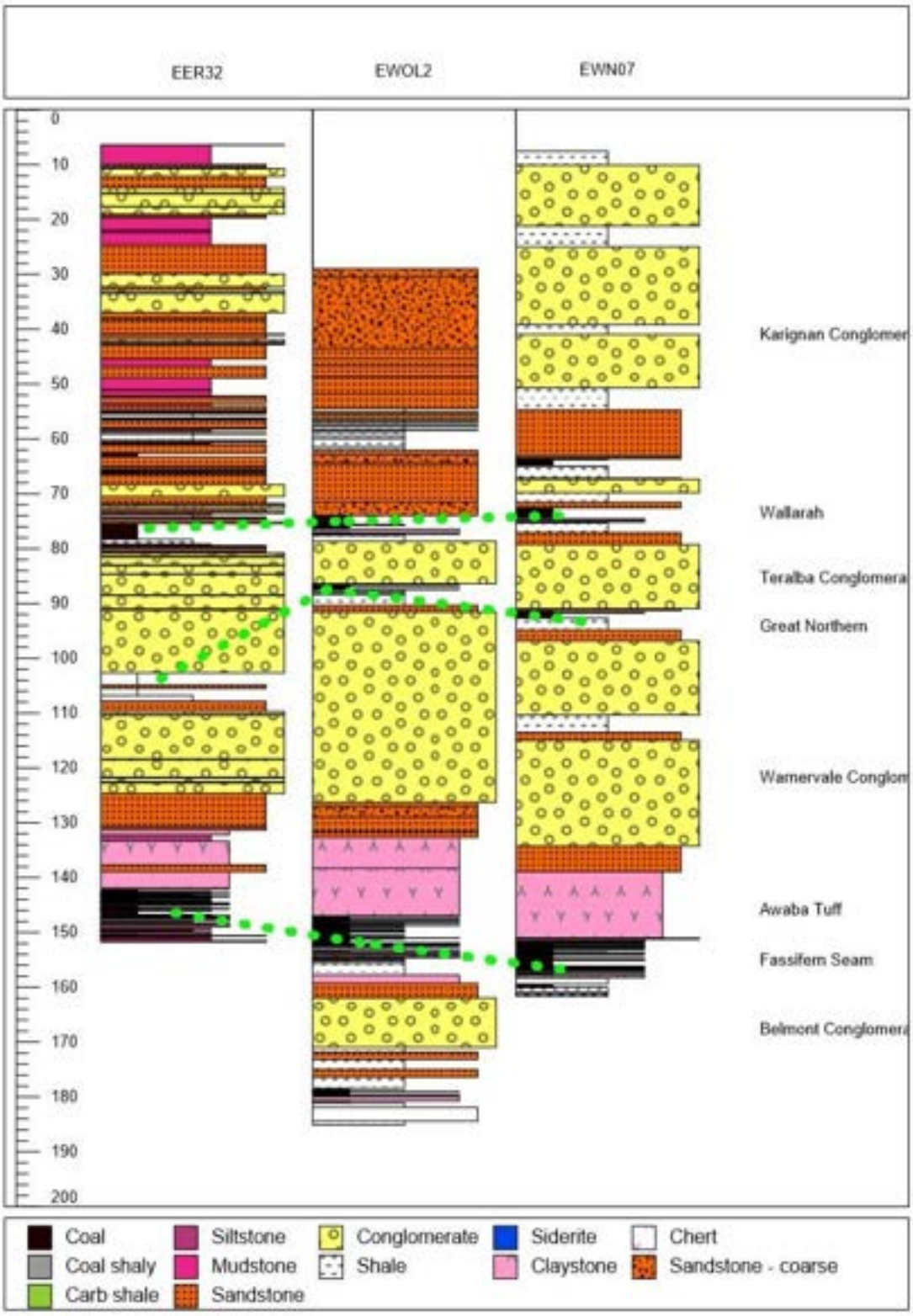


Figure 3 Core logs - EER32-EWOL2- EWN07

There has been no laboratory testing of the overburden sequence at Chain Valley Colliery, so inferences need to be drawn from testing of the same and similar stratigraphic units at other mine sites. Table 1 summarises the rock strength testing conducted for Myuna. As a group, conglomerates have lower strength but some of this may be related to the fact that most of the conglomerate samples were taken from shallow depths where there may have been some alteration/weathering. Previous analyses of the conglomerates in the Newcastle coalfield have used 65 MPa (modulus = 18) and these values will be adopted in this report. Claystones/tuffs have a wide range of strengths with an average strength of 53 MPa.

Table 1 Summary of uniaxial compressive strength testing by lithology – Myuna data

	Tuff/ claystone	Conglomerate	Siltstone	Sandstone Fine - medium	Sandstone Medium - coarse	Laminite
Average (MPa)	53	35	54	61	61	75
Std Dev (MPa)	52	18	30	31	10	25
Minimum (MPa)	6	12	5	3	43	37
Maximum (MPa)	211	108	110	106	73	125

2.3 Extraction interval

2.3.1 Fassifern Seam

Within the limitations of the qualitative logging conducted at the time, the logs reveal a consistent ply structure in the coal seam with some variation in the non-coal lithologies in the floor of the seam (Figure 4).

The depth to the top of the Fassifern Seam varies between 150 m to 170 m (Figure 1). As currently proposed, the working section will be 3.2 m high and runs from the FCR ply down to about the base of the FAS T plies and occasionally into the FAS U ply, depending on local coal thickness.

2.3.2 Immediate roof

Above the 1.0-1.5 m of coal tops there is a thick sequence of claystone roof (= Awaba Tuff). The logs make no reference to bedding structures in the Awaba Tuff. At Mannering the basal 1 m of the Awaba Tuff was often found to be thinly bedded and the rest of it was very thickly bedded. The Awaba Tuff is typically of high strength – say 40-80 MPa, averaging 53 MPa.

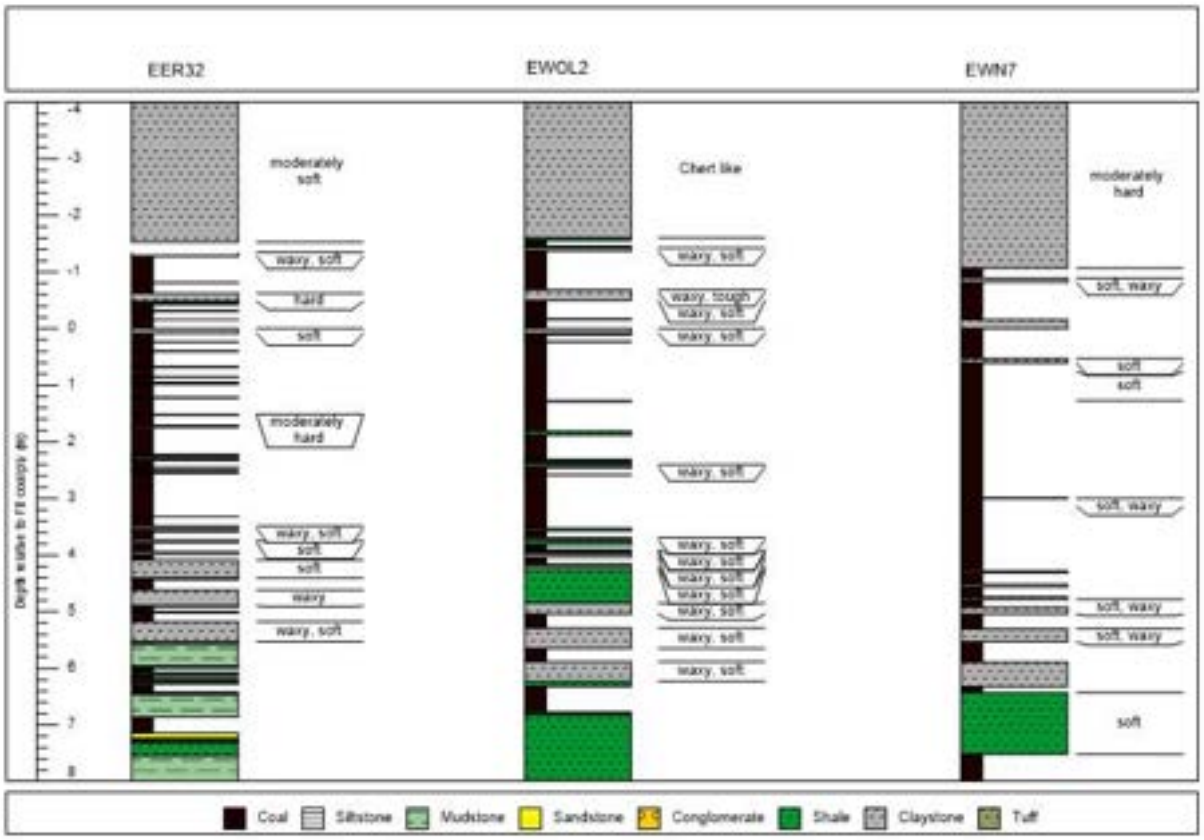


Figure 4 Immediate roof and floor of Fassifern Seam

2.3.3 Immediate working floor

In this report we have adopted the term claystone instead of tuff, so the reported "Claystone" includes both claystones and tuffs. Of particular importance are the relatively thick claystone units towards the base of the seam which have been logged as "soft" and/or "waxy". Such units are present in all of the holes examined at Chain Valley, although the logging of their strengths is not consistent. The terminology used at the time is not defined. It is assessed that these descriptions may indicate strengths of less than 2.5 MPa. The CoalLog dictionary, developed some 50 years later, defines "soft" as having an S_u (undrained shear strength) of 25 kPa which can be taken as equivalent to a UCS (Uniaxial Compressive Strength) of 50 kPa, and "hard" as an S_u of 200 kPa (UCS=500 kPa). We assess that "waxy" may correspond to either C6 or R1 in the CoalLog schema.

The Strata2 report (CHV-016) states that the claystone strengths range between 0.7 MPa to 5.7 MPa, averaging between 2.2 MPa to 2.4 MPa. These values were obtained from Point Load Strength Index (PLSI) testing. PLSI testing requires brittle failure, and it is unlikely that this was achieved for such low strength claystones where plastic deformation would dominate[1]. The Strata2 report includes laboratory testing of mudstone/siltstones at about 70 MPa but not of any claystones.

A DgS report (CHV-002/10b) presents a summary of testing (Figure 5) which suggests values as low as 1 MPa are possible although it is understood that this does not include testing from the specific area of interest.

[1] - it has been reported in the engineering literature that UCS values derived from PLSI strength values are highly ambiguous if results are less than 25 MPa. Hoek, Kaiser Bawden 1998

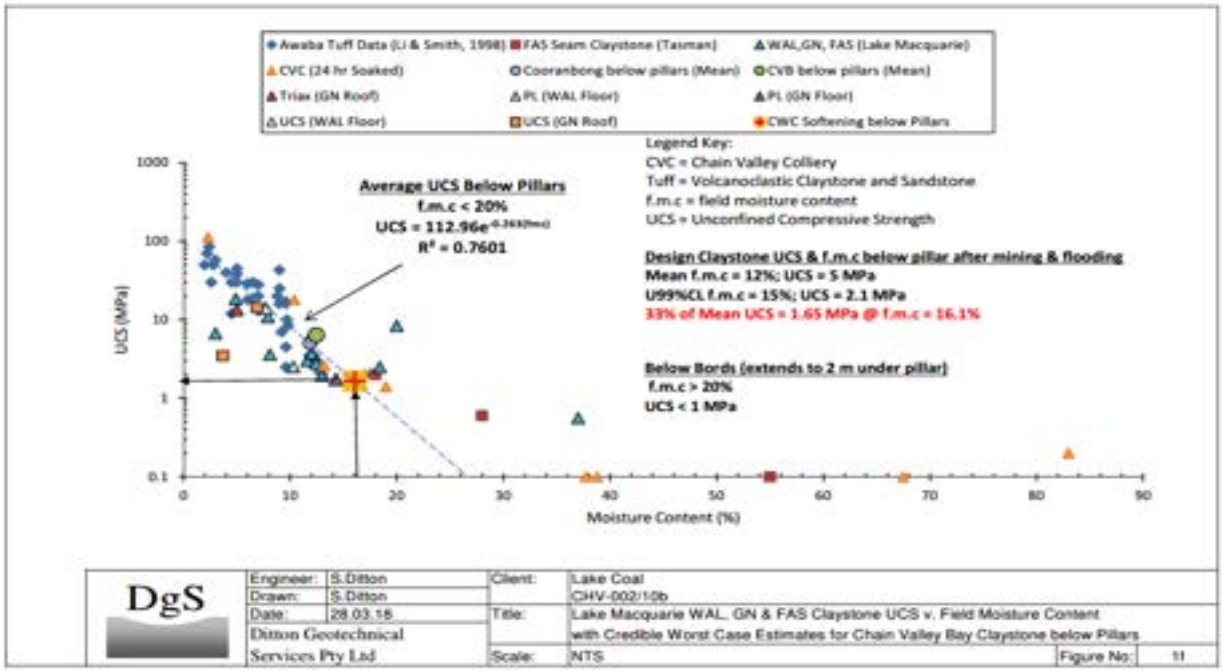


Figure 5 Summary of testing of claystones

We are aware of recent logging of claystones in the Fassifern Seam at an adjacent colliery. The samples were not suitable for laboratory testing, but the field logging indicates R1 strength (CoalLog – UCS < 1 MPa) for some of the layers.

Some of the lower strength claystones have been reported to slake and disperse in water. This observation, together with the reported low UCS values, suggests that they may behave somewhat similarly to heavily overconsolidated clays. Data on the coefficient of consolidation (Cv) is available from the Awaba Tuff at Mandalong and this suggests an average value of 0.006 m^2/day (Figure 6).

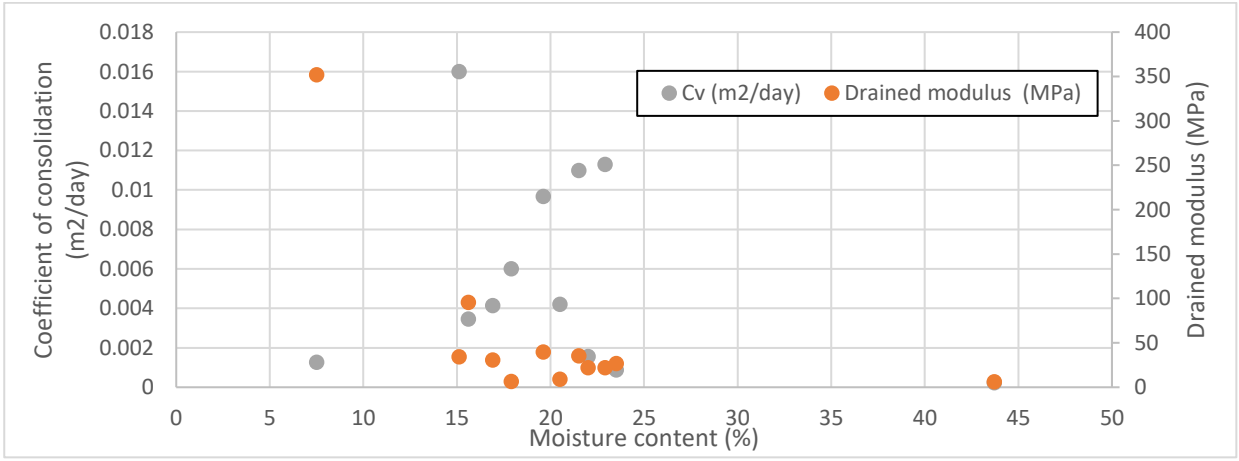


Figure 6 Coefficient of Consolidation and drained modulus testing of the Awaba Tuff at Mandalong.

2.3.4 Sequence below the Fassifern Seam

Historic practice in coal exploration in the area has been that few of the boreholes extended more than 2 m below the base of the Fassifern Seam. EWOL2 extended down to the Pilot Seam (Figure 3) and intersected a hard chert-like claystone and then sandstones and conglomerates (Belmont Conglomerate).

2.4 Geological structures

There are no mine workings in the overlying Wallarah or Great Northern Seams which previously have been used to extrapolate fault structures to other seams. The dominant structural grain of the coalfield involves north-west trending structures, so based on the conditions encountered in the Wyee longwalls and the miniwalls MW1-MW12 there is confidence that the conditions in the Northern area will be similar. Ongoing mapping in the current workings continue to confirm this is the case.

3 Subsidence estimation

3.1 Previous bord and pillar workings in the Fassifern Seam

3.1.1 Mannering Colliery - subsidence

First workings were conducted in the Fassifern Seam at Mannering Colliery in and around 2007 (Figure 7). The depth of cover as indicated from the boreholes is in the order of 180 m. The pillars were on 30 m centres with 5.5m roadways with some barriers and some cuts into some pillars. The extraction ratio is estimated to have been 33 % within the pillar workings, and less if the barriers are included in the calculations. The change in stress on the pillars would have been 2.25 MPa.

A subsidence line was installed immediately prior to the mining in the Fassifern Seam but after the limited mining in the Great Northern Seam in this area (Figure 7). The survey pegs were located in a road easement, and many are reported to have been damaged. Recent upgrades to Ruttleys Road have destroyed the survey pegs.

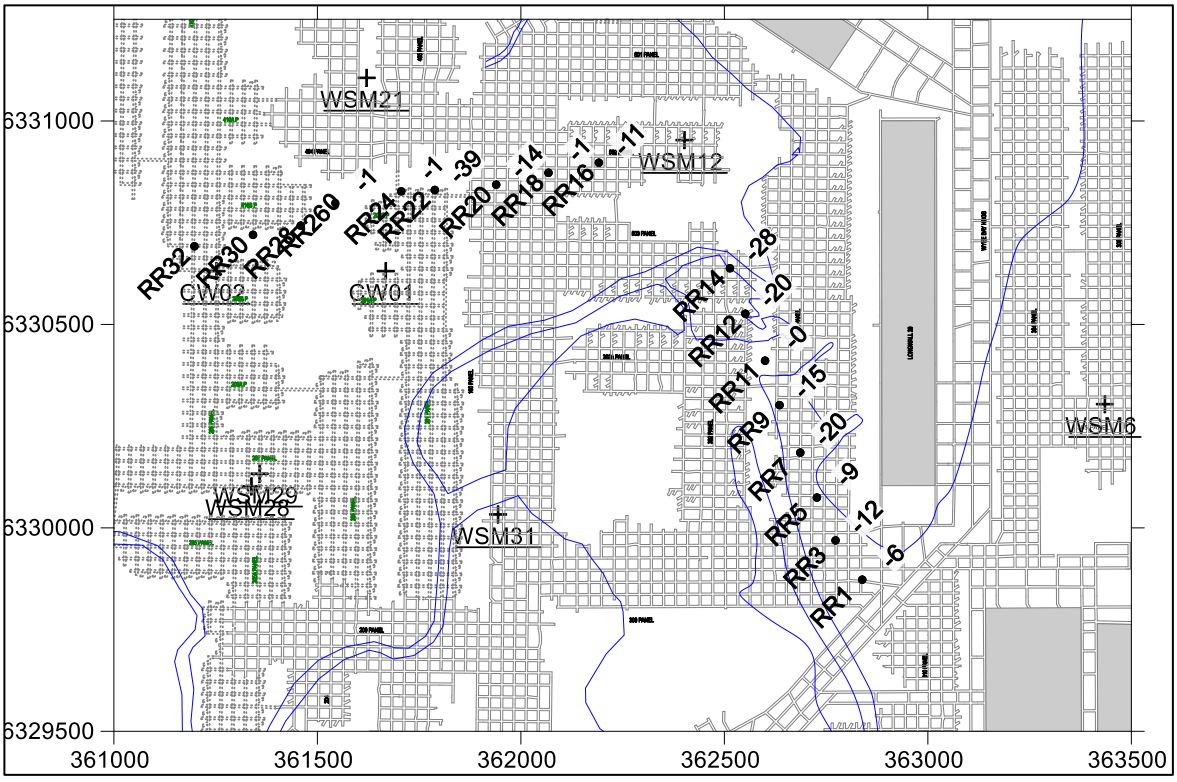


Figure 7 Survey line along Ruttleys Road showing subsidence as of December 2008 (in millimetres) and the mine workings.

The location of the pegs with respect to the mine plan is shown below, with the thin lines showing the extent of mining at each month (Figure 8). The resolution of the contour labels is not good but Figure 9 includes information on when the survey line was undermined. It is noteworthy that peg RR22 which has the reported greatest subsidence is located at the edge of a panel and was undermined prior to the survey line being established.

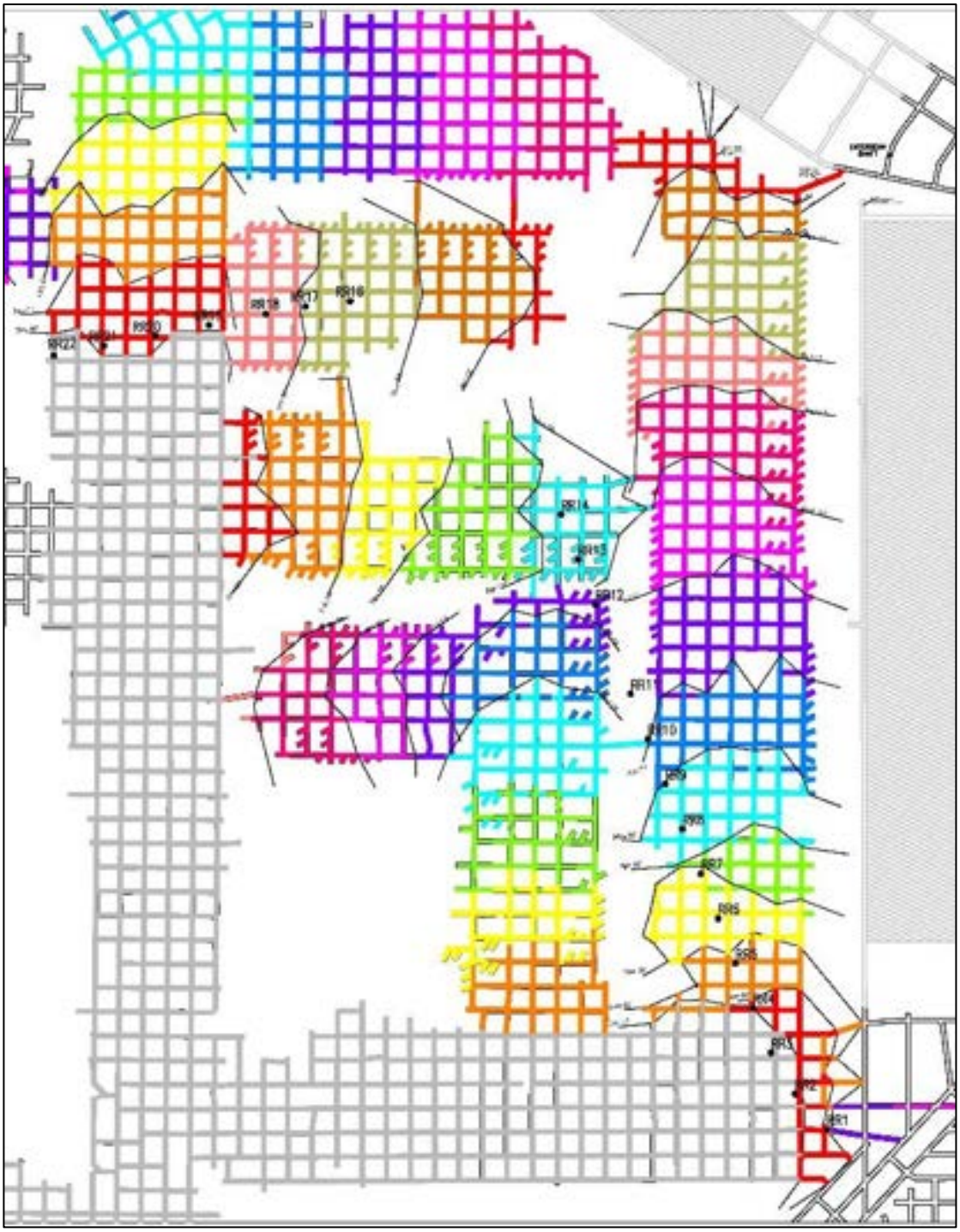


Figure 8 Mining progression in Fassifern Seam under Ruttleys Road

Figure 9 shows the progress of subsidence with the thick black lines (drawn at the +10 interval) identifying where mining was being conducted under the pegs. It is noted that RR22 shows the greatest subsidence even though it is located right at the edge of mining in the period being considered. The subsidence ranged between 0 mm and 39 mm. The non-ideal nature of the data is recognized and the decision was made to restrict our analysis to the last survey and, in the face of the variability, to progress by taking the average value of all data in the set. We chose not to exclude any data set – neither the high values from RR22 value nor the very low ones – as such an action would imply more confidence in the data than we believe is justifiable. At such low deformation levels, subsidence surveys are approaching their level of detection and are also exposed to soil shrink/swell movements.

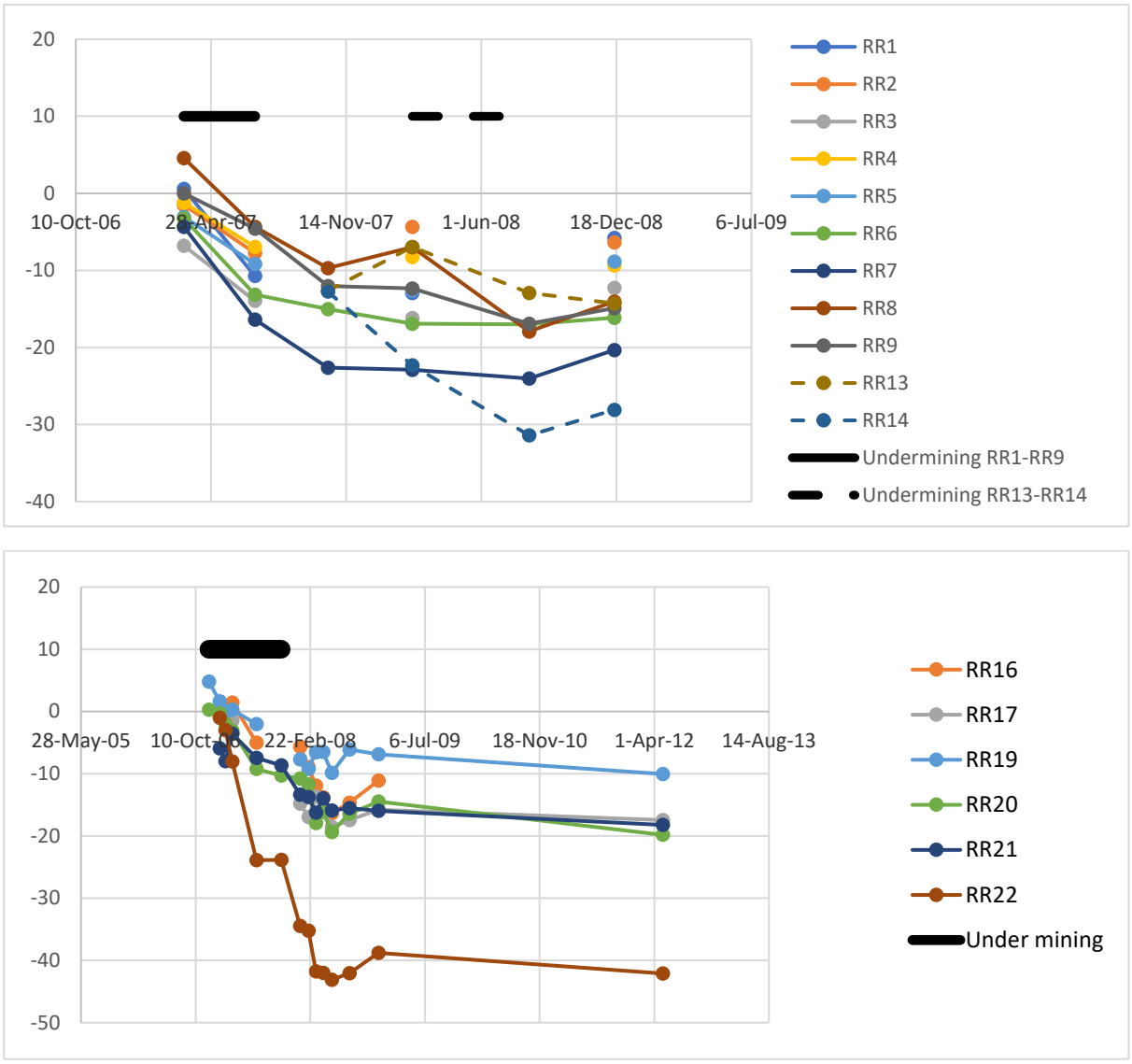


Figure 9 Ruttleys Road survey data including indications of when pegs were undermined.

Our interpretation of this data set is that the vertical subsidence should be taken as the average of the data - 15 mm. The subsidence would have been the result of compression of the Fassifern coal itself, and the roof and floor materials. It is not possible to identify the individual components, but the overall Fassifern pillar system can be ascribed a subsidence compression factor of 6.7 mm/MPa stress change (15/2.25).

3.1.2 Chain Valley – subsidence in Sunshine/Balgonnia area

Surface subsidence surveys have been recently conducted in the Sunshine/Balgonnia peninsula area (Figure 10). The surveys indicate that there has been 10 mm to 20 mm of subsidence along the foreshore and less than 10 mm along Dandaraga and Hillcrest Roads. There is some minor upsidence (< 5 mm).

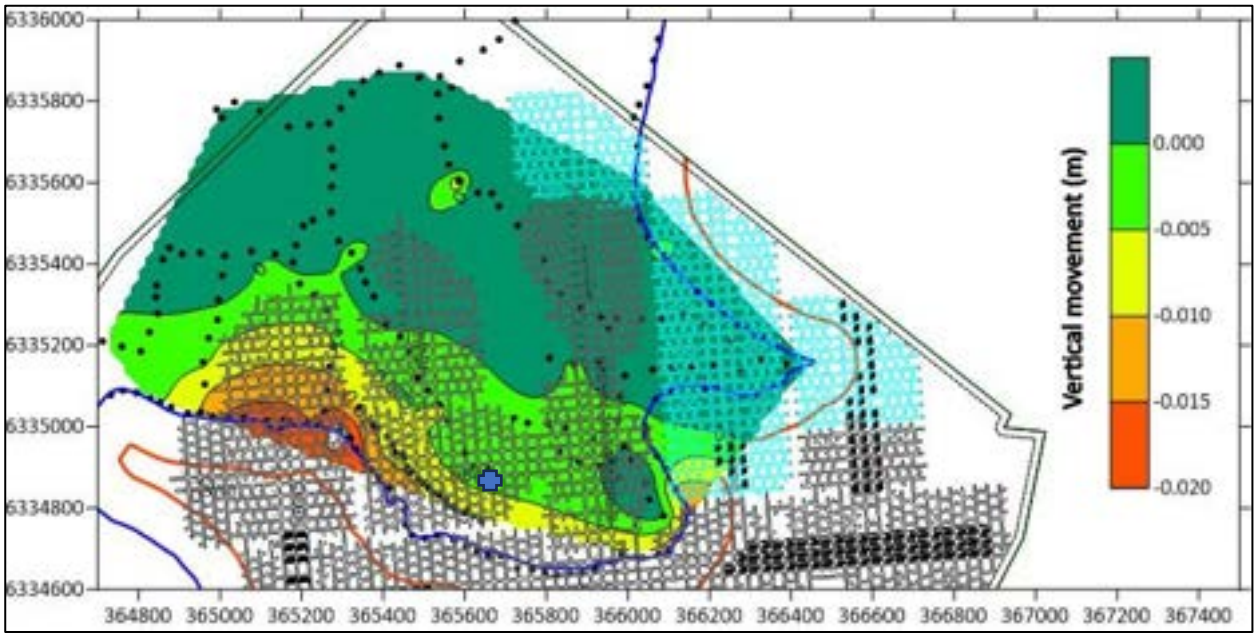


Figure 10 Surface subsidence in the Sunshine/Balgonnia area approximate location of EWN07 (subsidence data is the minimum recorded since surveys began)

It is noted that the survey accuracy is reported to be 2 mm, so the accuracy of a subsidence calculation is 4 mm. This can be seen in the compilation of the survey results along Line 50 located on the foreshore (Figure 11).

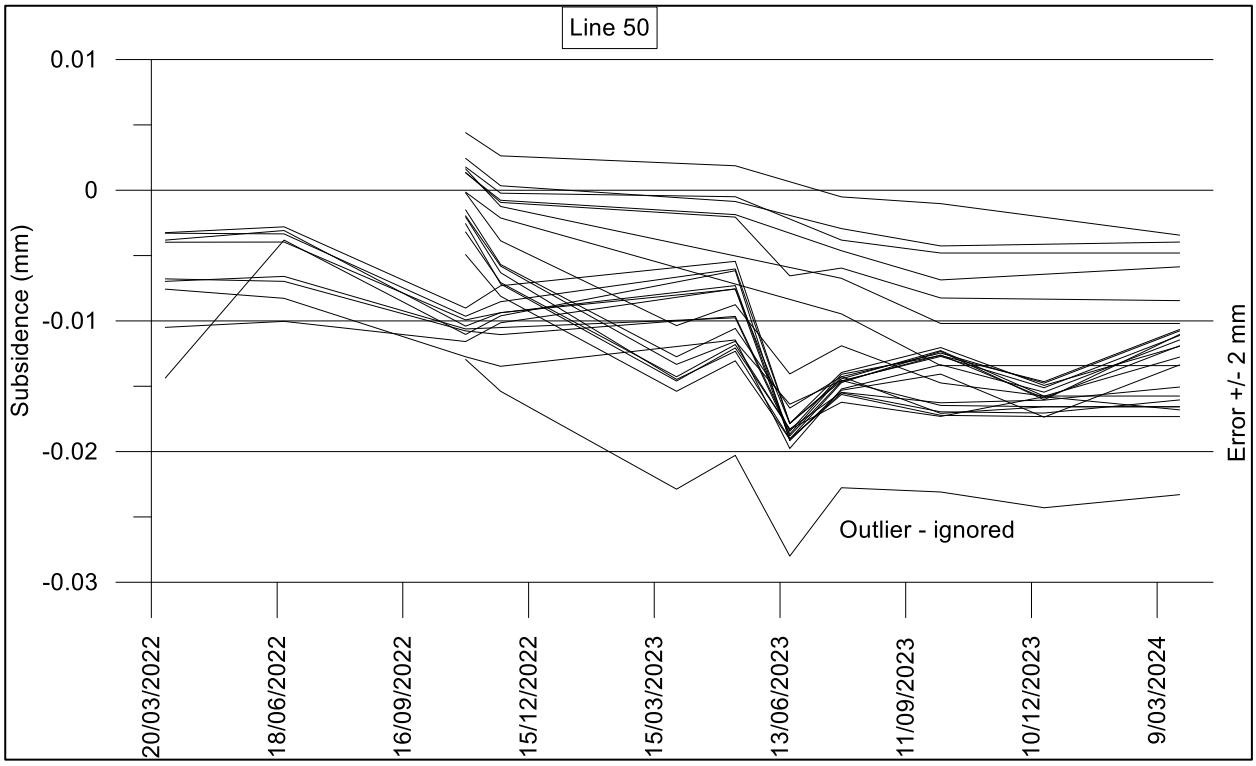


Figure 11 Line 50 -compilation of surveys over time

The extent of the underground workings in the Fassifern Seam at the time of the latest survey is shown in Figure 10 and is a continuation of the herringbone mining system involving long-term stable pillars, and either supported or un-supported roadways.

In EWN7 the depth to the Fassifern seam is 152 m. In the spine pillars, the mine layout resulted in an extraction of 33% and a vertical stress change on the pillars of 1.86 MPa. Adopting a value of 15 mm for the vertical subsidence the subsidence compression factor is 8 mm/MPa (15/1.86). In the herringbones themselves, the extraction ratio is 39 %, giving a stress change of 2.4 MPa implying a subsidence compression factor of 6.25 mm/MPa (15/2.4).

The minor upsidence to the north east and north west is assessed to be hogging in response to the sagging above the mined area.

3.1.3 Tasman Mine

The Fassifern Seam (2.2-2.5 m) was mined using the Duncan system with pillars on 45 m centres followed by double-sided lifting with 20 - 22.5 m roadways resulting. The general layout involved 5 entries giving an extraction panel of a nominal 200 m width and an inter-panel barrier of 34 m. High pillar stability factors applied to the Duncan pillars.

Floor heave was observed and after a period of time subsidence in excess of 0.5 m was measured whereas it was initially predicted to be about 0.1 m[2]. It was reported that there were claystone layers of 0.1-0.4 m thick in the floor of the Fassifern Seam which apparently had strengths of 2-3 MPa. The proposed failure mode was related to the claystone beds softening to 0.15 -1.0 MPa although it is not stated as to whether this was in the floor of the roadways or under the pillars.

3.1.4 Summary

The subsidence above bord and pillar layouts in the Fassifern Seam is very low and close to survey detection limits unless the survey pegs are installed on bedrock. Subsidence compression indexes of between 6.7 to 8.0 mm/MPa stress change can be derived. A value of 8 mm/MPa will be adopted for the analyses presented below.

4 Pillar design

4.1 Pillar dimensions

For 30m x 27m pillars, stripping will result in a line of 10.5 m wide remnant pillars flanked on three sides by a 5.5m roadway and the other by a 16.5 m void – this ignores the sawtooth edges that result from the lifting.

Single sided lifting in the runouts results in 83 m wide panel, 17m spans, 13m wide pillars.

4.2 Coal and floor stability

The following analysis of the pillar/floor system is based on 170 m depth, and a 3.2m extracted thickness.

Stability analyses are presented in Table 2 and Table 3. It is assessed that the ground conditions during the stripping will be adequate based on the following considerations:

1. The loads are overestimated with the tributary area assumption.
2. The remnant widths of 10.5 m and 13 m compare well with fenders previously used in full pillar extraction goafs which were typically 5 m or w/h>2.0.

[2] Ditton, S and Sutherland, T. 2013. Management of subsidence at the Tasman and Abel Mines – issues and outcomes. Coal Operators' Conference. University of Wollongong.

3. The FoS values for the remnants are low in the context of pillars but high in the context of fenders with the important issue being that the workforce is located surrounded by pillars with FoS values in excess of 2.63.
4. Floor heave may develop after stripping, but it is unlikely to impact the stripping operation itself. The analyses adopted the 1 m/1MPa claystone strength used in previous reports.

Table 2 Pillar and floor stability when stripping spine pillars

Centres (m)	Initial FoS	Remnant size (m)	Stripped span (m)	Remnant Pillar FoS	Remnant width/height	Floor FoS
30*27	2.63	10*24.5	17	0.77	3.13	0.33

Table 3 Pillar and floor stability when lifting runouts

Dimensions	Extraction void	Height	Pillar (Bieniawski)	Floor
13*100	17	3.2	1.07	0.52

5 Connective fracturing

The worst case estimate of vertical extent of immediate collapse associated with spans to be formed is assessed to be the same order as the extraction width – 17 mm. It is likely to be less than this as there are likely to be thick units within the Awaba Tuff (see Section 9).

The proposed stripping of spine pillars results in unsupported spans of 17 m but at the mining depths being considered there is not a hazard with regards to rockhead and connection to Lake Macquarie. Figure 12 extends the approach adopted in our report DCV-05 regarding rock head and minimum mining depth for the case of a 17 m wide by 500 m long void. At a stability factor of 2.0 and assuming a low horizontal/vertical stress ratio (k) of 1.0, the minimum thickness of fresh rock is 50 m which translates to a minimum mining depth of 80 m (assumes 20 m of weathered rock and 10 m lake depth).

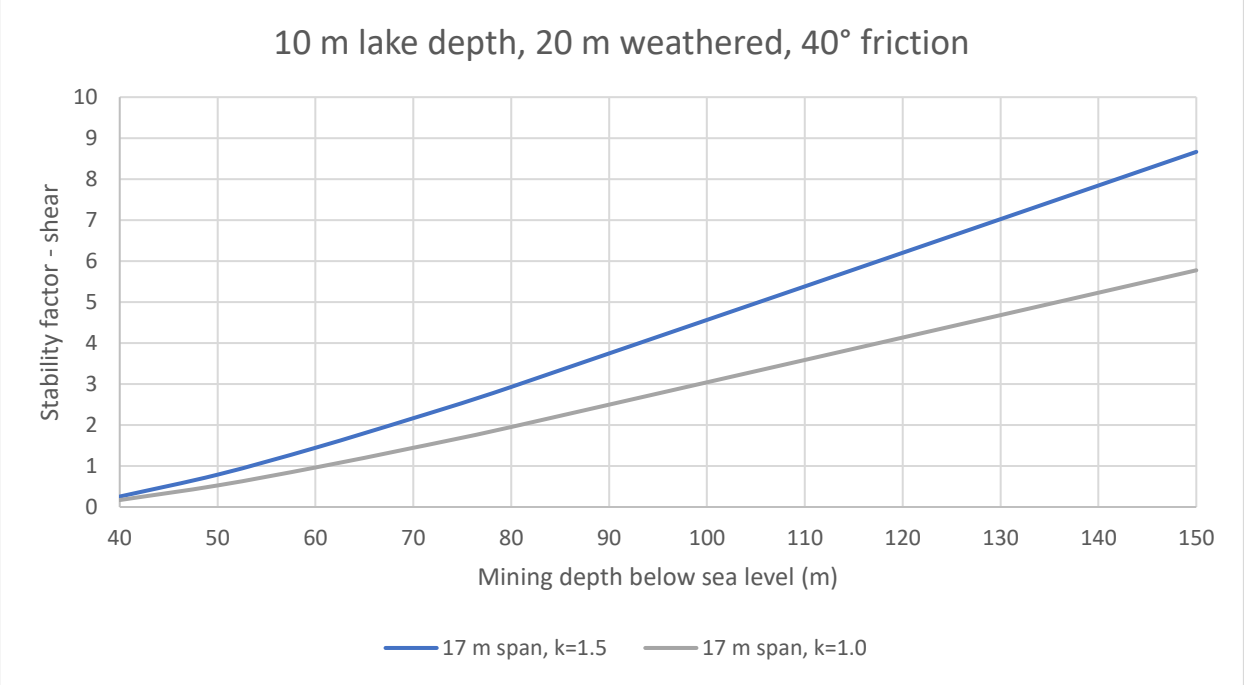


Figure 12 Analysis of a block collapse above a 16.5 m by 500 m void.

Combined with the predicted shallow roof collapses the mine layout with only single sided lifting mitigates against a wind blast hazard.

6 Subsidence

To estimate subsidence, it is assumed that the pillar remnants provide no vertical restraint to the overburden and hence the stripped or lifted area is equivalent to an extracted void that is between 70 m and 83 m wide. This is also a conservative assumption regarding the prediction of vertical subsidence.

Note that before stripping, the subsidence above the spine pillars is estimated to be 18 mm based on a compression index of 10 mm/MPa. There will be no increase in subsidence if the claystones under the pillar do not yield.

If the claystones do yield and fail, then subsidence will be determined by the sag of thick units – layers within the Awaba Tuff or conglomerates. Most likely the key unit will be the Warnervale Conglomerate or possibly the Teralba Conglomerate. For a 70 m wide void Figure 13 indicates that a 10 m thickness would be required at seam level, and reducing if the critical layer is higher up in the sequence. These thicknesses are available in the Warnervale and the Teralba Conglomerates (Figure 3). A specific estimate of subsidence requires knowledge of the thickness of such units – 20 m is rational implying sag of 95 mm. In this case the total subsidence would be 113 mm (18 mm from the chevron development plus 95 mm), reducing if the conglomerates are thicker.

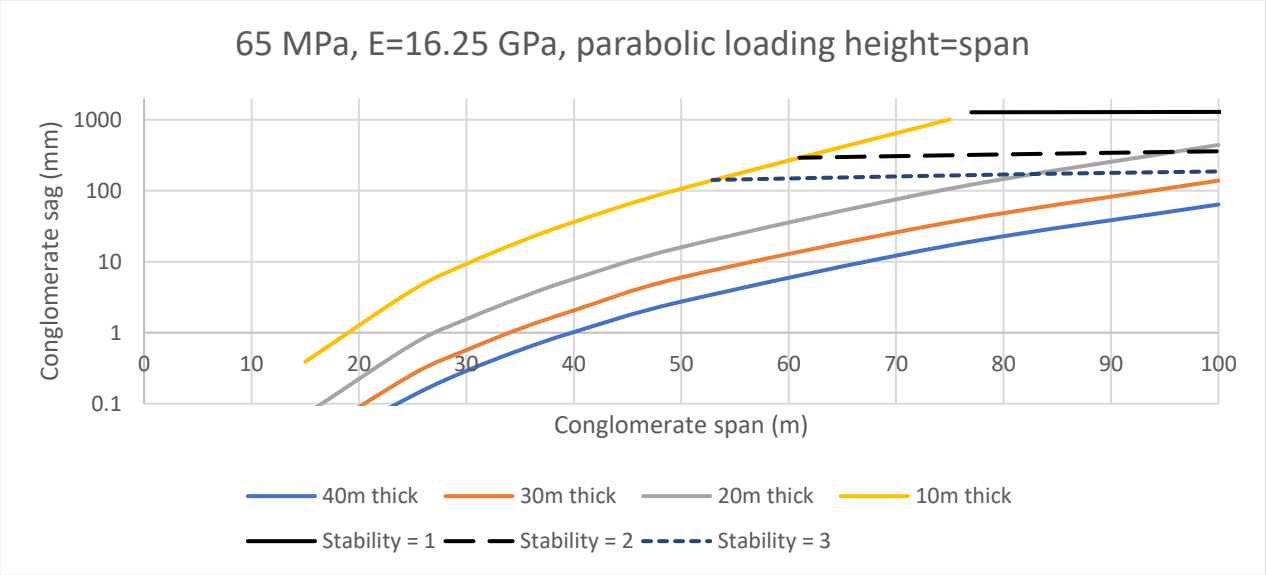


Figure 13 Sensitivity study of the deflection and stability of conglomerates relative to span and conglomerate thickness – 16.5m spans

It should be apparent that the predictions are based on a number of inferred properties and assumptions: the main one being that the remnant pillars punch into the floor and result in a larger effective span for the conglomerate and hence the additional 95 mm of deformation. In terms of likelihood our predictions can be characterised as:

- Likely – 18 mm
- Possible – 113 mm
- Very unlikely – 226 mm

We recommend that hazard assessment be based on the possible level – 113 mm.

An alternative empirical prediction based on the Holla curve for Newcastle would be a width/height ratio of 70/170 = 0.41, a Smax/T = 0.05 and a maximum subsidence of 160 mm.

7 Impacts

The predicted maximum subsidence is 113 mm. There is little information on angle of draw for the Newcastle area and especially for narrow panels relative to the depth of mining: a value of 15.7° has been adopted[3]. From this value it is calculated that subsidence deformation greater than 20 mm will extend 48 m from the edge of the secondary extraction panels.

7.1 The Lake Bed

The lake bed contours, derived from bathometric surveys from 2012 onwards, are shown in Figure 14. Given the gently sloping lake bed topography and the expected maximum subsidence of 113 mm, it is considered unlikely that there would be an adverse impact on the lake bed.

7.2 Sea Grass Beds

Sea grass beds exist along the foreshore, below the Low-Water Mark. The Sea Grass Protection Barrier (SGPB) is defined by a 26.5° angle of draw from the mapped beds and is contained within the HWMSB shown in Figure 14. The predicted mining induced subsidence in excess of 20 mm does not impinge on the predicted HWMSB. It is therefore assessed that there would be no adverse impact on the sea grass beds as a result of the proposed extraction.

7.3 The Lake Foreshore

The High-Water Mark Protection Barrier (HWMPB) as shown in Figure 14 is defined by 35° angles of draw each side of the High-Water Mark. The proposed secondary extraction locations are located outside of the HWMPB and any subsidence of the foreshore is predicted to be less than 20 mm and hence have no adverse impact.

7.4 Minor Cliffs

Along the southern edge of the Morisset Peninsula is an approximately 200m length of minor (i.e., ~8m high) cliffs formed in the Munmorah Conglomerate, with an overlying steep (typically 20-25°) slope (Figure 15). These cliffs are within the HWMPB and hence no subsidence in excess of 20 mm is predicted. No mining induced impacts or cliff instability is predicted.

7.5 Built Features

Built features relevant to the area of interest are shown in Figure 16. There are two low water buoys (063 and 064) in the Morisset Peninsula area. There are some houses and jetties along the foreshore and these are within the HWMPB.

Given that <20mm of subsidence is predicted for HWMPB, no measurable impacts are expected on the foreshore features.

Given the limited overburden caving and predicted vertical subsidence of <0.14 m it is unlikely that measurable horizontal movements will be experienced beyond an angle of draw of 15.7° from the extraction limits.

[3] See Figure 9, Holla (1987) Mine subsidence in New South Wales 2. Surface subsidence prediction in the Newcastle Coalfield.

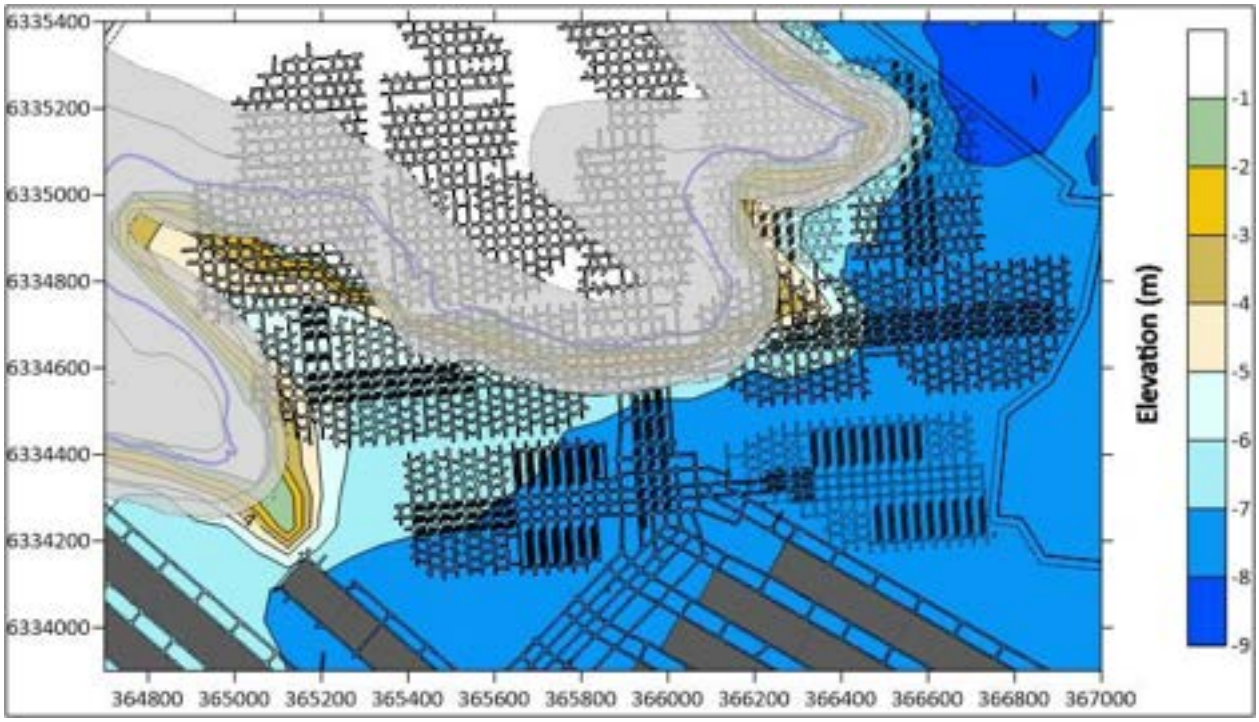


Figure 14 Proposed plan and lake bathymetry (HWMPB shown as grey overlay)



Figure 15 Typical minor cliff.



Figure 16 Surface features in Fishery Point area.

8 Monitoring

We are not aware of a monitoring technology that could be deployed the confirm the predictions. The prediction is inside the resolution of bathymetric methods which is understood to be 200 mm (the precision of each measurement is +/- 100 mm). Bathymetry will not provide confirmation of the prediction but could be used to identify the failure of the design approach.

A useful geotechnical strategy would be to inspect/monitor the completed stripped/lifted area where safely accessible to assess if there is floor heave associated with pillar punching.

9 Extraction conditions

The proposed 17 m span is well in excess of what can be expected for the FB ply to remain stable. Mobile Roof Supports will be required to assist in the control of the coal tops (about 1.5 m) and possibly about 1 m of thinly bedded Awaba Tuff.

Based on the experiences at Tasman Mine, it is likely that there will be a thick enough layer within the Awaba Tuff to span the 17 m voids. A relationship between tuff thickness and spanning capability (Figure 17) suggests that a 0.97 m thick layer would just be able to span across the 17 m wide voids that are to be formed – from recent coring at Myuna it is assessed such thicknesses are present although the experiences at Mannering suggests that they are not at the base of the unit - hence there would be some scat development expected.

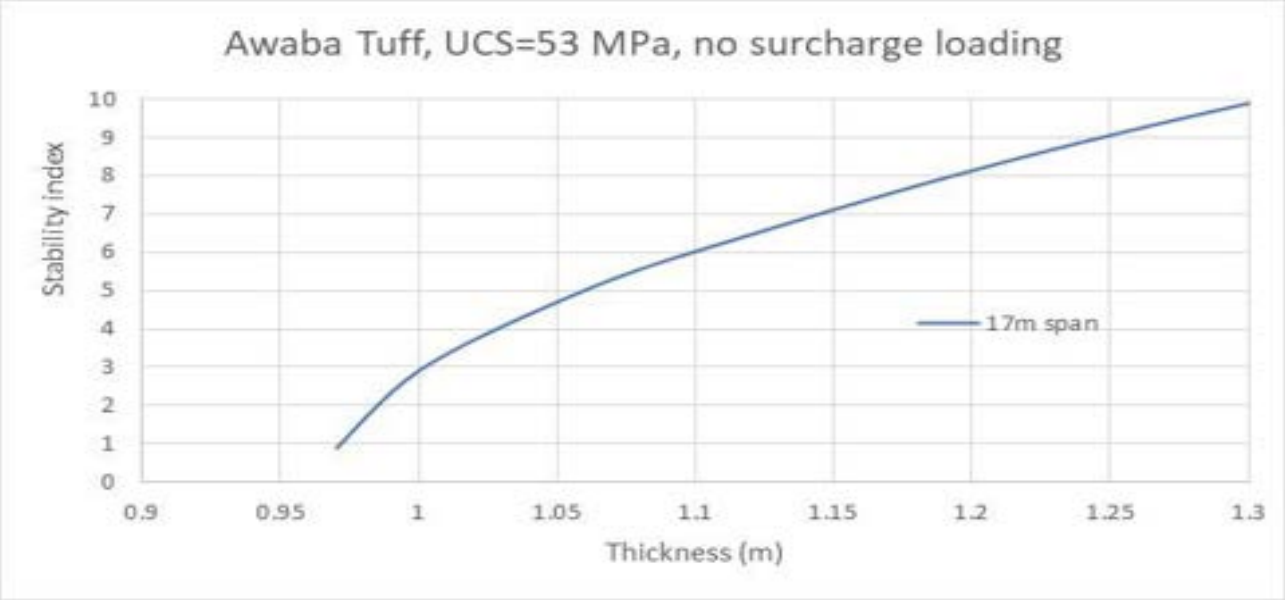


Figure 17 Spanning capability of Awaba Tuff (UCS=53 MPa, no surcharge loading).

10 Assessment

Stripping of spine pillars results in 17 m wide voids, the roof of which should be readily manageable with mobile roof supports as the height of collapse is likely to be no more than about 2 m. It is possible that the remnant 10 m and 13 m wide pillars will punch into the floor and generate floor heave but this will inbye of the stripping. Note that the onset of floor heave deformations requires downward movement of the overburden (i.e. thick conglomerates): it is possible that although the pillars do not provide restraint to the overburden there will be insufficient deformation to induce floor heave.

The predicted maximum subsidence at the floor of Lake Macquarie is 113 mm.

Over time, the roof may collapse/crack to about 17 m – that is to the width of the voids. There is no risk of connected cracking extending from the Fassifern Seam and the floor of Lake Macquarie.

11 Risks and Uncertainties

Partial pillar extraction was recently successfully conducted in the Fassifern Seam at Tasman Mine using voids that are much less than those proposed. There is a high level of confidence that similar ground conditions will obtained in the northern area of Chain Valley Colliery.

The subsidence predictions are based on interpretations of measured subsidence outcomes from recent mining in the Sunshine and Ruttleys Road area and based on our assessment that the geology of the Fassifern Seam is very similar. The panel and pillar dimensions are somewhat similar so there is negligible geometric extrapolation.

The key geotechnical uncertainty is the presumed strength and thickness of low strength claystone layers. It must be accepted that floor behaviour is poorly understood due in part to lack of geotechnical knowledge of the claystones/tuffs. The proposed mine layout reduces the risks associated with this uncertainty to negligible levels.

Appendix - Geotechnical considerations/behaviour models

So as not to distract from the mining engineering application and recommendations, some of the detailed geotechnical issues associated with mining in the Newcastle coal measures are addressed in this appendix.

Separate from the complexities of characterising the engineering geology of the site, there is a need to conduct engineering analyses. These can be in the form of "closed form solutions" or numerical models. Both are applications of elastic theory, and both are limited by the available engineering geology knowledge.

Failure/collapse of claystone

Possibility of the onset of undrained conditions in low strength claystones during retreat mining

In soil mechanics the concept of undrained loading is used when the rate of loading is very much greater than the rate at which the induced pore water pressure dissipates. This concept applies to most failures of clay-rich soils that occur during construction. It is readily implemented in design by adopting a friction angle value of zero and an undrained shear strength value of half the UCS.

The key engineering design question for Newcastle coal measures becomes whether the rate of increase in pillar loading is greater than the rate at which the pore pressures can dissipate from the claystones. Galvin (2016)[4] states that *"under normal circumstances it is difficult to conceive a friction angle of most coal mine strata, including claystone, being less than 10°. Pillar load builds up over a period of time as the mining face is advanced, thereby providing time for some of the excess pore pressure to be dissipated and for partial recovery in friction angle".*

What is meant by "normal circumstance"? Galvin identifies the possibility of delayed failure of massive strata could result in a step increase in pillar loading but at Chain Valley the conglomerates have not failed – the evidence is that they are spanning between the pillars.

For Chain Valley Mini Walls MW1-12, it is estimated that the extraction proceeded at about 7 m/day. The width of the vertical stress abutment ahead of the retreating miniwalls would have been in the order of 72 m (Peng and Chiang, 1984[5]). The increase in vertical stress in advance of the extraction can be estimated to be in the order of 5 MPa at the maingate corner and an additional 5 MPa at the tailgate corner. This gives a potential rise in pore pressure of 5 MPa over a period of 10.3 days.

The rate of dissipation of pore pressure is related to the coefficient of consolidation (Cv) and the drainage path length. Cv values are available for Awaba Tuff with an average of 0.006 m^2/day and these are similar to quoted values for heavily overconsolidated clays (Lee White Ingles, 1983[6]). Assuming that coal layers represent high conductivity layers connected to a free drainage face, the drainage path length is either half the thickness of the claystone layer if there is coal above and below, the full thickness if there are "normal" coal measure rocks at either the top or bottom of the clay layer, or the full pillar width if there are normal coal measures rocks enclosing the claystone.

[4] Galvin JM 2016 Ground Engineering – Principles and Practice for Underground Coal Mining. Springer.
[5] Peng SS and Chiang HS 1984 Longwall Mining. New York Wiley.
[6] Lee IK White W, Ingles OG 1983 Geotechnical Engineering Pitman.

According to Figure 18 while there would be effectively full dissipation over 10.3 days with a 0.25 m drainage path length, there would be only 55% dissipation for a 0.5 m path length and less than 30% if there was a 1.0 m drainage path length.

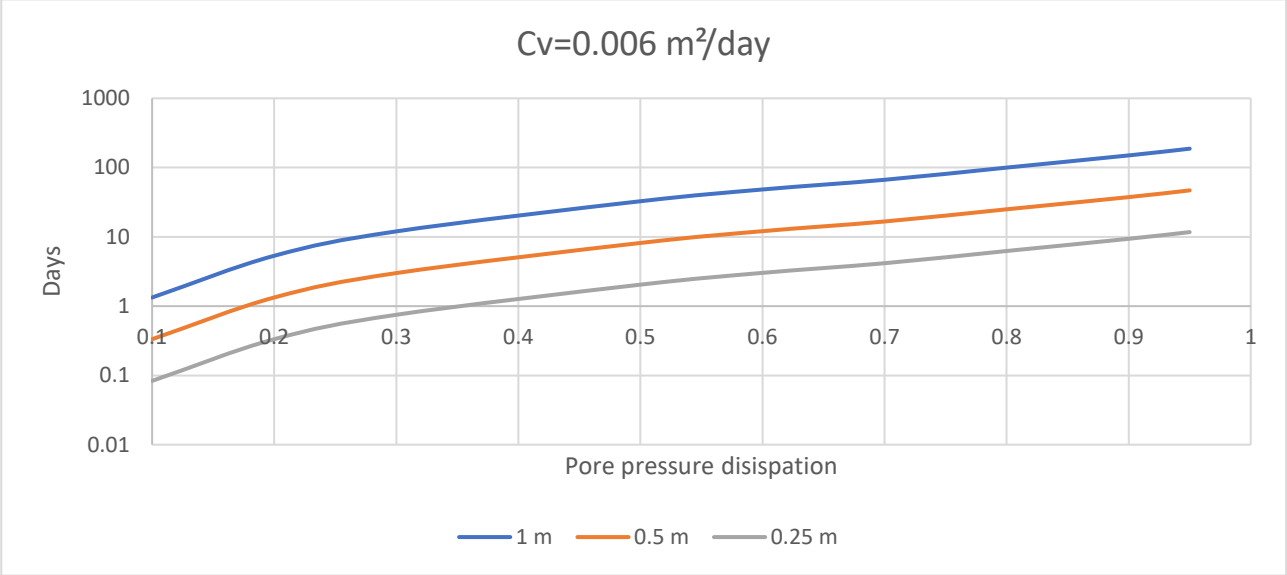


Figure 18 Rate of pore pressure dissipation

It is concluded that an undrained analysis is appropriate for regular caving, in addition to the delayed caving as recognised by Galvin (2016). It is noted that an undrained analysis results in the lowest bearing capacities and is therefore a worst-case scenario.

Use of Mandel and Salencon bearing factor

Foundation engineering approaches as used in civil engineering can be used. These approaches are based on elastic theory and are thus independent of dimensional and load scale.

The low strength of the claystones, and the fact that they rapidly slake and disperse in water, justifies the adoption of undrained strength. Adopting undrained conditions is also consistent with the subsidence events occurring very soon after mining (within 1- 2 years).

The Mandel and Salencon[7] approach has been used to assess floor stability/bearing capacity:

Bearing capacity = 0.5*UCS*(4.14+W/(2*t))

where W is pillar width and t is thickness of the claystone unit.

The Mandel and Salencon formula is used for 4 reasons:

1. it is the first method discussed in the standard geotechnical engineering text book[8] that we use.
2. It more closely represents the behaviour model we have adopted.
3. It is more conservative (lower bearing capacities) than the Brown and Meyerhoff alternative.
4. Its simplicity readily allows sensitivity studies.

The rapid increase in the bearing factor with reduced thickness using the Mandel and Salencon relationship is shown in Figure 19. This is the reason why we focused on layers more than about 0.3 m

[7] Mandel, J, and Salencon, J. 1969, Force portante d'un sol sur une assise rigide. Paper presented at the 7th international conference on soil mechanics and foundation engineering. Mexico, 157-164. Sociedad Mexicana de Mechanica.
[8] Lee IK, White W and Ingles OG. 1983. Geotechnical Engineering. Page 346.

thick. We are fully aware of the limitations of the available bore hole data which is why we have used the empirically derived 1m/1MPa claystone index (which implicitly deals with "all" claystone layers).

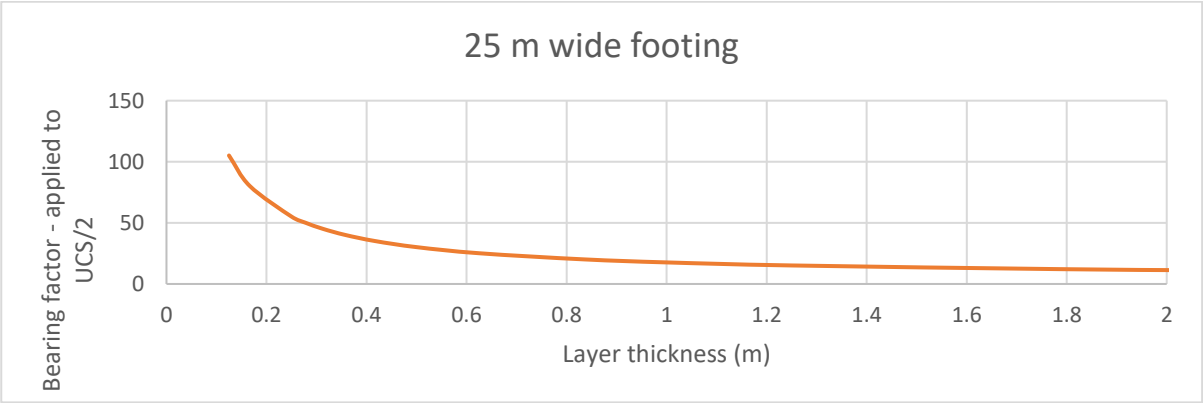


Figure 19 Increase in bearing capacity as the thickness of an undrained layer decreases

Regarding reliability, the method has been used successfully in coal mining operations in both NSW and Qld, specifically in the identification and avoidance of floor heave. We are aware of ad hoc criticisms about its use but no case study has been presented to support such. Accuracy implies knowledge of a true measurement – in engineering a true value is not and cannot be known at the time of the prediction and hence the term "accuracy" is not typically used.

Selection of the 1m/1MPa index

Floor failure will occur if the vertical loads exceed the bearing capacity. Estimating vertical loads is particularly complex in the presence of massive conglomerates such as are present at Chain Valley and Mannering. A valid estimate is only possible for wide extraction areas – multiple longwalls or miniwalls.

By back analysing the subsidence above MW S2-S5 (450 mm of subsidence, W=40 m, pillar stress = 12.6 MPa) and making an assumption that a bearing failure was only just avoided (factor of safety = 1.0) it was calculated that a 1 m thick claystone would have a strength of 1 MPa (0.8-1.0 MPa depending on depth). Alternatively, a 0.5 m thick layer of 0.45 - 0.57 MPa strength is equally valid. It is assessed that these values are consistent with our interpretation of the various logs and tests summarised above. It is noted the 1m/1MPa index would also infer factors of safety of less than 0.6 applied to MW1-12 – where the pillar system did fail. For the case of Tasman, both the Duncan pillars and the inter-panel pillars would have had factor of safety values less than 0.5 – these also failed.

Note that if bearing failure develops it is not possible to determine the resulting deformation.

The 1 m at 1 MPa strength assumption has been adopted. This data was derived from back analysis so can be used without an additional modifying factor – the minimum required floor stability index is 1.0. A key point to note is that bearing capacity is independent of pillar height. Pillar height is a factor in determining coal pillar strength and there is a relationship between height and pillar width. When assessing pillar system performance in the context of the floor, it is only the width of the pillar and the load on the pillar that are material.

Span failure

Conglomerates

The subsidence information from Chain Valley and other mines in the Newcastle Coal measures indicate that thick conglomerate layers are able to span. Bathymetry shows negligible (<150 mm) deflections

above the extraction (between the chain pillars) at Wyee and for the Chain Valley miniwalls. Specific applications of a voussoir beam analysis to assess conglomerate spanning have been demonstrated at Mandalong and Awaba.

In this case the interest is on a thick jointed beam so classic elastic beam analyses are not appropriate. Voussoir beams are discussed in the rock mechanics literature and several analytical methods are available[9]. It is noted that voussoir beams fail by shear along joints, compression, or in a snap-through mechanism.

Based on our interpretation of the core logs – specifically the absence of non conglomerate/coarse sandstone layers - conglomerate layers of between 10 m and 40 m thick are present at Chain Valley and these can span large openings with relatively low deflection – for example a 97 m span of a 30 m thick conglomerate would deflect just over 100 mm and have a stability factor in excess of 2.0 (Figure 20): the figure also provides analyses for 20-40 m thickness to allow an appreciation of sensitivities. Note that the abscissa in this plot is the span of the conglomerate and this decreases if the spanning unit being considered is located significantly above the extraction panel.

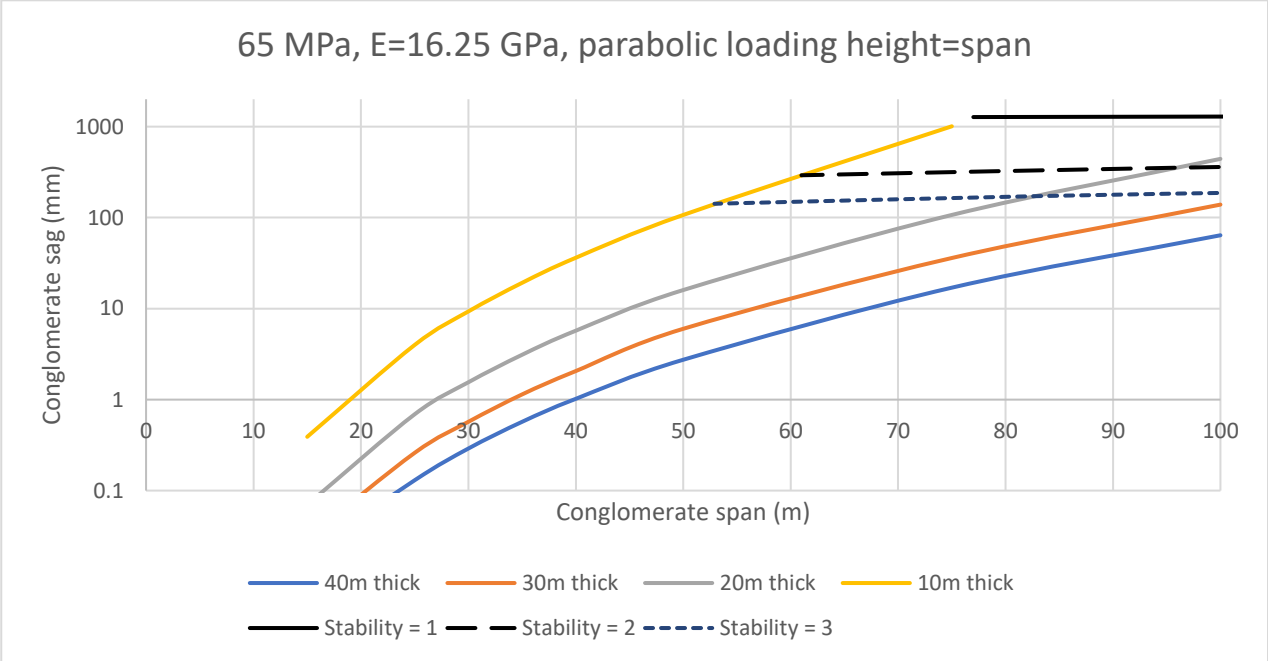


Figure 20 Sensitivity study of the deflection and stability of conglomerates relative to span and conglomerate thickness – 16.5m spans

A corollary of a model of a spanning conglomerate is that the vertical stresses underneath will decrease once the deflection develops. This means that the loads on any pillars below the spanning conglomerate will be low and related to the thickness of the interburden between the conglomerate and the Fassifern Seam. Furthermore, the design of intra-panel pillars can be conducted independent of subsidence considerations.

A similar analysis can be conducted for the Awaba Tuff, in this case to identify how thick layers need to be to span across roadways (Figure 21).

[9] Brady and Brown, Sofianos and Kapensis, CPillar.

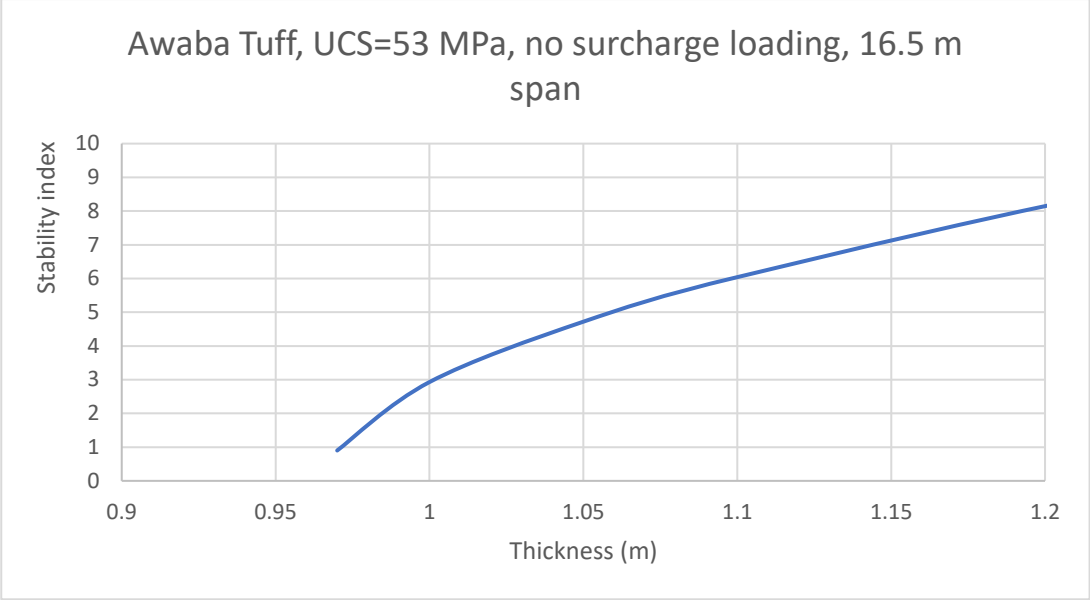


Figure 21 Spanning capability of the Awaba Tuff

Deformation of a pillar/roof/floor system

Assuming the coal component of a pillar does not fail, the surface subsidence would be the result of compression of the coal itself, and the roof and floor materials. It is not possible to identify and calculate the individual components, but the overall pillar system can be ascribed an empirical subsidence compression factor in the form of subsidence /stress change. This factor can be used for similar mining in the same seam at similar mining depths - it is not directly transferable to other seams.

The stress change is calculated from the same tributary area analysis used for the pillar stability. Note that the use of this index assumes that the floor does not fail, hence the prediction is only valid if the floor stability index is greater than 1.0. It is not possible to quantify the resulting subsidence if the floor does fail.

It is noted that no attempt has been made to determine a subsidence compression factor using numerical stress methods. This is primarily because of the high level of uncertainty regarding how to model possible stress-arching of conglomerates in the overburden and the interaction between pillars. These 2 factors are implicitly included in the empirically derived subsidence compression factor.

Appendix 15.3 HBE1 Subsidence Prediction Report (Amendment 2)

BYRNES GEOTECHNICAL

ACN 633 507 623

Chain Valley Colliery

Subsidence prediction – Northern Mining Area
Double sided lifting

REPORT: DCV-27

Date: March 2025

Report to: Nigel Birt

Report prepared by:

Ross Seedsman

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Executive Summary

After initial experiences with single-sided lifting, Delta is now considering the option of double-sided lifting in the E1 and HB-Mains/ N-Hdg portion of the Northern Mining Area. These panels are on the lake side of the High Water Mark Subsidence Barrier. The double-sided lifting will result in excavations that are 26 m wide separated by narrow pillars (fenders) that have an average width of 4.0 m. The fenders are unlikely to have a role in modifying subsidence so the effective mining voids are considered to be 92 m wide.

The narrow pillars should prevent wind blasts.

The predicted maximum subsidence at the floor of Lake Macquarie ranges between 18 mm to 236 mm, with a recommendation to use 140 mm in hazard assessments.

No mining induced impacts are predicted within or on the land side of the High Water Subsidence Barrier.

There is no risk of connected cracking extending from the Fassifern Seam up to the floor of Lake Macquarie. There are no workings in the Great Northern or Wallarah Seams.

The roof stability of these voids should be readily manageable with mobile roof supports, as the height of collapse is likely to be no more than about 2 m. Major wind blasts are not anticipated.

The background to some of the geotechnical concepts applied to this assessment is included as an appendix.

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1 Introduction

Delta Coal is updating the current Miniwall S5 and Northern Pillar Area Extraction Plan to amend proposed secondary extraction method. Figure 1 shows the location of the proposed double sided lifting panels relative to the previous miniwalls and the recent herringbones and single-sided lifting panels.

This report addresses the geotechnical safety of the proposed extraction, the extent of connective cracking above the extraction, and the likely subsidence of the lake bottom.

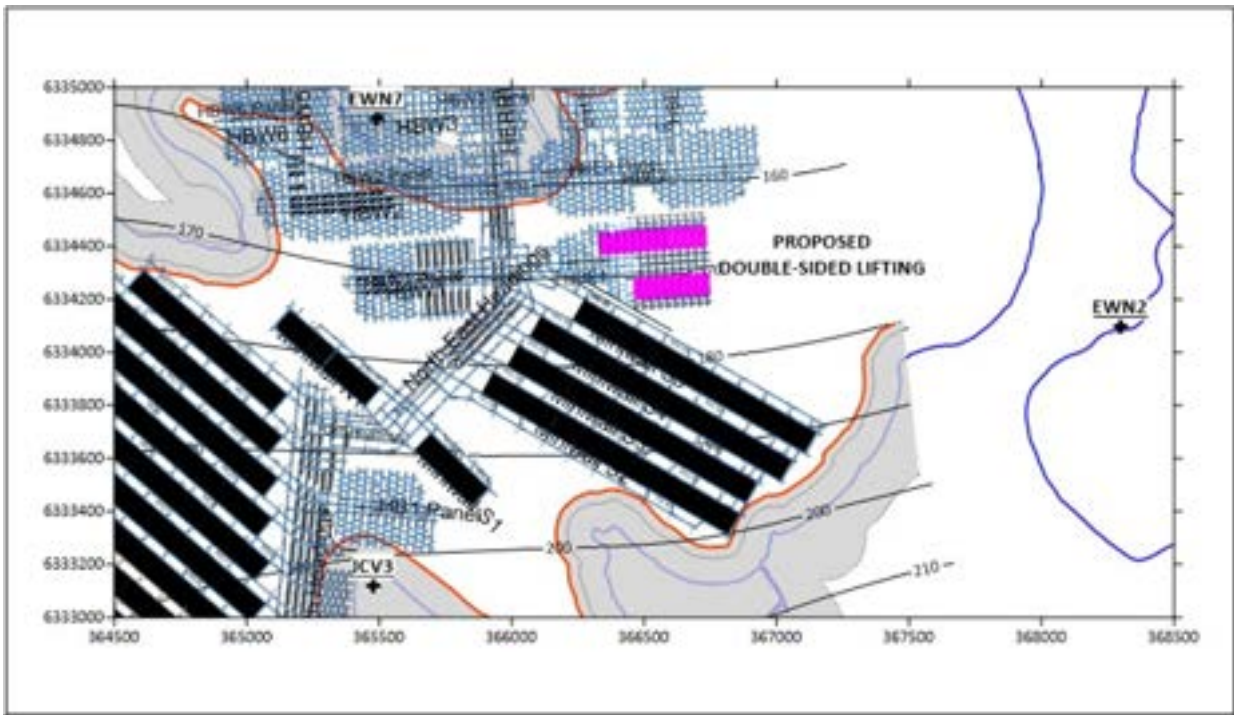
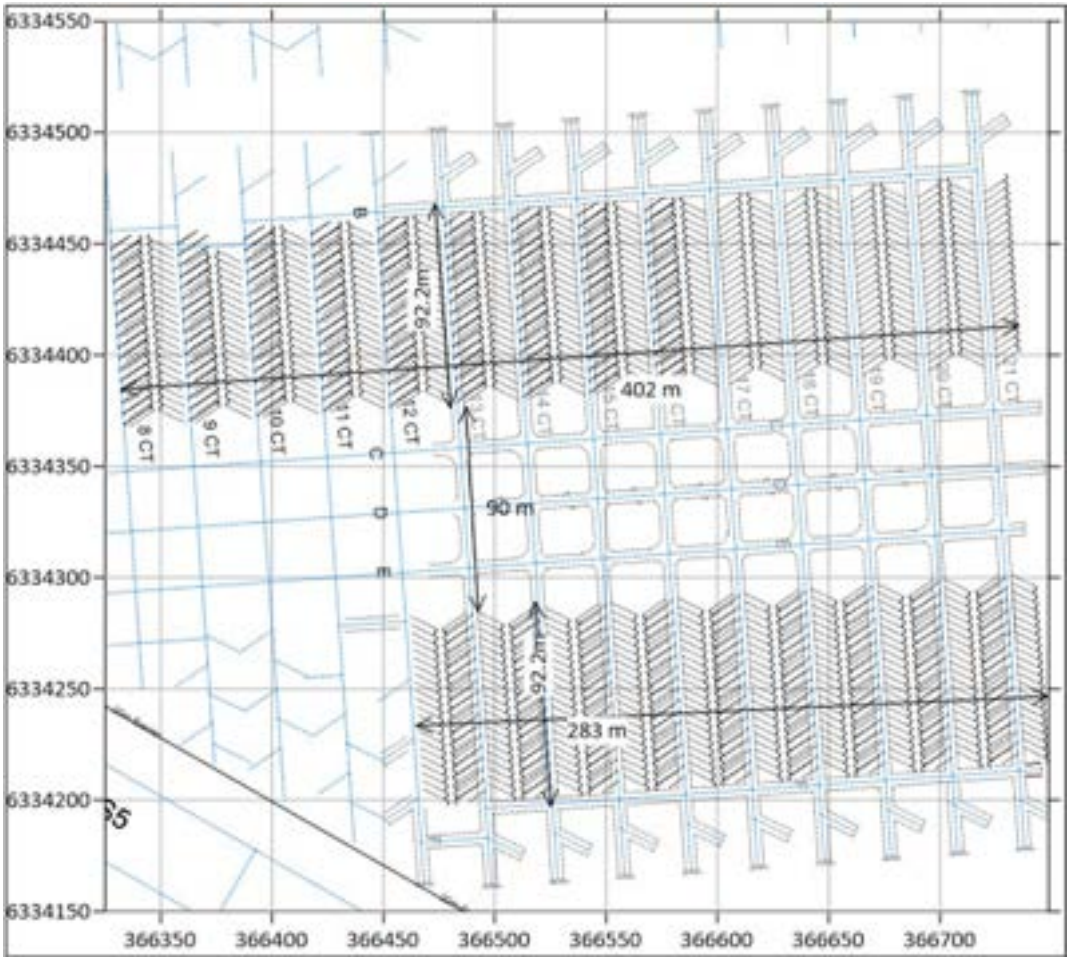


Figure 1 Mine plan showing the location of proposed double sided lifting panels (pink area), previous wide extraction panels (solid black rectangles), approved single sided lifting (grey), depth of mining, lake edge (blue), seagrass protection barrier (red) and the location of three boreholes reference in this report.

A herringbone layout is currently used with 3.2 m high development in the spine pillars and chevrons (Figure 2). The proposed mining is to conduct double-sided lifting method in some of the herringbone panels. Each lifting sequence results in a extraction void of 85.4m length and an average width of 26 m. There is a narrow fender of coal left between each sequence that has a minimum width of 2.6m and an average width of 4.0m.

As will be discussed below, these fenders will not provide restraint to overburden loading so the effective width of the extraction will be 92.2 m and the length will range between 283 m to 402 m. The 2 panels will be separated by 4 pillars with a combined width of 90 m.



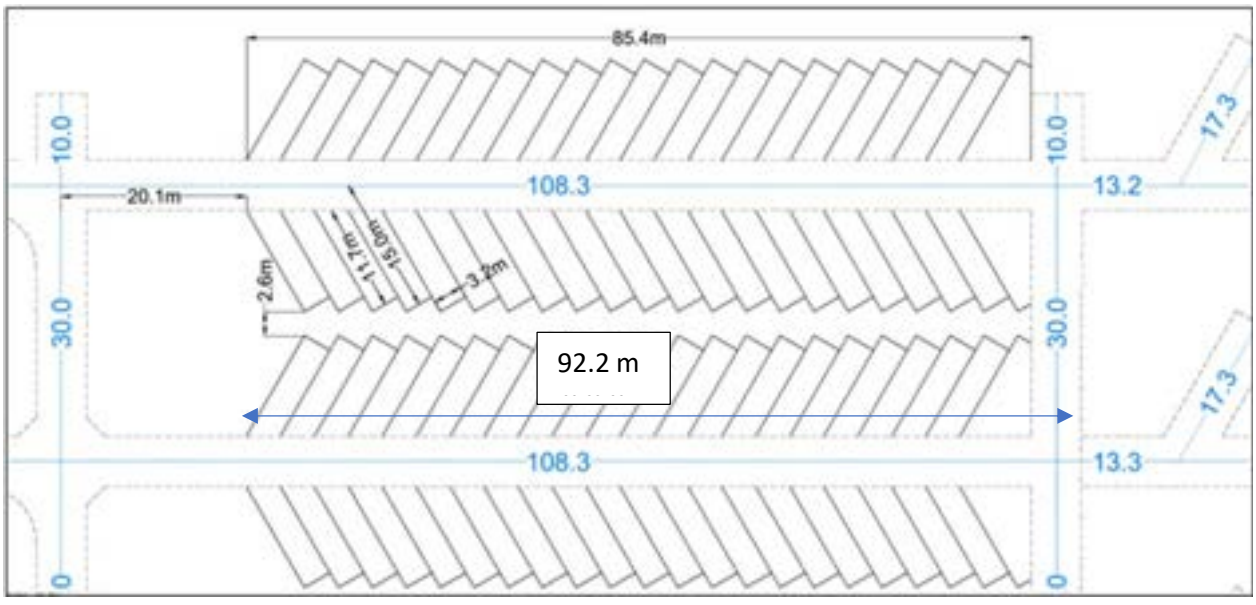


Figure 2 Double sided lifting dimensions

2 Geological/Geotechnical environment

The Fassifern Seam is to be mined and in the area of interest is similar to that currently being mined at Chain Valley Colliery (Figure 3). The Fassifern Seam and the overlying stratigraphic units are similar to those previously extracted at Mannering and Wyee Collieries.

2.1 Drillholes

The available drill logs for the area are based on holes drilled by the Joint Coal Board from 1956 onwards. These are good quality geological logs but do not provide geotechnical data except for some general comments regarding strength. The location of the 3 boreholes referenced in this report are shown in Figure 1.

2.2 Overburden

The overburden of the Fassifern Seam comprises the Awaba Tuff, the Warnervale Conglomerate, thin Wallarah and Great Northern Seams which have not been mined, and several massive conglomerate units (Figure 4).

The Fassifern - Great Northern Seam interburden typically consists of claystone (Awaba Tuff) and conglomerate. This interburden is typically around 30 m to 60 m thick. The Awaba Tuff sits within this interval (typically immediately above the Fassifern Seam) and in EWN7 is about 10 m thick. There are 1 or 2 conglomerate layers between the Fassifern Seam and the Great Northern Seam – the Warnervale Conglomerate – with maximum layer thickness of about 20 m, and about 25 m if coarse sandstones are included in the definition of this unit.

There has been no laboratory testing of the overburden sequence at Chain Valley Colliery, so inferences need to be drawn from testing of the same and similar stratigraphic units at other mine sites. Table 1 summarises the rock strength testing conducted for Myuna. As a group, conglomerates have lower strength but some of this may be related to the fact that most of the conglomerate samples were taken from shallow depths where there may have been some alteration/weathering. Previous analyses of the conglomerates in the Newcastle coalfield have used 65 MPa (modulus = 18) and these values will be adopted in this report. Claystones/tuffs have a wide range of strengths with an average strength of 53 MPa.

Table 1 Summary of uniaxial compressive strength testing by lithology – Myuna data

	Tuff/ claystone	Conglomerate	Siltstone	Sandstone Fine - medium	Sandstone Medium - coarse	Laminite
Average (MPa)	53	35	54	61	61	75
Std Dev (MPa)	52	18	30	31	10	25
Minimum (MPa)	6	12 (possibly weathered)	5	3	43	37
Maximum (MPa)	211	108	110	106	73	125

2.3 Fassifern Seam

Within the limitations of the qualitative logging conducted at the time, the logs reveal a consistent ply structure in the coal seam with some variation in the non-coal lithologies in the floor of the seam (Figure 4). The depth to the top of the Fassifern Seam is about 170 m (Figure 1). As currently proposed, the working section will be 3.2 m high and runs from either the FCR or FBR ply down to about the base of the FAS T plies (Figure 4) and occasionally into the FAS U ply, depending on local coal thickness.

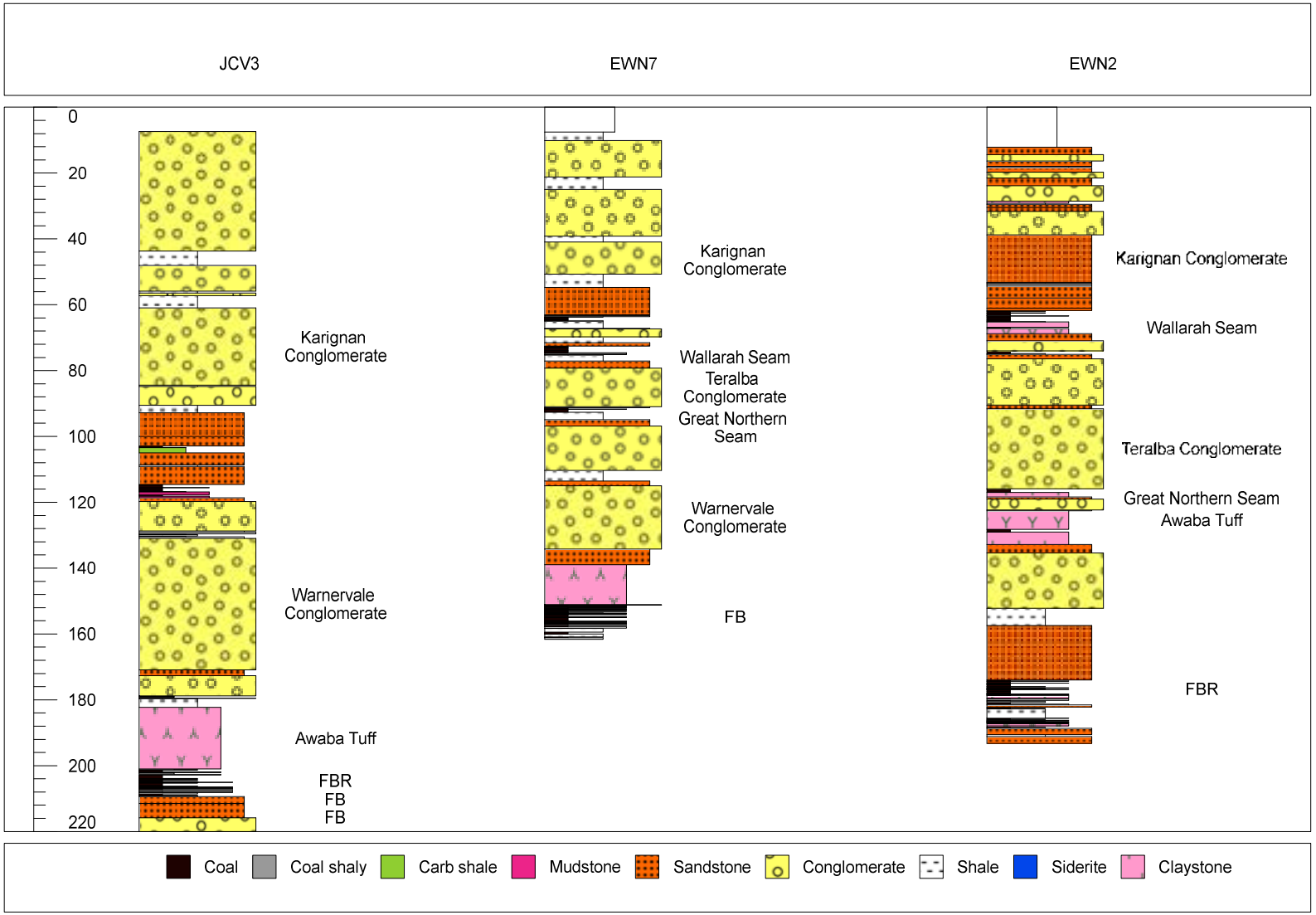


Figure 3 Geological logs of the 3 boreholes

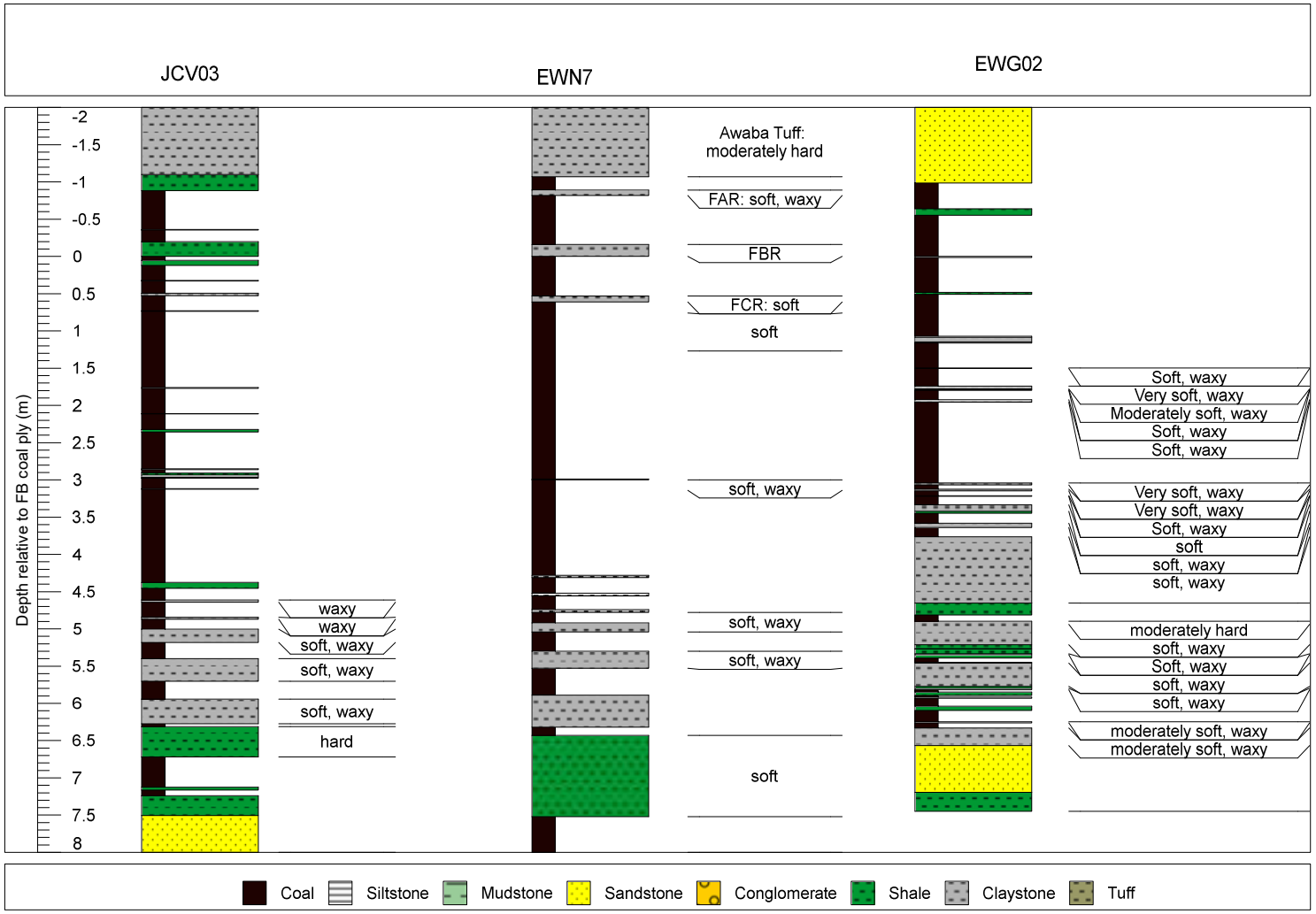


Figure 4 Overburden and floor logs - EWN7

2.3.1 Immediate roof

Above the 1.0 m of coal tops there is a 12 m thick sequence of claystone roof (= Awaba Tuff). The core logs make no reference to bedding structures in the Awaba Tuff. At Mannering the basal 1 m of the Awaba Tuff was often found to be thinly bedded and the rest of it was very thickly bedded. The Awaba Tuff is typically of high strength – say 40-80 MPa, averaging 53 MPa.

2.3.2 Immediate working floor

In this report we have adopted the term claystone instead of tuff, so the reported "Claystone" includes both claystones and tuffs. Of particular importance are the relatively thick claystone units towards the base of the seam which have been logged as "soft" and/or "waxy". Such units are present in all of the holes examined at Chain Valley, although the logging of their strengths is not consistent. The terminology used at the time is not defined. It is assessed that these descriptions may indicate strengths of less than 2.5 MPa. The CoalLog dictionary, developed some 50 years later, defines "soft" as having an S_u (undrained shear strength) of 25 kPa which can be taken as equivalent to a UCS (Uniaxial Compressive Strength) of 50 kPa, and "hard" as an S_u of 200 kPa (UCS=500 kPa). We assess that "waxy" may correspond to either C6 or R1 in the CoalLog schema.

The Strata2 report (CHV-016) states that the claystone strengths range between 0.7 MPa to 5.7 MPa, averaging between 2.2 MPa to 2.4 MPa. These values were obtained from Point Load Strength Index (PLSI) testing. PLSI testing requires brittle failure, and it is unlikely that this was achieved for such low strength claystones where plastic deformation would dominate[1]. The Strata2 report includes laboratory testing of mudstone/siltstones at about 70 MPa but not of any claystones.

A DgS report (CHV-002/10b) presents a summary of testing (Figure 5) which suggests values as low as 1 MPa are possible although it is understood that this does not include testing from the specific area of interest.

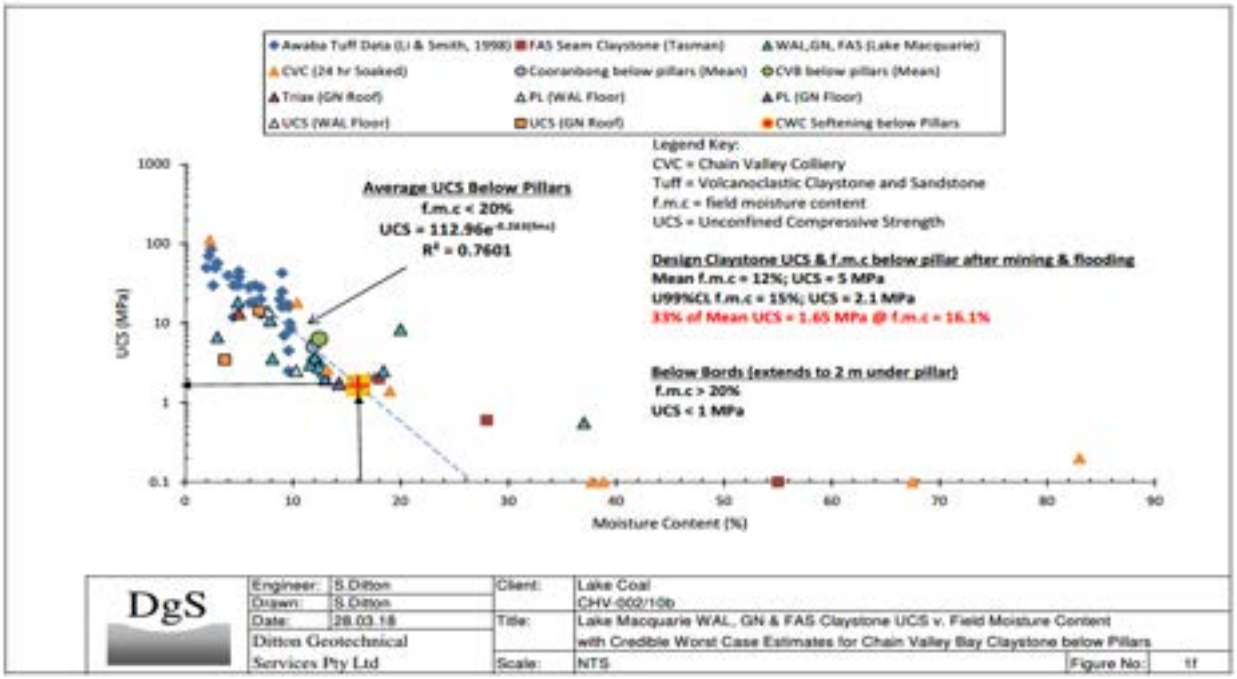


Figure 5 Summary of testing of claystones

[1] - it has been reported in the engineering literature that UCS values derived from PLSI strength values are highly ambiguous if results are less than 25 MPa. Hoek, Kaiser Bawden 1998

We are aware of recent logging of claystones in the Fassifern Seam at an adjacent colliery. The samples were not suitable for laboratory testing, but the field logging indicates R1 strength (CoalLog – UCS < 1 MPa) for some of the layers.

In previous analysis at Chain Valley we have found that a valid simplification is that the floor of the Fassifern Seam contains a 1m thick layer with a UCS of 1 MPa.

Some of the lower strength claystones have been reported to slake and disperse in water. This observation, together with the reported low UCS values, suggests that they may behave somewhat similarly to heavily overconsolidated clays. Data on the coefficient of consolidation (Cv) is available from the Awaba Tuff at Mandalong and this suggests an average value of 0.006 m^2/day (Figure 6).

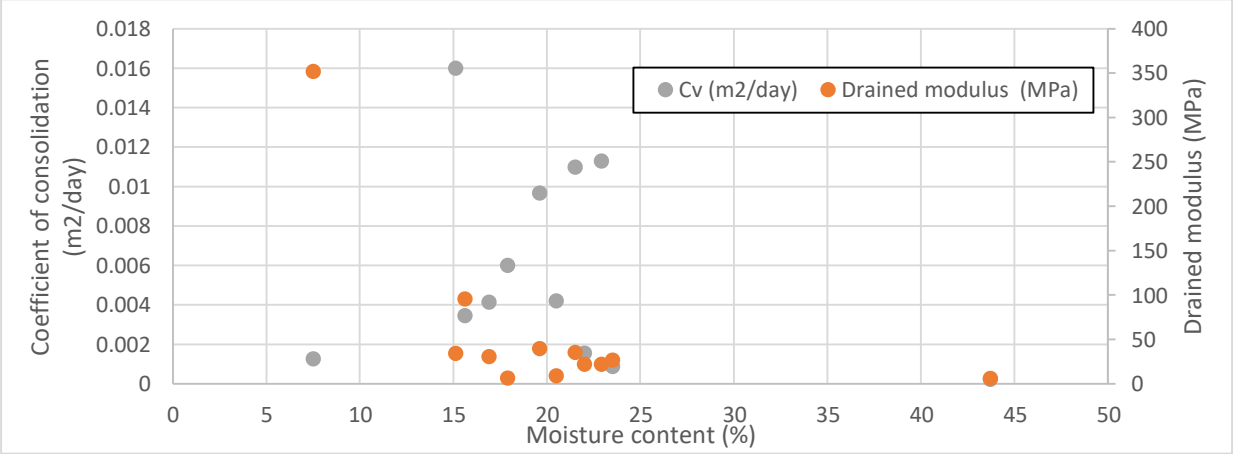


Figure 6 Coefficient of Consolidation and drained modulus testing of the Awaba Tuff at Mandalong.

2.3.3 Sequence below the Fassifern Seam

Historic practice in coal exploration in the area has been that few of the boreholes extended more than 2 m below the base of the Fassifern Seam. The highly banded and non-economic Pilot Seams lie within 10 m of the base of the Fassifern Seam.

2.4 Geological structures

There are no mine workings in the overlying Wallarah or Great Northern Seams which previously at Chain Valley have been used to extrapolate fault structures to the Fassifern Seam. The dominant structural grain of the coalfield involves north-west trending structures, so based on the conditions encountered in the Wyee longwalls and the miniwalls MW1-MW12 there is confidence that the conditions in the Northern area will be similar. Ongoing mapping in the current workings continue to confirm this is the case.

3 Previous mining

3.1 Single sided lifting – Chain Valley

Single-sided lifting began in November 2024. In single-sided lifting an extraction void of 16 m is created and the observations to date are that in most cases there is no collapse. There have been some collapses into the Awaba Tuff in areas of localised jointing or corrosion of support. These falls are choked-off so it has been difficult to observe their height – it has been reported that the collapse heights are possibly in the range of 2 m – 3 m which is similar to that predicted.

3.2 Pillar extraction – Tasman

Pillar extraction in the Fassifern Seam was conducted at Tasman Mine at depths less than 200 m: the working section at Tasman was thinner than that proposed for Chain Valley but the immediate floor was very similar. Initially a Wongawilli system was adopted but it was found that the Awaba Tuff did not collapse even when the extracted spans were 106 m, and this led to a concern about delayed caving leading to wind rushes. The Duncan system was adopted utilising pillars on 45 m centres with double-sided lifting on all sides resulting in extraction voids of 24.5 m to 22.5 m for depths of 120 m and 160 m respectively. These extraction widths were used to ensure that the factor of safety of the pillars was in excess of 1.6 using the UniNSW pillar design procedure. Tyler and Sutherland (2011)[2] report that the mining conditions were good with no serious safety incidents. Some floor heave of up to 300-500 mm was observed in deeper areas[3].

3.3 Subsidence

3.3.1 Tasman

In 2011, the maximum subsidence associated with the Duncan Method at Tasman Mine was 101 mm above a 250 m panel at about 150 m depth, but by 2013 the maximum subsidence in the same location was 521 mm. This was attributed to the softening of claystone units in the floor and large panel widths. The subsidence above an adjacent 203 m wide panel was only 100 mm.

Our interpretation is that the subsidence event can be explained by the greater panel widths allowing greater deflection of the overburden. The claystones did not soften due to water ingress – they were always soft and it was their strength that predetermined the low strength of the pillar/floor system. The UniNSW procedure does not consider this factor.

3.3.2 Wyee longwalls

Li et al[4] report subsidence results (bathymetry) above some of the longwalls at the then Wyee Colliery. The cover depths were of the order of 160 m and the face widths were 130 m -140 m with 45 m chain pillars. A maximum subsidence of 650 mm was measured from the bathymetry (Figure 7, Table 2). An inspection of the bathymetry reveals that the subsidence above the chain pillars for LW17-19 was about 350 mm, suggesting that the sag between the pillars was in the order of 300 mm.

Table 2 Summary of Wyee longwalls in Fassifern Seam

	LW17-18	LW19	LW20	LW21	LW22-23
Cover depth (m)	162-174	162-174	175-181	161-185	180-195
Rock head (m)	151-159	151-159	158-162	156-172	162-178
Face width (m)	130	130	140	140	150
Extraction (m)	3.2	3.2	3.2	3.2	3.2
Chain pillar width (m)	45	45			45
Observed max subsidence (m)	0.65	0.65	0.4	0.65	0.3

3.3.3 Chain Valley Miniwalls

Miniwalls MW1-MW12 were 97 m wide with 30 m – 33 m pillars at a nominal 200 m depth. Subsidence above the miniwalls of up to 1150 mm was in excess of the predictions (720 mm), and the Approval limit

[2] Tyler, K and Sutherland A. The Duncan Method of Pillar Extraction at Tasman Mine. 2001 Coal Operators Conference

[3] Ditton S and Sutherland A. 2013. Management of subsidence at the Tasman and Abel Mines – issues and outcomes. 2013 Coal Operators Conference.

[4] Li G, Forster I, Fellowes M, Myors A. A case study on longwall mining under the tidal waters of Lake Macquarie. 2006 Coal Operators' Conference. AusIMM Illawarra Branch.

(780 mm). It is not possible to discern the sag subsidence above individual miniwalls and the subsidence above the chain pillars ranges from 0.25 m to 1.0 m (Figure 8).

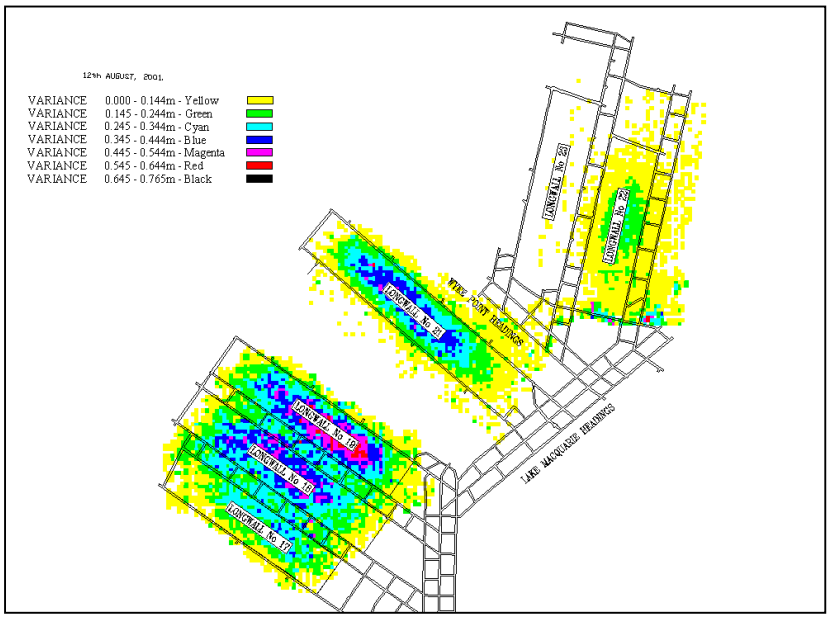


Figure 7 Bathymetry above Wyee longwalls

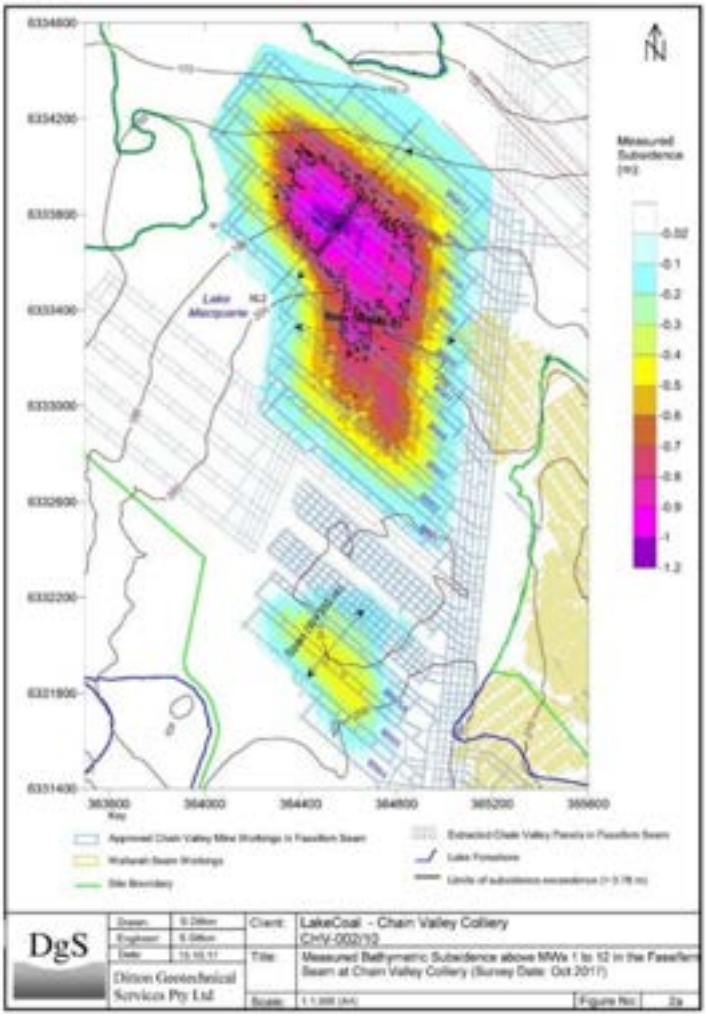


Figure 8 MW1-12 bathymetry showing up to 1.2 m of subsidence but sag above each miniwalls panel cannot be resolved.

Miniwalls S2 – S5 were of the same width (97 m) but with chain wider pillars (40 m) and at a shallower depth (140-170 m). The bathymetry shows up to 450 mm above the pillars and 550-600 mm above the centre of the miniwalls (Figure 9).

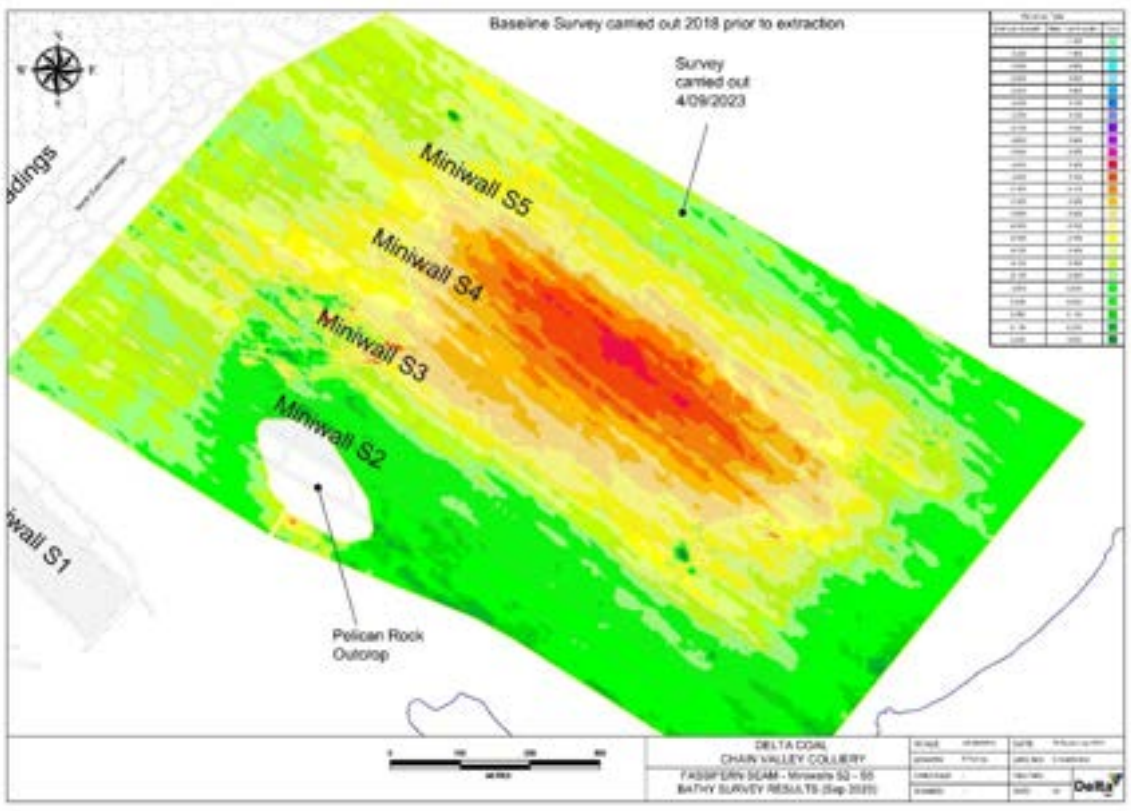


Figure 9: Bathymetry above the S2-S5 miniwalls: sg above individual panels cannot be resolved.

4 Analysis

4.1 Top coal

Using presumed values for the strength and modulus of the top coal (30 MPa, 5.1 GPa), Figure 10 indicates that for a ply thickness of 0.8 m (either FA or FB) and a span of 16.5 m span, collapse of the coal tops would occur. For a 0.5 m thick ply, collapse of a 16.5 m span could occur if there was about 1 m of surcharge from the thinly bedded Awaba Tuff. This is consistent with the reported conditions in single-sided lifting.

Extending this analysis to the proposed 26 m spans it is likely that routine collapse of the coal tops will develop during double-sided lifting.

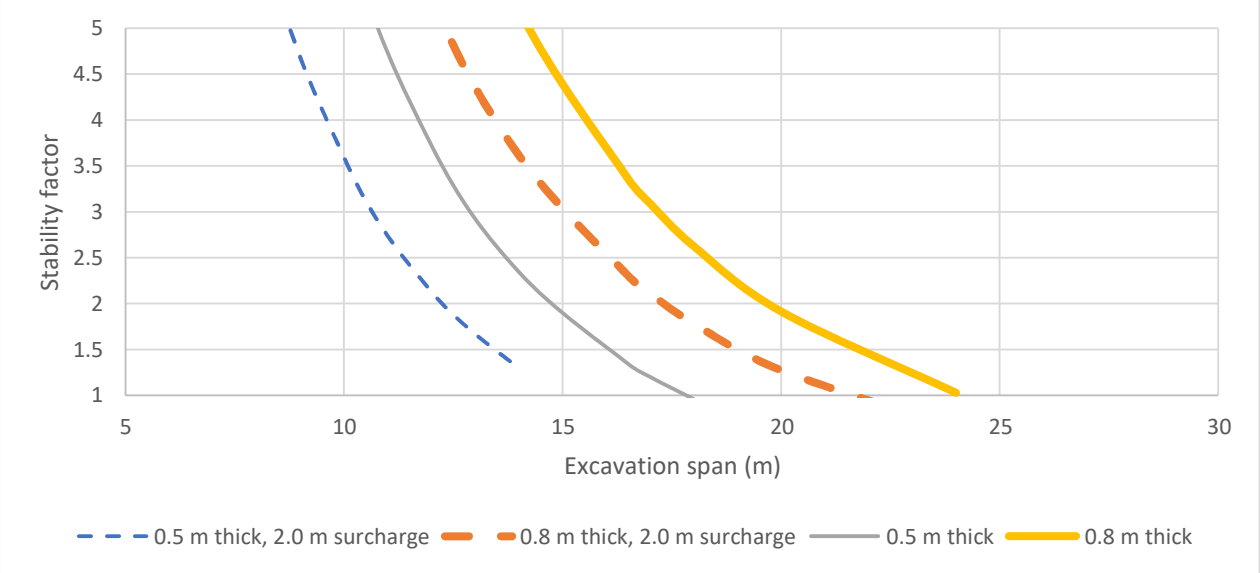


Figure 10 Stability of the top coal decreases with increasing span and is lower if there is surcharge loading from the base of the tuff.

4.2 Awaba Tuff

Observations to date with the single sided lifting are that failure of the immediate roof does not extend very far, if at all, into the Awaba Tuff. At Tasman, the Awaba Tuff did not collapse with 106 m spans. This is consistent with a beam analysis assuming that panel widths do not result in collapse of upper conglomerates. Figure 11 shows that a massive 10 m thick unit can span in excess of 100 m.

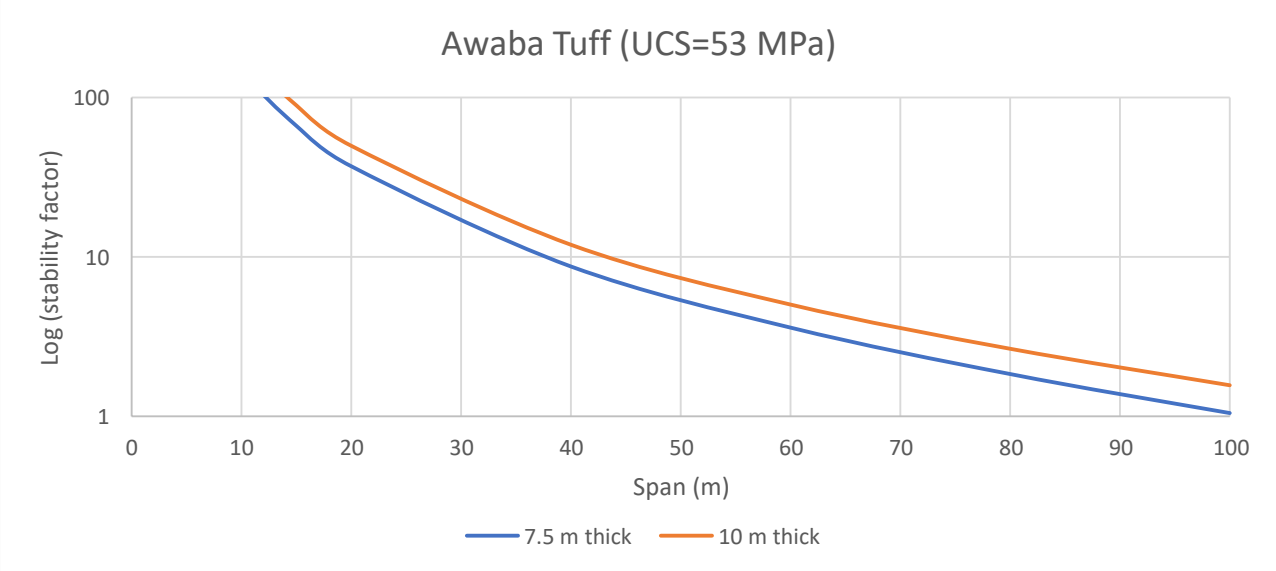


Figure 11 Spanning capacity of the Awaba Tuff

It is assessed that from Figure 11 that, while collapse of the coal tops is likely for 26 m spans, there will not be large collapses of the Awaba Tuff – the maximum height of failure is likely to be restricted to any thinly bedded units at its base.

4.3 Warnervale Conglomerate

Figure 12 extends the earlier analysis to examine the proposed extraction width of 92 m including the location of a conglomerate to be 20 m above the Fassifern Seam and the rock mass above conglomerate layer arching over at 10°. This analysis assumes that there are no spanning units above the modelled

layer. A 20 m thick conglomerate layer is indicated to be thick enough to span (stability factor>2.0) with 218 mm of deflection.

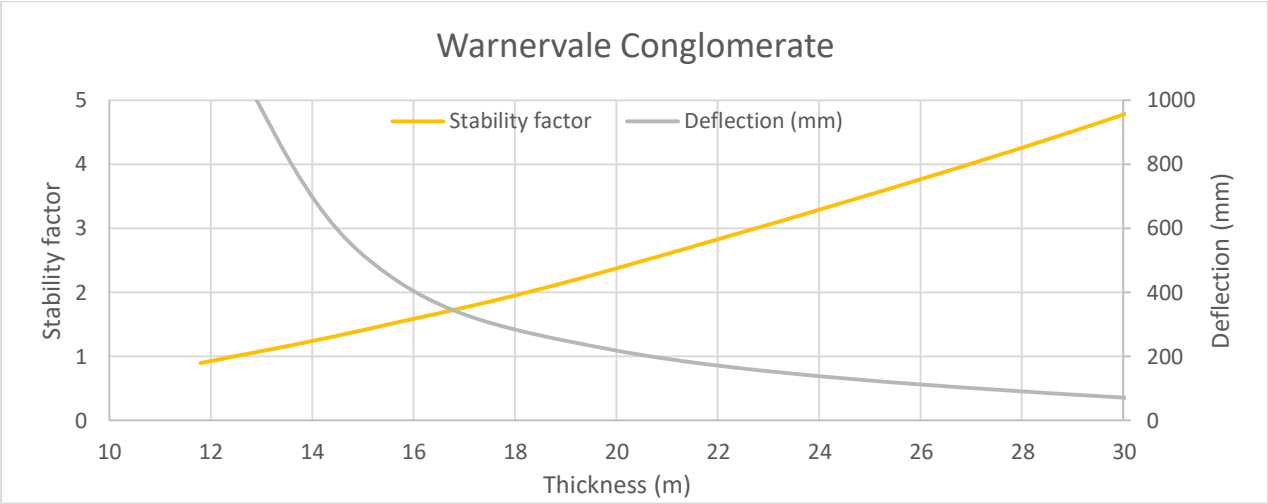


Figure 12 Analysis of the thickness of the Warnervale Conglomerate thickness required to span 92 m.

The thickness of the lower unit of the Warnervale Conglomerate is in the order of 20 m so no collapse of the full overburden sequence is anticipated for the proposed pillar extraction spans. The predicted deflection of a 20 m unit is about 218 mm.

4.4 Karigan Conglomerate

Surface subsidence may be determined by conglomerate layers high in the geological sequence. Figure 13 suggests that a 10 m thick layer in the Karignan Conglomerate, which lies 110 m above the Fassifern Seam, would have high levels of stability and deflect 122 mm.

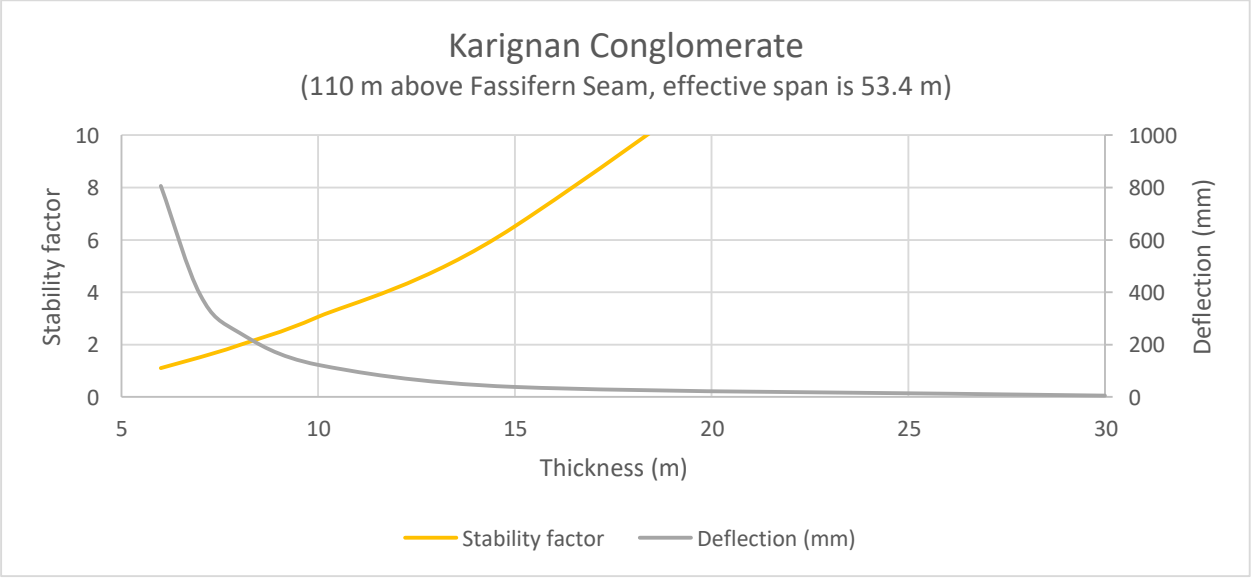


Figure 13 Analysis of thickness of Karignan Conglomerate to span 92m wide panel in the Fassifern Seam

4.5 Pillars

Inspection of Figure 2 reveals that the proposed areas of double-sided lifting are separated by 4 rows of pillars in the spine headings with a total width of 90 m; this width is much greater than the width of the chain pillars used in the miniwalls. The areas of herringbone pillars and spine pillars have high levels of

stability and the likely deformations will not be significantly greater than those already predicted after the double-sided lifting is conducted (18 mm).

4.5.1 Fenders

The bearing capacity of the floor under the fenders can be estimated using the Mandel and Salencon method approach. For a 1m/1 MPa floor claystone model, the bearing capacity of a 4m wide fender is 4.07 MPa, which is less than the strength of the coal component using the UniNSW pillar strength approach.

If and when the fenders are loaded they will punch into the floor given the presence of the low strength claystones. They will provide no restraint to any overburden deflections - this has been assumed in the determination of the sag of the Warnervale Conglomerate (see Section 4.3). They will continue to provide a "intact barrier" between each lifting sequence and hence serve to mitigate the wind rush hazard by localising any collapse of the Awaba Tuff to within the earlier lifting sequences and forcing a circuitous blast flow path via the spine headings.

5 Connective fracturing

The analyses outlined above indicate that there is unlikely to be failure of the Awaba Tuff or the Warnervale Conglomerate. This means that there is no hazard of connected fracturing to the lake bottom.

6 Subsidence

To estimate subsidence, it is assumed that the fenders provide no vertical restraint to the overburden and hence the double-sided lifting panels are equivalent to extracted voids of 92m.

Note that before stripping, the subsidence above the spine pillars is estimated to be 18 mm based on a compression index of 10 mm/MPa.

For a 92 m wide void Figure 12 indicates that a 20 m thickness of Warnervale Conglomerate would deflect 218 mm. Other conglomerates higher in the sequence could also deflect less – for example if a 10 m thick spanning unit is present in the Karignan Conglomerate the deflection would be 122 mm.

It should be apparent that the predictions are based on a number of inferred properties and assumptions. In terms of likelihood our predictions can be characterised as:

- Likely – 18 mm
- Possible – 140 mm (18 + 122)
- Very unlikely – 236 mm (18+ 218)

We recommend that hazard assessment be based on the possible level – 140 mm.

An alternative empirical prediction based on the Holla curve for Newcastle would be a width/height ratio of 92/170 = 0.53, a Smax/T = 0.05 and a maximum subsidence of 160 mm.

7 Impacts

The predicted possible maximum subsidence is 140 mm. There is little information on angle of draw for the Newcastle area and especially for narrow panels relative to the depth of mining: a value of 15.7° has

been adopted[5]. From this value it is calculated that subsidence deformation greater than 20 mm will extend 48 m from the edge of the secondary extraction panels.

7.1 The Lake Bed

The lake bed contours, derived from bathometric surveys from 2012 onwards, are shown in Figure 14. Given the gently sloping lake bed topography and the expected maximum subsidence of 140 mm, it is considered unlikely that there would be an adverse impact on the lake bed.

7.2 Sea Grass Beds

Sea grass beds exist along the foreshore, below the Low-Water Mark. The Sea Grass Protection Barrier (SGPB) is defined by a 26.5° angle of draw from the mapped beds and is contained within the HWMSB shown in Figure 14. The predicted mining induced subsidence in excess of 20 mm does not impinge on the predicted HWMSB. It is therefore assessed that there would be no adverse impact on the sea grass beds as a result of the proposed extraction.

7.3 The Lake Foreshore

The High-Water Mark Protection Barrier (HWMPB) as shown in Figure 14 is defined by 35° angles of draw each side of the High-Water Mark. The proposed secondary extraction locations are located outside of the HWMPB and any subsidence of the foreshore is predicted to be less than 20 mm and hence have no adverse impact.

7.4 Minor Cliffs

Along the southern edge of the Morisset Peninsula is an approximately 200m length of minor (i.e., ~8m high) cliffs formed in the Munmorah Conglomerate, with an overlying steep (typically 20-25°) slope (Figure 15). These cliffs are within the HWMPB and hence no subsidence in excess of 20 mm is predicted. No mining induced impacts or cliff instability is predicted.

7.5 Built Features

Built features relevant to the area of interest are shown in Figure 16. There are two low water buoys (063 and 064) in the Morisset Peninsula area. There are some houses and jetties along the foreshore and these are within the HWMPB.

Given that <20mm of subsidence is predicted for HWMPB, no measurable impacts are expected on the foreshore features.

Given the limited overburden caving and predicted vertical subsidence of <0.14 m it is unlikely that measurable horizontal movements will be experienced beyond an angle of draw of 15.7° from the extraction limits.

[5] See Figure 9, Holla (1987) Mine subsidence in New South Wales 2. Surface subsidence prediction in the Newcastle Coalfield.

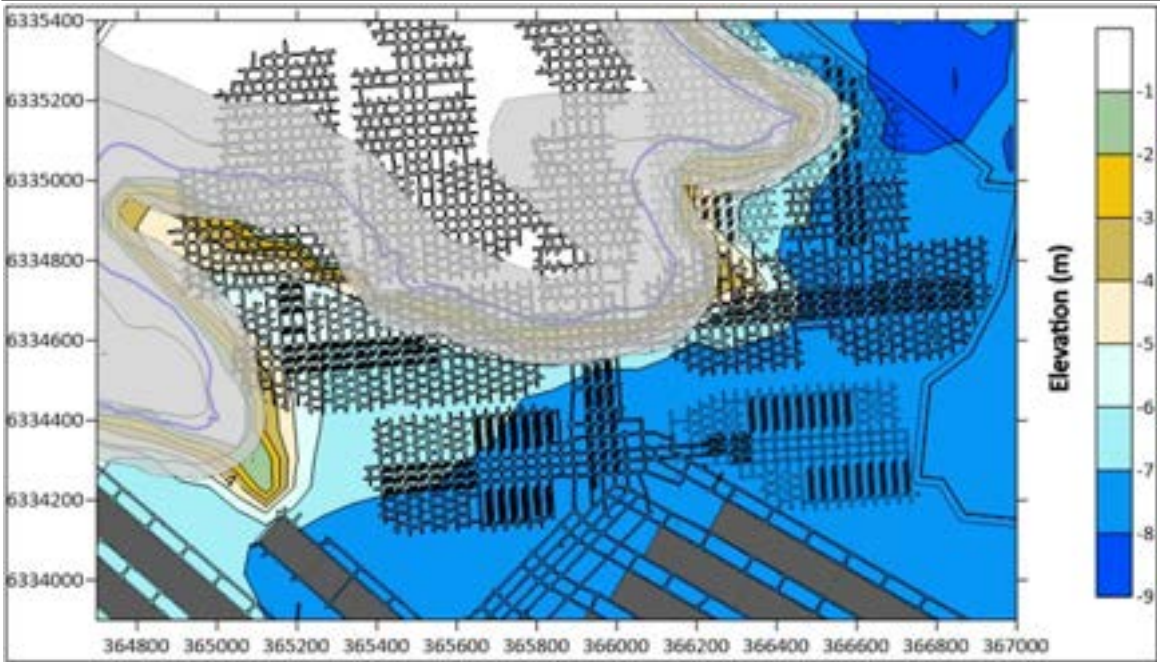


Figure 14 Proposed plan and lake bathymetry (HWMPB shown as grey overlay)



Figure 15 Typical minor cliff.



Figure 16 Surface features in Fishery Point area.

8 Monitoring

We are not aware of a monitoring technology that could be deployed to confirm the predictions. The prediction is less than the resolution of bathymetric methods which is understood to be 200 mm (the precision of each measurement is +/- 100 mm). Bathymetry will not provide confirmation of the prediction, but could provide an indication if there has been a major error in the prediction.

A useful geotechnical strategy would be to inspect/monitor the completed stripped/lifted area where safely accessible to assess if there is floor heave associated with pillar punching.

9 Extraction conditions

The proposed 26 m spans are in excess of what can be expected for the FA or FB plies to remain stable in all conditions. Based on the experiences at Tasman Mine and our analysis, it is likely that there will be a thick enough layer within the Awaba Tuff to span the 26 m voids. Mobile Roof Supports will be required to assist in the control of the coal tops (about 1.5 m) and possibly about 1 m of thinly bedded Awaba Tuff. It is assessed that major wind blasts are unlikely as the fenders limit the area of the void and hence the volume of air that can be displaced. The is a localised lesser wind blast hazard within each sequence as it is extracted but experiences at Tasman suggest that this may not be significant.

Some floor heave (say less than 300 mm) should be anticipated during lifting related to brittle failure and associated dilation in the floor coal and claystones.

10 Risks and Uncertainties

Partial pillar extraction was recently successfully conducted in the Fassifern Seam at Tasman Mine using excavations similar to those proposed if the fenders are included in the consideration. There is a high level of confidence that similar ground conditions will be encountered in the proposed mining at Chain Valley Colliery.

The subsidence predictions are based primarily on interpretations of subsidence outcomes from Wyee and the Chain valley miniwalls and relying on our assessment that the geology of the Fassifern Seam is very similar. The panel and pillar dimensions are somewhat similar so there is negligible geometric extrapolation.

The various predictions are based on an engineering geology model that has been developed over the recent years. They can be used in mine planning and operations on the understanding that the as

encountered geology is as expected. Any deviations, and especially in the context of fault disruptions, may make the predictions invalid and as such should be communicated to us immediately.

The key geotechnical uncertainty is the presumed strength and thickness of low strength claystone layers. It must be accepted that floor behaviour is poorly understood due in part to lack of geotechnical knowledge of the claystones/tuffs.

Appendix - Geotechnical considerations/behaviour models

So as not to distract from the mining engineering application and recommendations, some of the detailed geotechnical issues associated with mining in the Newcastle coal measures are addressed in this appendix.

Separate from the complexities of characterising the engineering geology of the site, there is a need to conduct engineering analyses. These can be in the form of "closed form solutions" or numerical models. Both are applications of elastic theory, and both are limited by the available engineering geology knowledge.

Failure/collapse of claystone

Possibility of the onset of undrained conditions in low strength claystones during retreat mining

In soil mechanics the concept of undrained loading is used when the rate of loading is very much greater than the rate at which the induced pore water pressure dissipates. This concept applies to most failures of clay-rich soils that occur during construction. It is readily implemented in design by adopting a friction angle value of zero and an undrained shear strength value of half the UCS.

The key engineering design question for Newcastle coal measures becomes whether the rate of increase in pillar loading is greater than the rate at which the pore pressures can dissipate from the claystones. Galvin (2016)[6] states that *"under normal circumstances it is difficult to conceive a friction angle of most coal mine strata, including claystone, being less than 10°. Pillar load builds up over a period of time as the mining face is advanced, thereby providing time for some of the excess pore pressure to be dissipated and for partial recovery in friction angle".*

What is meant by "normal circumstance"? Galvin identifies the possibility of delayed failure of massive strata could result in a step increase in pillar loading but at Chain Valley the conglomerates have not failed – the evidence is that they are spanning between the pillars.

For Chain Valley Mini Walls MW1-12, it is estimated that the extraction proceeded at about 7 m/day. The width of the vertical stress abutment ahead of the retreating miniwalls would have been in the order of 72 m (Peng and Chiang, 1984[7]). The increase in vertical stress in advance of the extraction can be estimated to be in the order of 5 MPa at the maingate corner and an additional 5 MPa at the tailgate corner. This gives a potential rise in pore pressure of 5 MPa over a period of 10.3 days.

The rate of dissipation of pore pressure is related to the coefficient of consolidation (Cv) and the drainage path length. Cv values are available for Awaba Tuff with an average of 0.006 m^2/day and these are similar to quoted values for heavily overconsolidated clays (Lee White Ingles, 1983[8]). Assuming that coal layers represent high conductivity layers connected to a free drainage face, the drainage path length is either half the thickness of the claystone layer if there is coal above and below, the full thickness if there are "normal" coal measure rocks at either the top or bottom of the clay layer, or the full pillar width if there are normal coal measures rocks enclosing the claystone.

[6] Galvin JM 2016 Ground Engineering – Principles and Practice for Underground Coal Mining. Springer.
[7] Peng SS and Chiang HS 1984 Longwall Mining. New York Wiley.
[8] Lee IK White W, Ingles OG 1983 Geotechnical Engineering Pitman.

According to Figure 17 while there would be effectively full dissipation over 10.3 days with a 0.25 m drainage path length, there would be only 55% dissipation for a 0.5 m path length and less than 30% if there was a 1.0 m drainage path length.

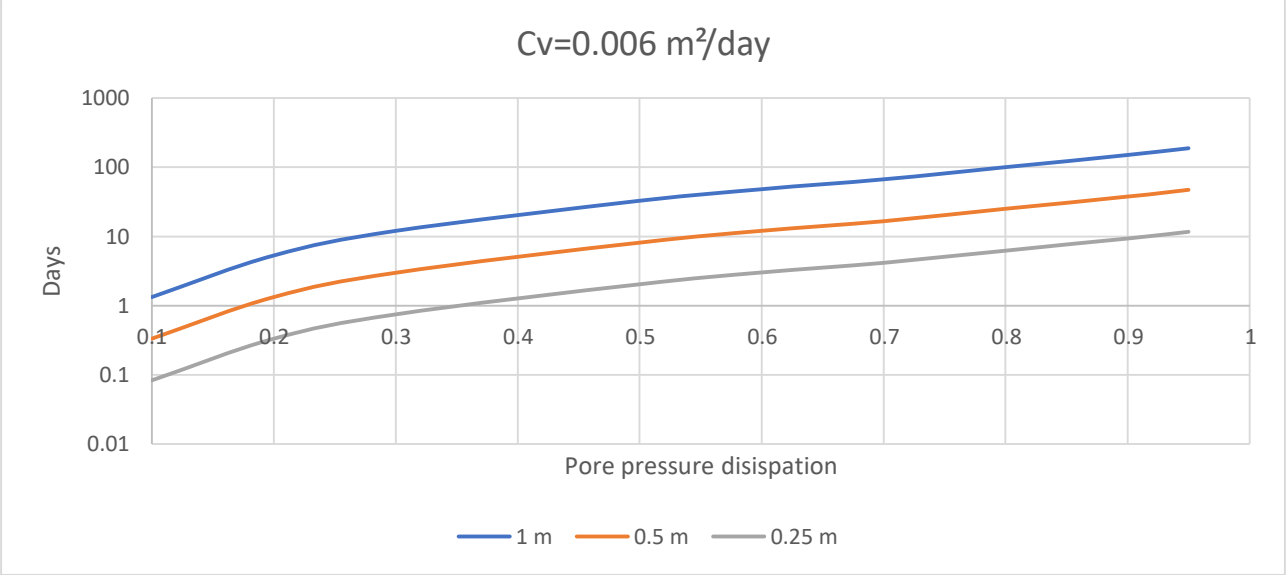


Figure 17 Rate of pore pressure dissipation

It is concluded that an undrained analysis is appropriate for regular caving, in addition to the delayed caving as recognised by Galvin (2016). It is noted that an undrained analysis results in the lowest bearing capacities and is therefore a worst-case scenario.

Use of Mandel and Salencon bearing factor

Foundation engineering approaches as used in civil engineering can be used. These approaches are based on elastic theory and are thus independent of dimensional and load scale.

The low strength of the claystones, and the fact that they rapidly slake and disperse in water, justifies the adoption of undrained strength. Adopting undrained conditions is also consistent with the subsidence events occurring very soon after mining (within 1- 2 years).

The Mandel and Salencon[9] approach has been used to assess floor stability/bearing capacity:

Bearing capacity = 0.5*UCS*(4.14+W/(2*t))

where W is pillar width and t is thickness of the claystone unit.

The Mandel and Salencon formula is used for 4 reasons:

1. it is the first method discussed in the standard geotechnical engineering text book[10] that we use.
2. It more closely represents the behaviour model we have adopted.
3. It is more conservative (lower bearing capacities) than the Brown and Meyerhoff alternative.
4. Its simplicity readily allows sensitivity studies.

[9] Mandel, J, and Salencon, J. 1969, Force portante d'un sol sur une assise rigide. Paper presented at the 7th international conference on soil mechanics and foundation engineering. Mexico, 157-164. Sociedad Mexicana de Mechanica.
[10] Lee IK, White W and Ingles OG. 1983. Geotechnical Engineering. Page 346.

The rapid increase in the bearing factor with reduced thickness using the Mandel and Salencon relationship is shown in Figure 18. This is the reason why we focused on layers more than about 0.3 m thick. We are fully aware of the limitations of the available bore hole data which is why we have used the empirically derived 1m/1MPa claystone index (which implicitly deals with "all" claystone layers).

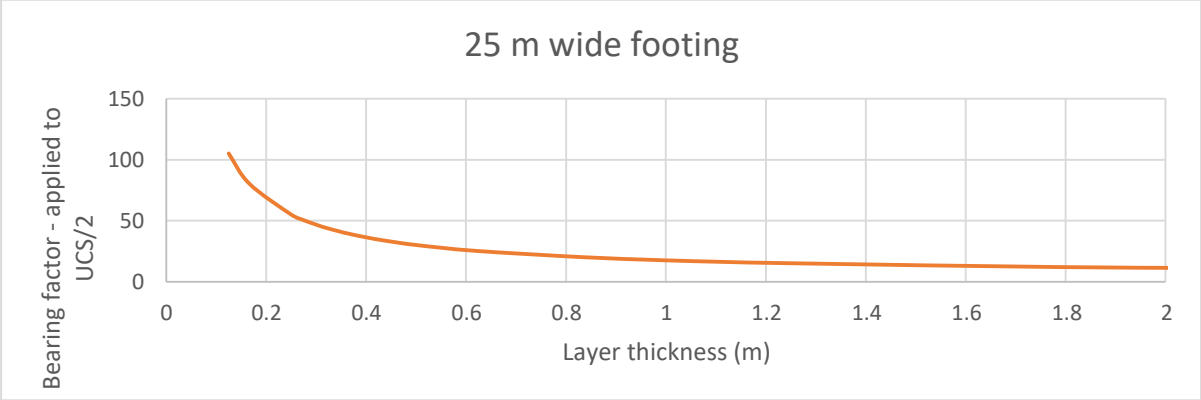


Figure 18 Increase in bearing capacity as the thickness of an undrained layer decreases

Regarding reliability, the method has been used successfully in coal mining operations in both NSW and Qld, specifically in the identification and avoidance of floor heave. We are aware of ad hoc criticisms about its use but no case study has been presented to support such. Accuracy implies knowledge of a true measurement – in engineering a true value is not and cannot be known at the time of the prediction and hence the term "accuracy" is not typically used.

Selection of the 1m/1MPa index

Floor failure will occur if the vertical loads exceed the bearing capacity. Estimating vertical loads is particularly complex in the presence of massive conglomerates such as are present at Chain Valley and Mannering. A valid estimate is only possible for wide extraction areas – multiple longwalls or miniwalls.

By back analysing the subsidence above MW S2-S5 (450 mm of subsidence, W=40 m, pillar stress = 12.6 MPa) and making an assumption that a bearing failure was only just avoided (factor of safety = 1.0) it was calculated that a 1 m thick claystone would have a strength of 1 MPa (0.8-1.0 MPa depending on depth). Alternatively, a 0.5 m thick layer of 0.45 - 0.57 MPa strength is equally valid. It is assessed that these values are consistent with our interpretation of the various logs and tests summarised above. It is noted the 1m/1MPa index would also infer factors of safety of less than 0.6 applied to MW1-12 – where the pillar system did fail. For the case of Tasman, both the Duncan pillars and the inter-panel pillars would have had factor of safety values less than 0.5 – these also failed.

Note that if bearing failure develops it is not possible to determine the resulting deformation.

The 1 m at 1 MPa strength assumption has been adopted. This data was derived from back analysis so can be used without an additional modifying factor – the minimum required floor stability index is 1.0. A key point to note is that bearing capacity is independent of pillar height. Pillar height is a factor in determining coal pillar strength and there is a relationship between height and pillar width. When assessing pillar system performance in the context of the floor, it is only the width of the pillar and the load on the pillar that are material.

Span failure

Conglomerates

The subsidence information from Chain Valley and other mines in the Newcastle Coal measures indicate that thick conglomerate layers are able to span. Bathymetry shows negligible (<150 mm) deflections above the extraction (between the chain pillars) at Wyee and for the Chain Valley miniwalls. Specific applications of a voussoir beam analysis to assess conglomerate spanning have been demonstrated at Mandalong and Awaba.

In this case the interest is on a thick jointed beam so classic elastic beam analyses are not appropriate. Voussoir beams are discussed in the rock mechanics literature and several analytical methods are available[11]. It is noted that voussoir beams fail by shear along joints, compression, or in a snap-through mechanism.

Based on our interpretation of the core logs – specifically the absence of non conglomerate/coarse sandstone layers - conglomerate layers of between 10 m and 40 m thick are present at Chain Valley and these can span large openings with relatively low deflection – for example a 97 m span of a 30 m thick conglomerate would deflect just over 100 mm and have a stability factor in excess of 2.0 (Figure 19): the figure also provides analyses for 20-40 m thickness to allow an appreciation of sensitivities. Note that the abscissa in this plot is the span of the conglomerate and this decreases if the spanning unit being considered is located significantly above the extraction panel.

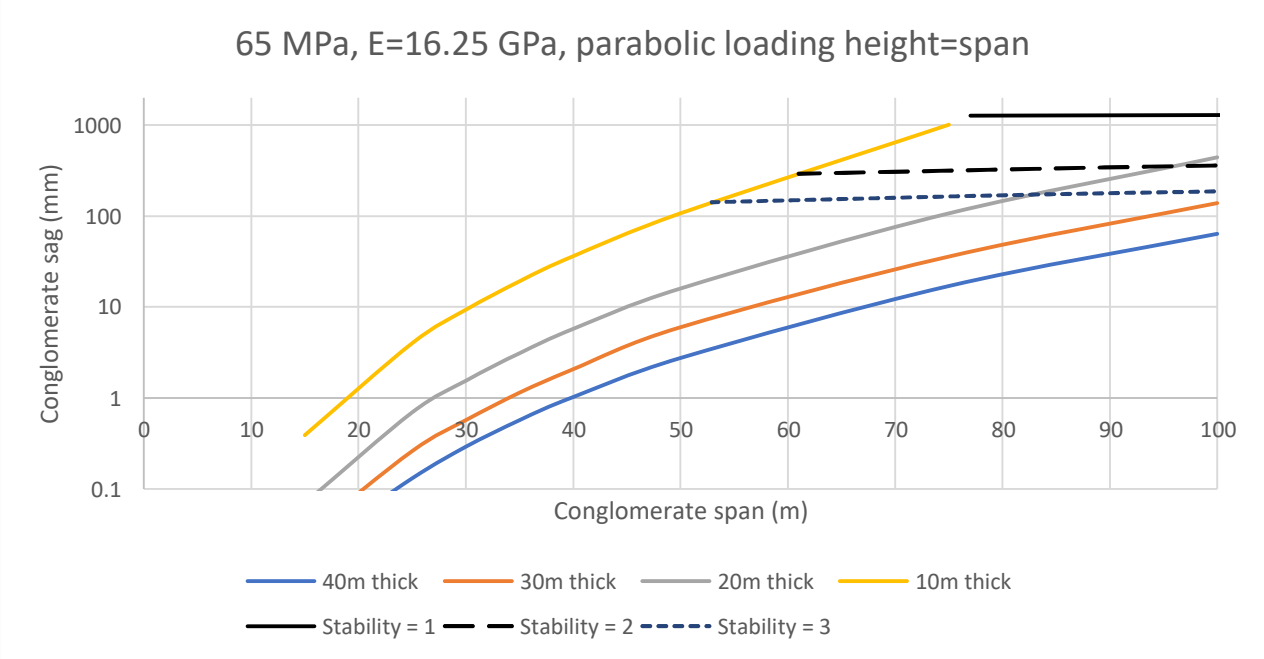


Figure 19 Sensitivity study of the deflection and stability of conglomerates relative to span and conglomerate thickness – 16.5m spans

A corollary of a model of a spanning conglomerate is that the vertical stresses underneath will decrease once the deflection develops. This means that the loads on any pillars below the spanning conglomerate will be low and related to the thickness of the interburden between the conglomerate and the Fassifern Seam. Furthermore, the design of intra-panel pillars can be conducted independent of subsidence considerations.

A similar analysis can be conducted for the Awaba Tuff, in this case to identify how thick layers need to be to span across roadways (Figure 20).

[11] Brady and Brown, Sofianos and Kapensis, CPillar.

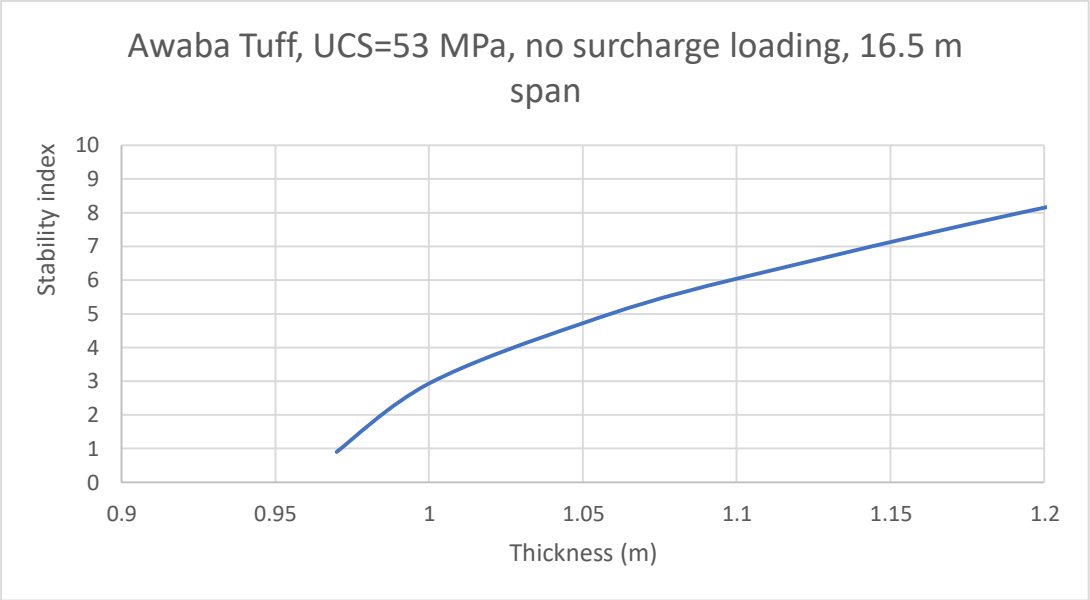


Figure 20 Spanning capability of the Awaba Tuff

Deformation of a pillar/roof/floor system

Assuming the coal component of a pillar does not fail, the surface subsidence would be the result of compression of the coal itself, and the roof and floor materials. It is not possible to identify and calculate the individual components, but the overall pillar system can be ascribed an empirical subsidence compression factor in the form of subsidence /stress change. This factor can be used for similar mining in the same seam at similar mining depths - it is not directly transferable to other seams.

The stress change is calculated from the same tributary area analysis used for the pillar stability. Note that the use of this index assumes that the floor does not fail, hence the prediction is only valid if the floor stability index is greater than 1.0. It is not possible to quantify the resulting subsidence if the floor does fail.

It is noted that no attempt has been made to determine a subsidence compression factor using numerical stress methods. This is primarily because of the high level of uncertainty regarding how to model possible stress-arching of conglomerates in the overburden and the interaction between pillars. These 2 factors are implicitly included in the empirically derived subsidence compression factor.

Appendix 15.4 Northeast and North Headings Subsidence Prediction Report (Amendment 3)

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DELTA COAL
CHAIN VALLEY COLLIERY

Adequacy of Barrier Pillars Between Extracted Miniwalls (MW's 1 to 3, 6 to 12 and S2 to S5) and Proposed Double-Sided Lifting-Off in the Northeast and North Main Headings

NOVEMBER 2025

REPORT: CHAIN VALLEY12/2

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REPORT ON : Adequacy of Barrier Pillars Between Extracted Miniwalls (MW's 1 to 3, '6 to 12 and S2 to S5) and Proposed Double-Sided Lifting-Off in the Northeast and North Main Headings

REPORT NO : CHAIN VALLEY12/2

REFERENCE : Our proposal dated 17th September 2025

PREPARED BY : Russell Frith

REVIEWED BY : Guy Reed and the Client's Representative

DATE : 17th November 2025



.....
Russell Frith
Senior Principal Geotechnical Engineer

Disclaimer

This technical report has been prepared based on: (a) instructions by the Client as to the required scope of work; (b) technical and other supporting information supplied to Mine Advice by the Client; and (c) the use of relevant technical concepts and methods as determined by Mine Advice in their role as a consulting and professional engineering service provider. The Client warrants that all of the information it provides to Mine Advice is complete and accurate, and that it has fully disclosed to Mine Advice any and all relevant matters which may reasonably affect the conclusions that are reached in this report.

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EXECUTIVE SUMMARY

A geotechnical engineering design study has been undertaken to analyse and quantify the effectiveness of specific barrier pillar systems along the Northeast Mains and North Mains as "*isolation barriers*" to prevent pre-existing subsidence above adjacent miniwall panels being re-activated by proposed double-sided lifting-off along both mains panels.

As per the supplied Scope of Work, strategic remnant pillar guidelines to be left within lifting-off areas, have been developed for both remnants aligned along the mains as well as across or perpendicular to the mains, the objective of such remnants being to (a) promote increased levels of operational safety around windblast potential and internally generated abutment stresses due to lifting-off, and (b) provide further assurance that spanning of overlying conglomerate members can be reliably invoked in maintaining subsidence levels within the mining approval limit of 780 mm.

Barrier pillar systems have been analysed for the following:

(i) coal pillar system stability,

(ii) the stability of the floor beneath barrier pillars,

(iii) likely and worst-case Angles of Draw emanating from the lifted-off areas out across barrier pillars, and

(iv) the maximum lateral extent of abutment stresses that might be generated from lifted-off areas.

The analyses completed as part of this study have concluded for both the Northeast Mains and North Mains cases, that:

(a) coal pillar system stability is well above any credible pillar yielding scenario, with or without any minor abutment stress considerations,

(b) average vertical pillar stresses within the barrier pillar systems are well below known critical levels for the Fassifern Seam whereby the onset of floor yield beneath coal pillars becomes a credible possibility, and

(c) predicted likely and even worst-case Angles of Draw (to 20 mm subsidence) as well as the maximum lateral extent of vertical abutment stress from lifted-off areas, are all contained within the footprint of the barrier pillar systems and therefore will not impact/re-activate existing subsidence above adjacent miniwalls.

The overall conclusion is that any overburden subsidence that extends across the proposed barrier pillar systems due to double-sided lifting-off in both the Northeast and North Mains, will be substantially less than 20 mm if not zero, with any associated re-activation of overburden movement at the very outbye end of adjacent miniwall panels being of no practical significance in terms of potentially causing exceedances of the mining approval S_{max} limit of 780 mm over and above those that already exist.

1.0 INTRODUCTION

This report, which is the third in a series of three relevant technical reports pertaining to lifting-off in the Northeast and North Mains, including **Mine Advice 2024** and **Mine Advice 2025**, addresses two further aspects related to the design of suitable mining layouts for double-sided lifting-off purposes, namely:

(i) modifying the lifting-layout to incorporate strategic remnant pillars oriented perpendicular to rather than parallel with the lifting direction, and

(ii) ensuring that the barrier pillars adjacent to the proposed lifting-off areas (marked in red shading in **Figure 1.1**) are sufficient to prevent significant further subsidence above already extracted miniwall panels.

In the case of (i), strategic "*in-panel*" remnant pillars are being left in place to both limit overburden lowering to < 780 mm (as required under the mining approval conditions for working under Lake Macquarie) as well as mitigate the threat of windblasts during second workings. In the case of (ii), the barrier pillars need to ensure that pre-existing subsidence above already extracted miniwall panels is not substantially re-activated by the proposed lifting-off within mains, sections within MW's 1-3 and 6-12 having already exceeded the S_{max} upper limit of 780 mm based on bathymetric surveys (see **Figure 1.2**).

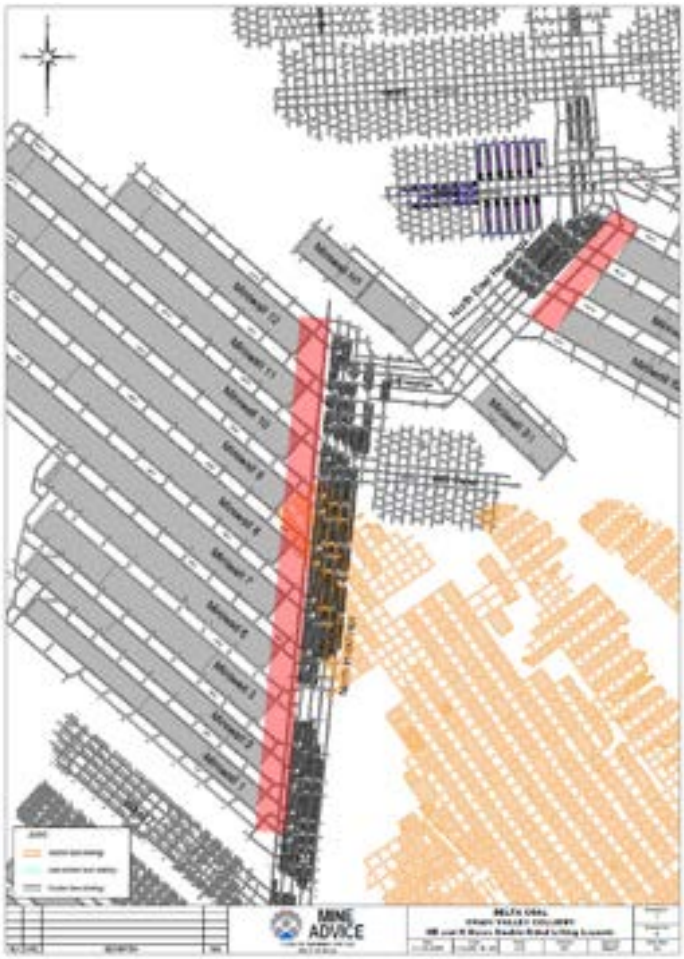


FIGURE 1.1. Specific Barrier Pillars (Marked in Red Shading)

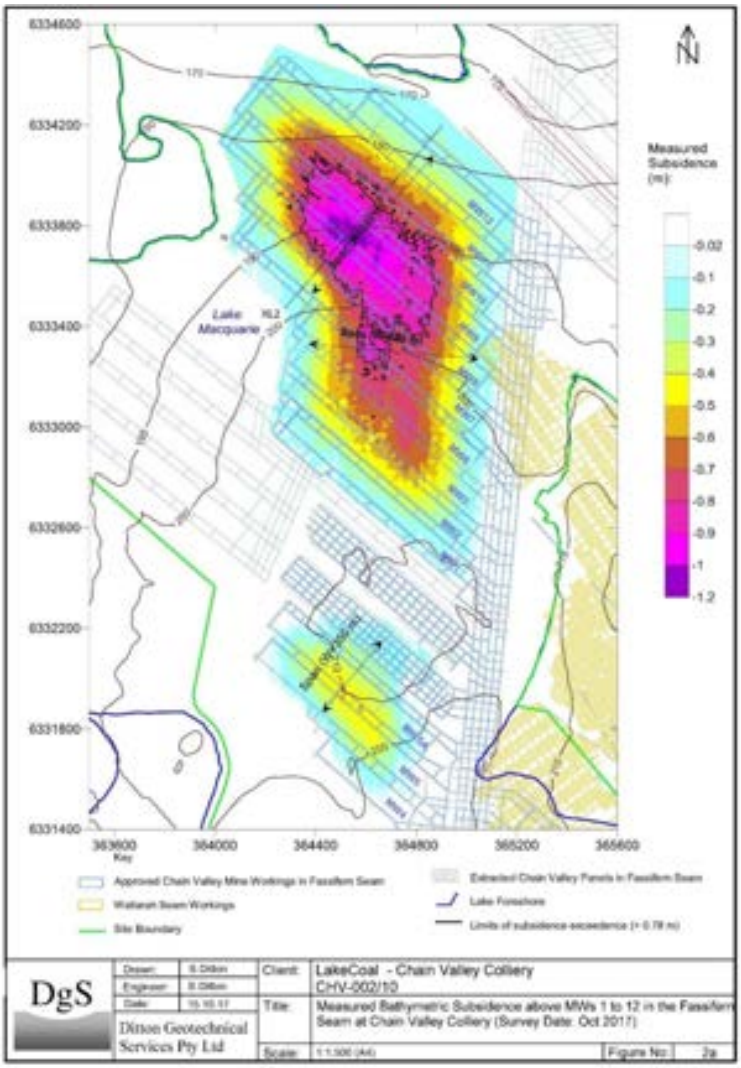


FIGURE 1.2. Example Bathymetric Measured Subsidence above MW's 1 to 12 at Chain Valley

The focus of the analyses is in assessing the extent by which overburden movements due to planned double-sided lifting off in the Northeast and North Mains (as indicated in **Figure 1.1**) might reasonably be expected to extend across the various panel-end barrier pillars adjacent to already extracted miniwall panels and so increase the pre-existing subsidence levels within the miniwall footprints.

The associated concern is that mining approval conditions beneath Lake Macquarie limit subsidence at the base of the lake to no more than 780 mm and miniwall extraction has in places already exceeded this by some amount (see **Figure 1.2**). Such areas must not be further influenced by the proposed double-sided lifting-off in adjacent main headings and all other areas with current total subsidence of < 780 mm must not be influenced to the extent that total subsidence could credibly increase to > 780 mm.

The work is being sub-divided into two separate stages as the generic remnant pillar layout in future lifting-off areas needs to be finalised, at least in terms of mine site optionality, before the adequacy of the various specific barrier pillars can be assessed on a meaningful and case-by-case basis:

Stage 1 (Section 2.0): to incorporate perpendicular strategic remnant pillars within proposed lifting layouts, as a second mine-site option in addition to the parallel strategic remnant pillars suggested in **Mine Advice 2025**, the relevant section of that report being **Section 4.5.2.3**.

Stage 2 (Section 3.0): addresses the question as to whether existing subsidence above relevant miniwall panels will be increased (or not) by the planned double-sided lifting-off layouts developed by the mine-site from Stage 1. In other words, whether the solid coal pillars between the outbye end of miniwall panels and the proposed lifting-off areas can be classified as "*isolation*" barriers whereby overburden subsidence due to lifting-off does not extend across the barriers and potentially increase subsidence above miniwall panels, particularly those miniwall areas whereby known subsidence has already exceeded the maximum allowable under the current approval conditions or is just below that limit at the current time.

Stage 2 will be addressed using a range of analysis methods, including:

- the extent by which pre-existing areas of excessive subsidence above extracted miniwalls are in any way directly connected to the overburden strata above the various barrier pillars,
- likely Angles of Draw outside of the lifted-off areas in both the Northeast and North Mains,
- likely magnitude and lateral extent of vertical abutment stress effects outside of lifted-off areas, and
- barrier pillar system stability and any concerns over non-elastic coal or roof/floor strata compression due to vertical abutment stress increases on barrier pillars.

The outcome from Stage 2 will be a series of independent technical analyses that in combination allow informed conclusions to be reached as to the risk-based potential for overburden movements following double-sided lifting-off to extend across the various barrier pillars into areas of already extracted miniwall panels.

2.0 FINALISATION OF LIFTING-OFF LAYOUTS INCLUDING STRATEGIC REMNANTS

The original mine-site proposed double-sided lifting layout for the Northeast and North Main Headings (see **Figure 1.1**) did not allow for the leaving of what Mine Advice term as "*strategic remnant pillars*" within the extracted area for the specific purposes of either (a) improved subsidence control/prediction reliability, and/or (b) windblast mitigation. It is assumed that this was linked to the current double-sided lifting layouts in use in the Northern Area (**Figure 2.1**), as outlined in **Byrnes Geotechnical Services (BGS) 2025**, whereby remnant coal within lifted-off areas consists of a 2.6 m to 4 m wide fender between run-outs.

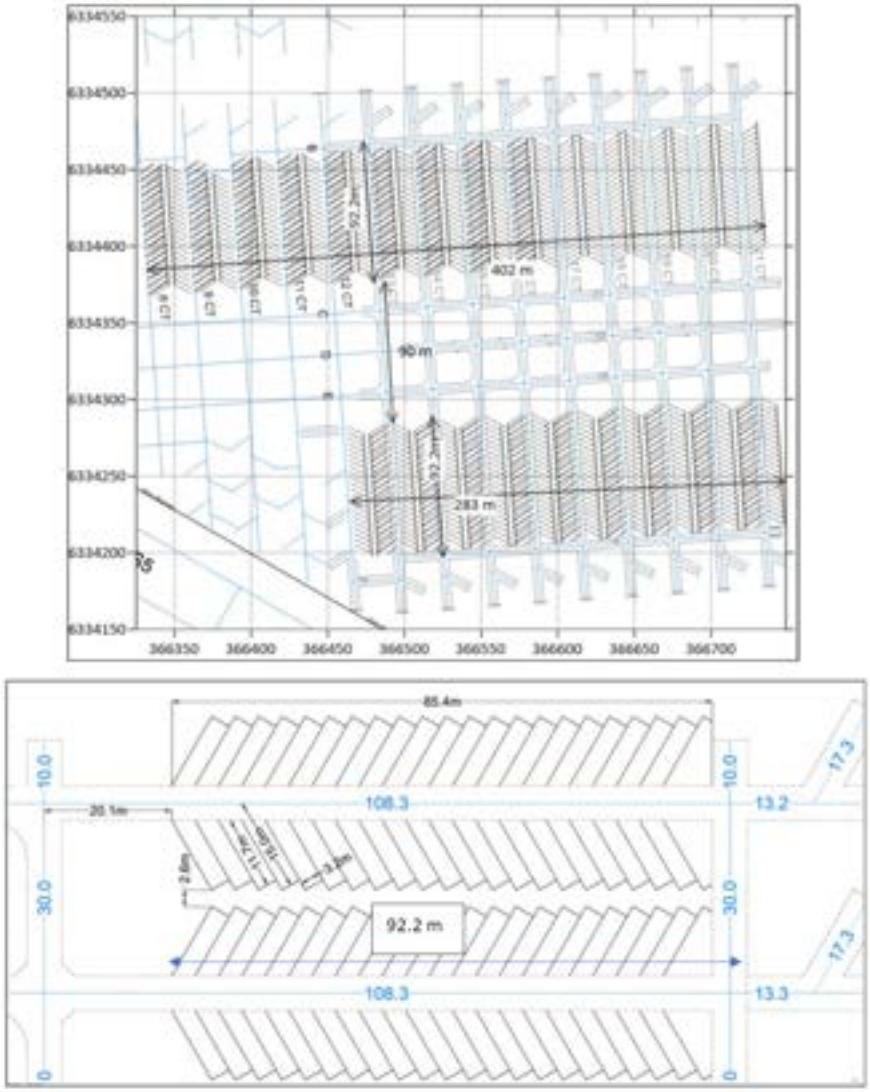


FIGURE 2.1. Generic Double-Sided Lifting Layouts for the Northern Area (BGS 2025)

The same S_{max} restriction of 780 mm is understood to apply in the Northern area of the mine due to it also being below Lake Macquarie, with **BGS 2025** concluding that for an extraction width of up to 92.2 m (as is evident in **Figure 2.1**), and the leaving of thin fenders between lifting runs of 2.6 m to 4 m width being ignored for the purpose of subsidence prediction, "*the predicted maximum subsidence at the floor of Lake Macquarie ranges between 18 mm to 236 mm, with a recommendation to use 140 mm in hazard assessments*".

The above subsidence prediction is predominantly linked to the predicted stability or spanning of both the Warnervale and/or Karigan Conglomerates across a 92 m wide extraction span, in combination with the stability of the four rows of load-bearing pillars between adjacent extraction areas, as indicated in **Figure 2.1**.

Mine Advice 2025 returned broadly similar subsidence predictions for the mine site proposed double-sided lifting layouts along the Northeast and North Main Headings whereby for extraction widths as high as 142 m, the maximum predicted subsidence was no more than 200 mm, this being founded in "*High Subsidence Reduction Potential*" due to the inferred presence of one or more spanning thick conglomerate units within the overburden, no different in principle to **BGS 2025**.

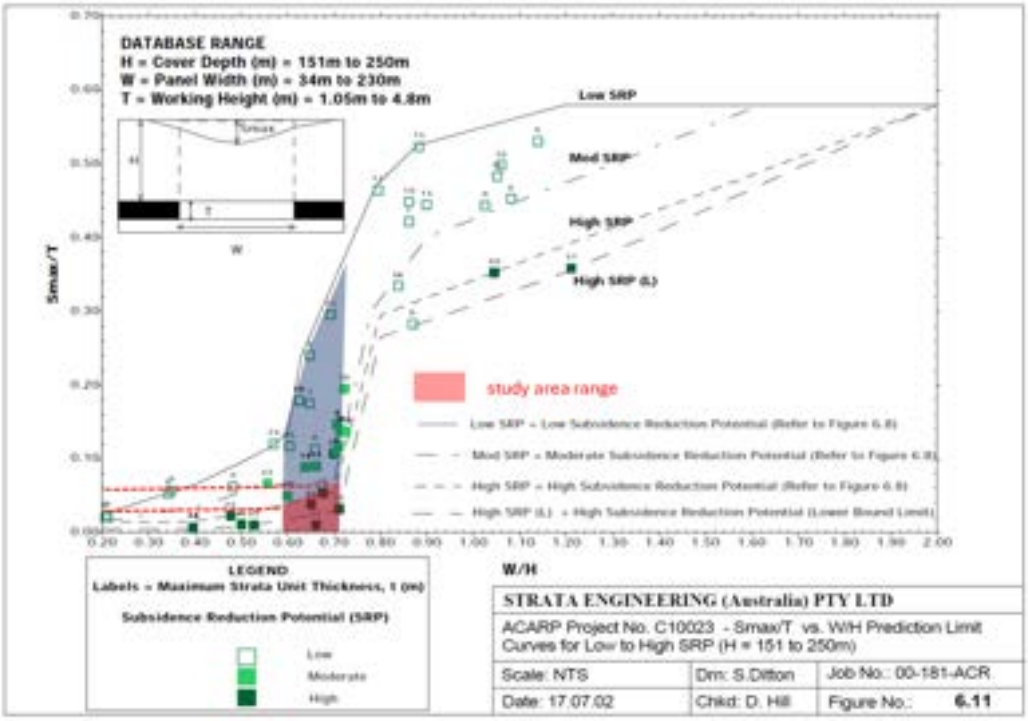


FIGURE 2.2. S_{max} Prediction Curves for Varying SRP and W/H for Cover Depths 151 m to 250 m (Mine Advice 2025)

Mine Advice 2025 also addressed the question as to what might occur if for some reason the assumed spanning conglomerates did not span in practice, this causing the prudence of solely relying on geological-based controls for critical mining outcomes to be further considered. In particular, if the spanning ability of the thick conglomerates (either in combination or isolation) were lost for whatever reason (e.g. undefined and unknown lithological or thickness variations, faulting effects etc.), then predicted S_{max} levels could increase to in excess of 780 mm (see blue shaded area in **Figure 2.2**), which would then exceed the mining approval conditions.

Without repeating the relevant section of **Mine Advice 2025**, it was recommended that the proposed lifting layouts be modified by leaving a central remnant "*spine pillar*" in place as illustrated in **Figure 2.3**, this substantially mitigating (a) the potential for S_{max} exceedances should conglomerate spanning be less than assumed by the pre-mining layout design, (b) internally developed abutment stresses negatively

impacting active lifting-off areas, and (c) windblast potential due to extraction spans without remnants otherwise being as high as 142 m in places.



FIGURE 2.3. Suggested Remnant Pillar and Associated Lifting Layout (Mine Advice 2025)

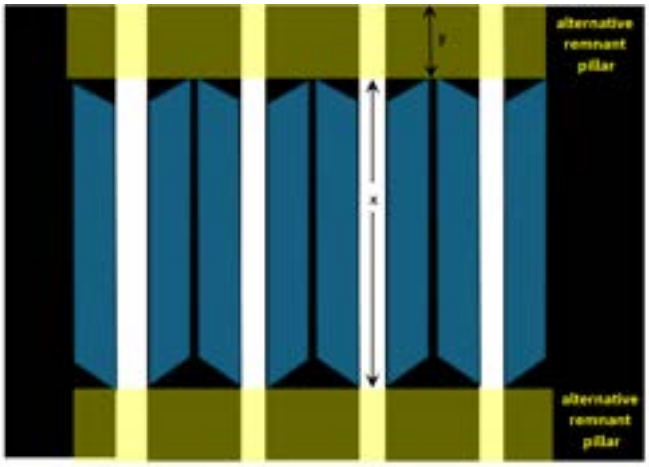


FIGURE 2.4. Generic Lifting Layout Showing Remnant Pillars Across the Panel

As part of the Scope of Work for this study, the question was asked as to whether and how the suggested remnant pillar in **Figure 2.3** could be left across the extraction panel rather than along it, as illustrated for comparison purposes in **Figure 2.4**, relevant design considerations being (a) how often to leave such a remnant pillar in place (dimension "x" in **Figure 2.4**), and (b) to what width (dimension "y" in **Figure 2.4**).

In general terms, dimension "x" needs to be sufficiently low to credibly prevent the occurrence of windblasts during operations, and "y" adequately large to ensure the on-going load-bearing ability of the resultant remnant pillars to both (a) separate lifted-off areas for windblast mitigation, as well as (b) contribute to subsidence minimisation in the event that the spanning ability of overlying conglomerates is less than assumed in the pre-mining layout design as previously discussed.

The minimum dimension for "y" is relatively straightforward to assign on the basis of a minimum pillar w/h ratio of 4, this being the lower limit of "*squat*" pillars that tend to strain-harden rather than rapidly strain-soften beyond peak loading, as described in detail in **Reed *et al* 2016**. This then leaves the question of how to assign a design value for "x"?

It is understood that the recent "*overpressure*" event in the Northern Area at Chain Valley occurred within an extraction width of up to 92 m and the leaving of thin fenders between 2.6 m and 4 m wide as can be seen in **Figure 2.1**. **BGS 2025** states that such thin fenders will not structurally fail/collapse by virtue of

the immediate floor (based on an assumed 1 m thick layer of tuffaceous claystone with a UCS of no more than 1 MPa) being sufficiently weak to ensure that floor yield occurs before any yield within the thin coal fender with an assumed pillar strength in the order of 4 MPa for a 4 m wide fender (refer Section 4.5.1 of **BGS 2025**). However, the report does not consider any of the following possible variations to this analysis that might otherwise result in the thin fenders yielding and hence potentially structurally collapsing by virtue of their low w/h ratio before floor yielding beneath them:

(i) that whilst the maximum fender width is 4 m its minimum width is 2.6 m (see **Figure 2.1**), therefore assigning a pillar strength to this fender based on an assumed pillar width of 4 m is optimistic in the context of the safety risk being analysed.

(ii) that it is conceivable based on the lifting geometries shown in **Figure 2.1** that the CM can reach further than the assumed maximum lift depth, hence fender widths could credibly be less than those assumed in the BGS analyses.

(iii) the potential for floor layers of 1 m thickness having UCS values > 1 MPa (e.g. due to lithological variations or changes in *in situ* moisture content, which influences UCS), which is in fact observed to be the case at adjacent mines that also work the Fassifern Seam.

If the potential for the structural collapse of the thin fenders is in any way a credible possibility rather than limiting the outcome to solely that of intact fenders punching into the underlying floor material, then the assumption in **BGS 2025** that the maximum extraction width in the Northern area within which goaf falls can occur is 26 m is based on questionable logic and certainly best-case or optimistic thinking. A safety-based prudent maximum extraction width assumption within which goaf falls can occur is the full extraction width of 92 m, which then results in an entirely different conclusion as to windblast potential.

The problem of windblasts and the leaving of thin fenders within the lifting-off layout is actually directly linked back to pre-existing pillar widths, which (it is assumed) were never designed for future double-sided lifting off. Consequently, it is impractical to either (a) reliably extract the thin fenders thereby promoting more regular and hence smaller falls of the immediate roof, or conversely (b) leaving a suitably thick fender in place to reliably prevent large area goaf falls across more than one adjacent lifted-off area.

The recent overpressure event at the mine suggests that with these thin coal fenders being inevitably left in place, an extraction width of 92 m is potentially somewhat susceptible to large goaf falls across more than one lifting sequence, with associated windblast potential. With no other information to refer to, it is being assumed that an extraction width of 92 m can be taken to represent a generic FoS of 1 in terms of the occurrence of goaf falls with the potential to produce windblast level air velocities (i.e. 20 m/s and greater) within the active mining area. Therefore, in terms of mitigating this risk to a lower level, it is suggested that a maximum extraction width of 50 m (i.e. dimension "x" in **Figure 2.4**) would be more appropriate as it implies an FoS against a windblast producing goaf fall closer to 2 than 1. It is noted that this is only a suggestion which the mine can choose to modify at its sole discretion based on acceptable levels of risk.

In reality, the maximum distance "x" between remnant pillars will be dictated by pre-existing cut-through centres for the mains pillars. In the Northeast Mains this varies from as little as 41.3 m (7 to 8 C/T) to 100 m (8 to 9 C/T). The same type of variations are also true of the North Main Headings. This means that in some instances double-sided lifting could be undertaken for the full pillar length between cut-throughs (C/T's), whereas in others a mid-pillar remnant would need to be left in place. Similarly, if a short pillar

were to be fully lifted between C/Ts with only a small Stook X being left in place at the outbye C/T (to protect the intersection), a remnant pillar would be required on the immediate outbye side of the C/T which would make setting up 3 BLS's for double-sided lifting far more difficult than if the inbye intersection were immediately available.

The mine has two basic options as to how it can optimise double-sided lifting layouts in both the Northeast and North Main Headings in terms of:

(i) in-panel subsidence control via ensuring that overlying conglomerates do not become unstable across extraction spans, and

(ii) promoting operational safety during second workings.

The first option is to simply leave a central spine pillar in place as outlined in **Mine Advice 2025** and illustrated in **Figure 2.3**, the second or alternate option being to leave remnant pillars in place across the panel with a w/h of no less than 4 every 50 m as a suggested design value, as illustrated in **Figure 2.4**. As to which option provides for the higher reserve recovery and/or productivity is out of the scope of this assessment but can be evaluated by the mine based on different lifting-off layout options.

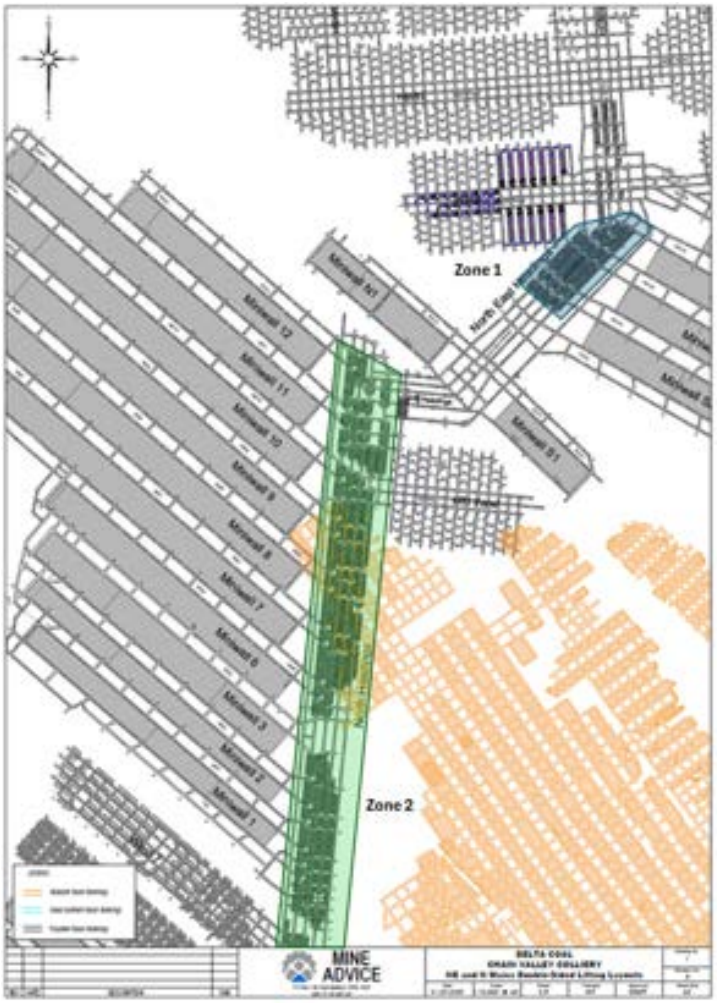


FIGURE 2.5. Zoning of Study Area (Mine Advice 2025)

	Cover Depth (m)	Panel Width (m)	W/H Ratio (to base of lake)	S_{max} (mm)	S_{rib} (mm)	Angle of Draw (°) Likely/Worst-Case
Zone 1 (4 rows)	170	118	0.69	192	87	14/23
Zone 2 (4 rows)	200	118	0.59	128	70	12/21
Zone 2 (5 rows)	200	142	0.71	192	87	14/23

TABLE 2.1. Summary of W/H and Relevant Subsidence Parameters (Based on Initial Proposed Double-Sided Lifting-Off Layouts Without In-Panel Remnants as per Figure 2.5)

With these two lifting layout options incorporating strategic remnant pillars being available, the second stage of the work can be undertaken using the general assumption that in-panel subsidence due to lifting-off within both the Northeast and North Main Headings will be consistent with the general predictions made in **Mine Advice 2025** (**Table 2.1**), which rely on High Subsidence Reduction Potential being maintained via the combined action of one or more overlying conglomerates and strategic remnant pillars within the layout (refer **Figure 2.5** for zoning details).

3.0 BARRIER PILLAR ADEQUACY AGAINST EXTRACTED MINIWALL PANELS

3.1 Review of Existing Subsidence Above Miniwall Panels

As an initial comment, it is noted that the available subsidence data at the lake bed is from bathymetric surveys. In the past such surveys have been assumed as having an inherent resolution of ± 200 mm, as compared to land surveys which commonly resolve to 20 mm, this limit being largely linked to natural surface elevation changes due to climatic effects. This fundamental difference in survey resolution needs to be given full consideration when analysing existing subsidence data, the appropriate interpretation of bathymetric surveys being that of "*indicative only*" due to the high inherent resolution.

From **Figure 3.1** it is evident that a significant subsidence trough has developed across MW's 1 to 3 and 6 to 12, particularly MW 3 onwards whereby face width increased to 91.6 m (centres) as compared to MW's 1 and 2. Maximum subsidence is locally > 1 m which exceeds the current approval limit of 780 mm.

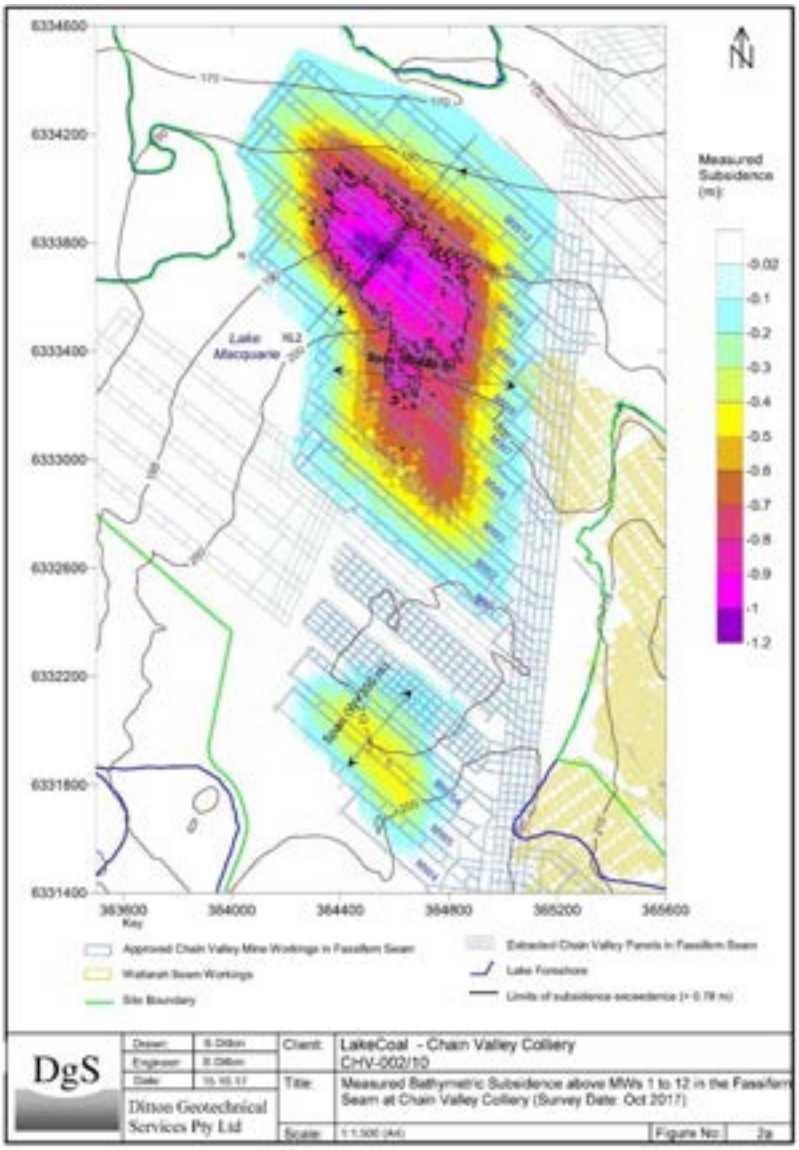


FIGURE 3.1. Bathymetric Measured Subsidence above MW's 1 to 12

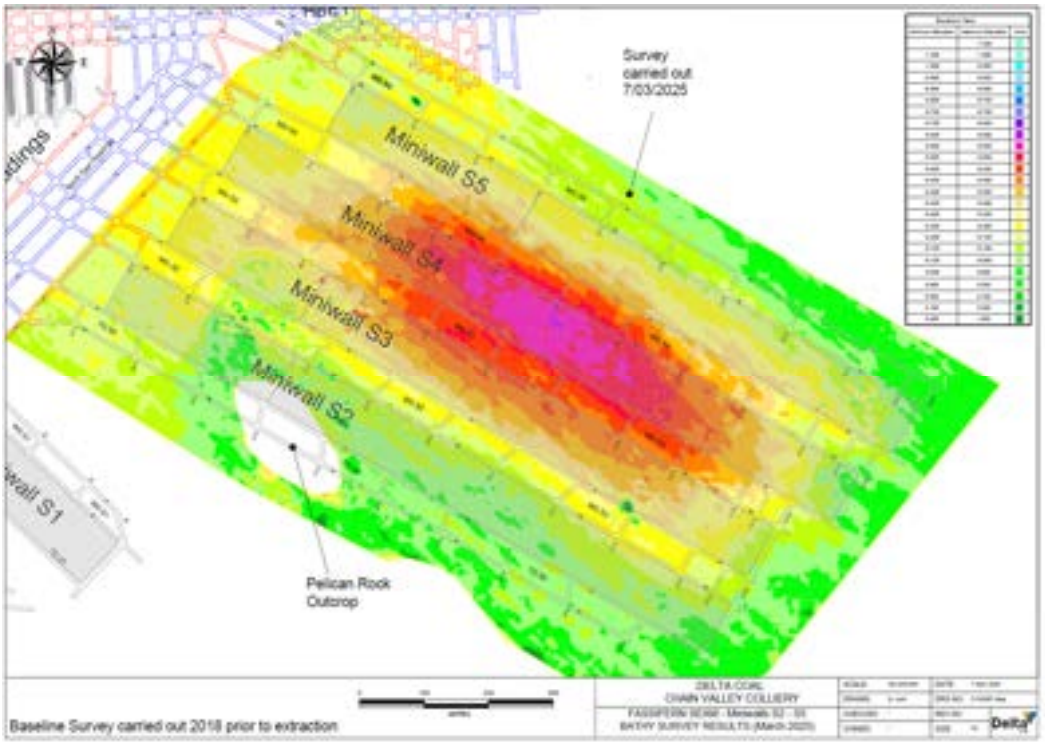


FIGURE 3.2. Bathymetric Measured Subsidence above MW's S2 to S5

The same general pattern of subsidence is evident across MW's S2 to S5 as shown in **Figure 3.2**, the main difference being that S_{max} is lower (< 600 mm as compared to in excess of 1 m). Without digressing into detail, the chain pillars between the S2 to S5 miniwalls being wider than between MW's S6 to 12 and the cover depth being marginally lower are the most likely reasons for this variation, particularly as there is no obvious evidence of discernible sag subsidence within individual panels in either **Figure 3.1** or **Figure 3.2**, rather a single subsidence trough across several miniwall panels which logically brings chain pillar system stability into consideration.

Recognising that S_{max} above MW's S2 to S5 does not exceed 780 mm, the extent of S_{max} being > 780 mm across MW's 6 to 12 is marked in **Figure 3.1** as a solid black line close to the limit of the 0.8 m shading-based isopach. The minimum distance from the outbye end of miniwall panels is found to be in the range 250 m to 300 m for MW's 8 and 9, with this offset distance increasing for MW's 10 and above as well as MW's 7 and below.

The estimated level of subsidence at the outbye ends miniwall panels is generally in the order of 250 mm in both **Figures 3.1** and **3.2**. Therefore, it logically follows that the barrier pillars between these miniwalls and the adjacent main headings might have been subjected to some level of abutment loading as a direct consequence of the self-evident chain pillar system yielding within miniwall panels. However given a survey resolution of ±200 mm it is difficult to be certain on this issue.

Having established that the various barriers pillars might have been influenced to some currently undefined degree by the miniwall panels adjacent to them, the relevant question is to what extent? To address this, consideration will be given to the yielding of miniwall chain pillars as are clearly controlling the development of the extensive subsidence troughs in **Figures 3.1** and **3.2**, in particular the extent by which yielding of either the coal pillar itself, the known weak floor interval beneath the pillar, or both, is

likely to have substantially shed and re-distributed overburden load, including therefore to the various barrier pillars at the outbye end of panels.

3.2 Assessment of Potential Load Shedding Due to Miniwall Chain Pillar System Yielding

In regard to the miniwall chain pillars, the issue of overburden load shedding due to coal pillar yield is well catered for in the published literature, with post-peak strain hardening of a coal pillar, thereby implying no substantive load shedding, incrementally increasing for pillar w/h ratios of 4 and greater. With the miniwall chain pillars having w/h ratios in the order of 10 and above, it is inevitably concluded that even if those chain pillars have yielded under Double Goaf abutment loading, little to no overburden load will have been re-distributed as a direct consequence.

The matter of the floor yielding beneath coal pillars is less covered in the published mining literature, but fortunately is well documented in published foundation engineering, as will now be described.

In the same way that coal pillars only rapidly shed and re-distribute overburden load as a function of their w/h ratio, most significantly at values less than 2 (**Reed *et al* 2016**), the same is also true of bearing or foundation failures beneath footings according to the thickness of yielding material (H) as a function of footing width (B), H/B beneath a footing in effect being the reciprocal of w/h ratio for a coal pillar.

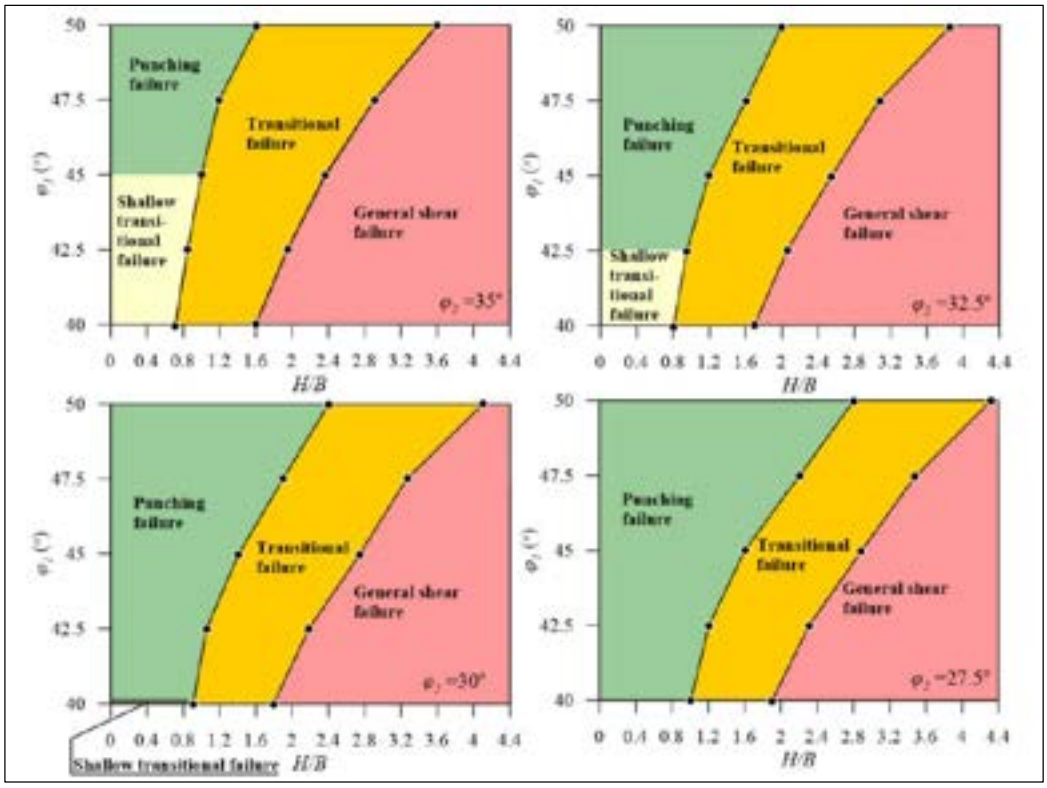


FIGURE 3.3. Failure Mechanisms for Strip Footings on Layered Sand for Different Friction Angles and Dimensionless Thickness H/B Combinations (**Kouretzis 2025**)

Figure 3.3 indicates different foundation failure modes according to varying H/B values and material friction angles, with full shear failure and associated load shedding only being applicable to "*general shear failure*" as indicated in **Figure 3.4**.

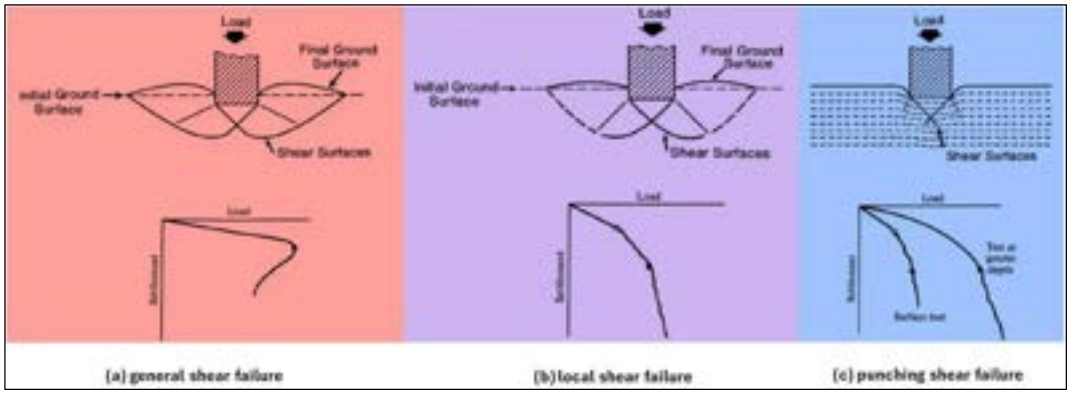


FIGURE 3.4. Different Foundation Failure Mechanisms and Associated Load-Settlement Response (CivilBlog.Org 2025)

For an assumed 6 m thick section of weak/soft immediate floor material (as per the coal/tuffaceous claystone sequence below the working section in the Fassifern Seam) and a footing width (i.e. chain pillar width) of no less than 30 m, a maximum H/B ratio of 0.2 is found. Based on **Figure 3.3** this clearly implies "*punching*" or "*shallow transitional*" failure (read "*local shear failure*" in **Figure 3.4**) as the likely failure mechanisms should floor material yield beneath miniwall chain pillars, from which **Figures 3.4 (b)** and **(c)** confirm some level of strain-hardening behaviour as a direct consequence, analogous to coal pillars with w/h values > 4.

The measured subsidence in **Figures 3.1** and **3.2** clearly confirms that some part of the chain pillar system between miniwall panels has yielded under double goaf loading with several panels in a sequence having been extracted. The simple analysis in this section indicates that whether it is the coal pillar, the floor beneath the pillar, or a combination of the two, chain pillar system yielding would not be expected to substantially shed overburden load and re-distribute it elsewhere, including the barrier pillars against the outbye main headings.

This behaviour also goes to explain why despite being clearly controlled by the geometry/shape of the extracted miniwall panels, the location of maximum subsidence is confined to the very centre of the extracted area and does not closely encroach either the inbye or outbye ends of panels, as is clearly evident in **Figures 3.1** and **3.2**. Had chain pillar system yielding resulted in substantial load shedding and re-distribution (as if unrestricted overburden caving was occurring in essence), it would be expected that more of a "*pillar run*" would be evident within the area of extracted miniwalls, thereby resulting in higher levels of subsidence towards the inbye and outbye ends of miniwall panels than is actually the case.

This finding is a significant positive aspect to the objectives of this study in terms of both (a) pre-existing abutment loading of barrier pillars due to in-panel miniwall subsidence, and (b) any minor yielding that might conceivably occur within the various strategic remnant pillars being left in-place within double-sided lifting-off areas, as described in **Section 2** of the report.

3.3 Barrier Pillar Stability

Prior to considering the overburden movements that might be transferred across the barrier pillars, it is necessary to analyse their likely stability both before and after lifting-off in the main headings, any large-

scale instability or system yield in either the coal pillar or underlying floor obviously rendering the barrier pillar as ineffective as an isolation barrier.

3.3.1 Barrier Pillar Configurations

The barrier pillar systems are different in their geometry and configuration in the Northeast Mains as compared to the North Mains, as will now be summarised.

Figure 3.5 shows the barrier pillar system between MW's 1 to 3 and 6 to 12 against the North Mains, with the following attributes:

- The maximum footprint of proposed double-sided lifting is shown by the shaded red area, noting that strategic remnants are not included for the purpose of assessing barrier pillar suitability.
- The "*effective*" goaf edge at the outbye end of miniwalls is estimated after having accounted for the orientation of miniwall panels relative to the mains and the inevitable staggered nature of their outbye finish locations.
- The barrier pillar "*system*" against the North Mains for any given miniwall panel ostensibly consists of five individual pillars (marked A to E in **Figure 3.5**), the largest clearly being pillar A with this system being generally repeated for all North Mains miniwall panels.

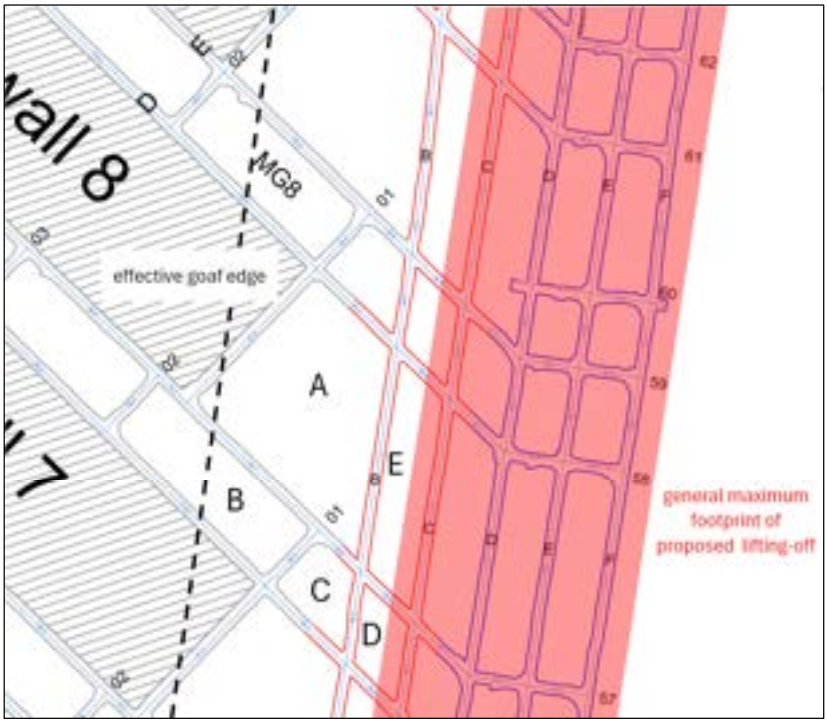


FIGURE 3.5. Barrier Pillar System and Adjacent Workings, North Main Headings

Figure 3.6 shows the barrier pillar system between MW's S2 to S5 against the Northeast Mains, with the following attributes:

- The maximum footprint of proposed double-sided lifting is shown by the shaded red area, noting that strategic remnants are not included for the purpose of assessing barrier pillar suitability.

- The "*effective*" goaf edge at the outbye end of miniwalls logically closely aligns with the outbye finish lines for MW's S2 to S4, with MW S5 finishing further to the east such that its extracted area is far more remote from the Northeast Mains than S2 to S4.

- The barrier pillar "*system*" only consists of four individual pillars (marked F to I in **Figure 3.6**), the largest clearly being pillar F, this system being generally repeated for all Northeast Mains miniwall panels, noting that the proposed double-sided lifting-off does not extend to being directly opposite MW S5.



FIGURE 3.6. Barrier Pillar System and Adjacent Workings, Northeast Main Headings

This then defines the two barrier pillar systems that need to be analysed as part of the study.

3.3.2 North Mains

Table 3.1 summarises key parameters for the five identified coal pillars that form the barrier pillar system against the North Main Headings. It is noted that in the case of pillar dimensions, obviously rectangular pillars (i.e. pillars B, D and E) have been assigned lengths and widths based on actual values from the mine plan, whereas obviously non-rectangular and irregular shaped pillars (i.e. pillars A and C) have been assigned lengths and widths based on the calculated effective width of 4 x area/perimeter (**Galvin 2016**).

Pillar	Area (m^2)	Perimeter (m)	Effective/Actual Dimensions (m)	Pillar Strength @ h = 3.2 m (MPa)	w/h	Load-Bearing Ability (N)
A	7480	367	81.5 x 81.5	164	25.5	1.2×10^{12}
B	2952	249	94.5 x 32.5	33.4	10.2	9.9×10^{10}
C	1155	141	32.8 x 32.8	27.7	10.3	$32. \times 10^{10}$
D	713	122	41 x 14	13.65	4.4	9.7×10^{9}
E	1802	256	106.3 x 14	14.21	4.4	2.6×10^{10}

TABLE 3.1. Summary of Barrier Pillar System Characteristics, North Mains (Figure 3.5)

By applying the barrier pillar system characteristics for the North Mains as contained in **Table 3.1** at an assumed cover depth of 200 m and making no density allowance for water in the lake (i.e. overburden SG = 2.5), it is found that:

(i) coal pillar system FoS against pillar failure using the UNSW strength equations under full tributary area loading = 16

(ii) coal pillar w/h range = 4.4 to 25.5

(iii) average pillar stress for all pillars = 6 MPa

Based on these outcomes it is inevitably concluded that there is no credible possibility of any form of coal pillar system instability within the North Mains barrier pillar system, even if low level abutment loads from the extracted miniwalls and/or areas of double-sided lifting are generated within the barrier pillar area (remembering that both pillar and floor yield do not significantly shed and re-distribute overburden load based on the specific pillar dimensions in use). Furthermore, average pillar stresses are well within proven levels whereby *en masse* failure of the coal/claystone sequence beneath pillars in the Fassifern Seam is not a credible possibility (for more details refer **Mine Advice 2024**), particularly as one of the barrier pillars has an effective width of 81.5 m which will act to substantially increase the load-bearing capacity of the coal/claystone floor beneath the pillar.

For reference purposes the distance from the western extremity of the proposed lifting-off area footprint to the effective miniwall goaf edge as indicated in **Figure 3.5** is in the order of 105 m, meaning that for a cover depth of 200 m, the Angle of Draw due to lifting-off would need to be greater than 27.7º for more than 20 mm of subsidence to be generated on the western side of the effective outbye goaf edge of the extracted miniwall panels.

3.3.3 Northeast Mains

Table 3.2 summarises key parameters for the four identified coal pillars that form the barrier pillar system against the Northeast Main Headings.

Pillar	Area (m^2)	Perimeter (m)	Effective/Actual Dimensions (m)	Pillar Strength @ h = 3.2 m (MPa)	w/h	Load-Bearing Ability (N)
F	5896	313	75.3 x 75.3	137.6	23.5	8.1×10^{11}
G	1879	175	43 x 43	44	13.4	8.27×10^{10}
H	3019	254	94.5 x 37.6	41.6	11.8	1.26×10^{11}
I	1425	154	37 x 37	33.7	11.6	4.8×10^{10}

TABLE 3.2. Summary of Barrier Pillar System Characteristics, Northeast Mains (Figure 3.6)

By applying the barrier pillar system characteristics for the Northeast Mains as contained in **Table 3.2** at an assumed cover depth of 170 m and making no density allowance for water in the lake (i.e. overburden SG = 2.5), it is found that:

(i) coal pillar system FoS against pillar failure using the UNSW strength equations under full trigutary area loading = 18.4

(ii) coal pillar w/h range = 11.6 to 23.5

(iii) average pillar stress for all pillars = 4.74 MPa.

Based on these outcomes it is again inevitably concluded that there is no credible possibility of any form of coal pillar system instability within the Northeast Mains barrier pillar system, even if low level abutment loads from the extracted miniwalls and/or areas of double-sided lifting are generated within the barrier pillar area. Furthermore, average pillar stresses are well within proven levels whereby *en masse* failure of the coal/claystone sequence beneath pillars in the Fassifern Seam is not a credible possibility, particularly as one of the barrier pillars has an effective width of 75 m which will act to substantially increase the load-bearing capacity of the coal/claystone floor beneath the pillar.

For reference purposes the distance from the eastern extremity of the proposed lifting-off area footprint to the outbye end of miniwalls shown in **Figure 3.6** is in the order of 110 m, meaning that for a cover depth of 170 m the Angle of Draw due to the lifting-off would need to be greater than 33º for greater than 20 mm of subsidence to be generated on the inbye side of the outbye goaf edge for the extracted miniwall panels.

3.4 Range of Predicted Angles of Draw for Proposed Double-Sided Lifting Off

Mine Advice 2025 made predictions of maximum subsidence as well as likely and worse case Angles of Draw outside of the proposed areas of double-sided lifting off (referring to **Ditton and Frith 2003**), as per **Table 3.3**. These values are relevant irrespective of what strategic remnant pillar strategy for the lifting-off area is adopted by the mine site.

	Cover Depth (m)	Panel Width (m)	W/H Ratio (to base of lake)	S_{max} (mm)	S_{rib} (mm)	Angle of Draw (°) Likely/Worst-Case
Northeast Mains (4 rows)	170	118	0.69	192	87	14/23
North Mains (4 rows)	200	118	0.59	128	70	12/21
North Mains (5 rows)	200	142	0.71	192	87	14/23

TABLE 3.3. Summary of W/H and In-Panel Subsidence Parameters (Based on Initial Proposed Double-Sided Lifting-Off Layout Without In-Panel Remnants as per Figure 2.5)

In terms of the Northeast Mains, it was determined in **Section 3.3.3** that an Angle of Draw of 33º due to double-sided lifting-off would need to develop for the 20 mm limit of subsidence to reach the extracted miniwall side of the barrier pillar system (**Figure 3.6**). The Angle of Draw predictions from **Mine Advice 2025** are a likely value of 14º and a worst-case value of 23º, hence it is concluded that any subsidence extending across the barrier pillar system due to the proposed double-sided lifting-off in the Northeast Mains will be substantially less than 20 mm if not zero, with any associated re-activation of overburden movements at the very outbye end of the adjacent miniwall panels (S2 to S5) being of no significance in terms of exceeding the mining approval S_{max} limit of 780 mm.

In terms of the North Mains, it was determined in **Section 3.3.2** that an Angle of Draw of 27º due to double-sided lifting-off would need to develop for the 20 mm limit of subsidence to reach the extracted

miniwall side of the barrier pillar system (**Figure 3.5**). The Angle of Draw predictions from **Mine Advice 2025** are likely values of 12º to 14º and a worst-case value of 23º, hence it is similarly concluded that any subsidence extending across the barrier pillar system due to proposed double-sided lifting-off in the North Mains will be substantially less than 20 mm if not zero, with any associated re-activation of overburden movement at the very outbye end of adjacent miniwall panels (1 to 3 and 6 to 12) being of no significance in terms of exceeding the mining approval S_{max} limit of 780 mm.

3.5 Lateral Extent of Abutment Stress Effects Outside the Lifted-Off Area

The final check as to barrier pillar system effectiveness is in estimating the maximum distance from the goaf edge that abutment stress effects are likely to be generated, this being done by reference to the Abutment Influence Zone ("D") parameter as developed as part of the Abutment Load Distribution Function published by **Peng and Chiang 1984**, this being a fundamental component of both the ALPS and ALTS chain pillar design methodologies.

The relevant equation is as below:

$$D = 5.13 \times H^{0.5}$$

Where:

H = cover depth (m), and

D = maximum distance from the goaf edge (m) that abutment stresses can be detected.

At a depth of 170 m for the Northeast Mains, D = 67 m and for the North Mains at a depth of 200 m, D = 72.5 m, both of these falling within the prescribed barrier pillar system areas and not reaching the outbye end of extracted miniwalls. It is noted that this finding is entirely consistent with the predicted "*likely*" Angles of Draw in the order of 12º to 14º for both the Northeast and North Mains, which are also both fully contained within the prescribed barrier pillar system areas.

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CHAIN VALLEY COLLIERY

Assessment of Double-Sided Lifting for Secondary Extraction, NE and North Main Headings, Fassifern Seam

APRIL 2025

REPORT: CHAIN VALLEY11/1

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REPORT ON : Assessment of Double-Sided Lifting for Secondary Extraction, NE and North Main Headings, Fassifern Seam

REPORT NO : CHAIN VALLEY11/1

REFERENCE : Our proposal dated 23rd March 2025

PREPARED BY : Russell Frith

REVIEWED BY : Guy Reed and the Client's Representative

DATE : 29th April 2025



.....
Russell Frith
Senior Principal Geotechnical Engineer

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EXECUTIVE SUMMARY

A geotechnical review has been undertaken of a mine-site proposed double-sided lifting layout within the NE and North Main Headings at Chain Valley Colliery, this being an extension of a review for single-sided lifting throughout much of the same area of the mine in 2024.

The review has examined both (a) ensuring that surface subsidence and associated impacts are maintained within regulated limits, and also (b) workplace safety during lifting-off in terms of the engineering design of mining layouts, installed strata support, and a series of operational controls.

The major recommendation from the review is to leave a central spine pillar in place in order to both maintain operational safety risks at acceptably low levels and ensure that mining-induced subsidence is predominantly controlled by the layout geometry (extraction spans and remnant pillars) with a far lesser reliance being placed on the thickness and/or mechanical properties of one or more massive strata units within the overburden.

It is concluded that there is credible potential for both safe and productive double-sided lifting-off in both the NE and North Main Headings of the Fassifern Seam at Chain Valley based on applying a Hierarchy of Controls approach to strata control and subsidence risk management as outlined in this report.

1.0 INTRODUCTION

In October 2024, Mine Advice undertook a geotechnical evaluation of mine-site proposed single-sided lifting from existing roadways in the Herringbone (HB) Mains, Northeast Headings (NE Headings) and North Headings, the proposed layout being shown in **Figure 1.1** along with the high-water mark of the Lake Macquarie foreshore. The technical report (**Mine Advice 2024a**) addressed both operational safety and predicted levels of subsidence, acceptable levels of the latter being defined by approvals to mine in the area.

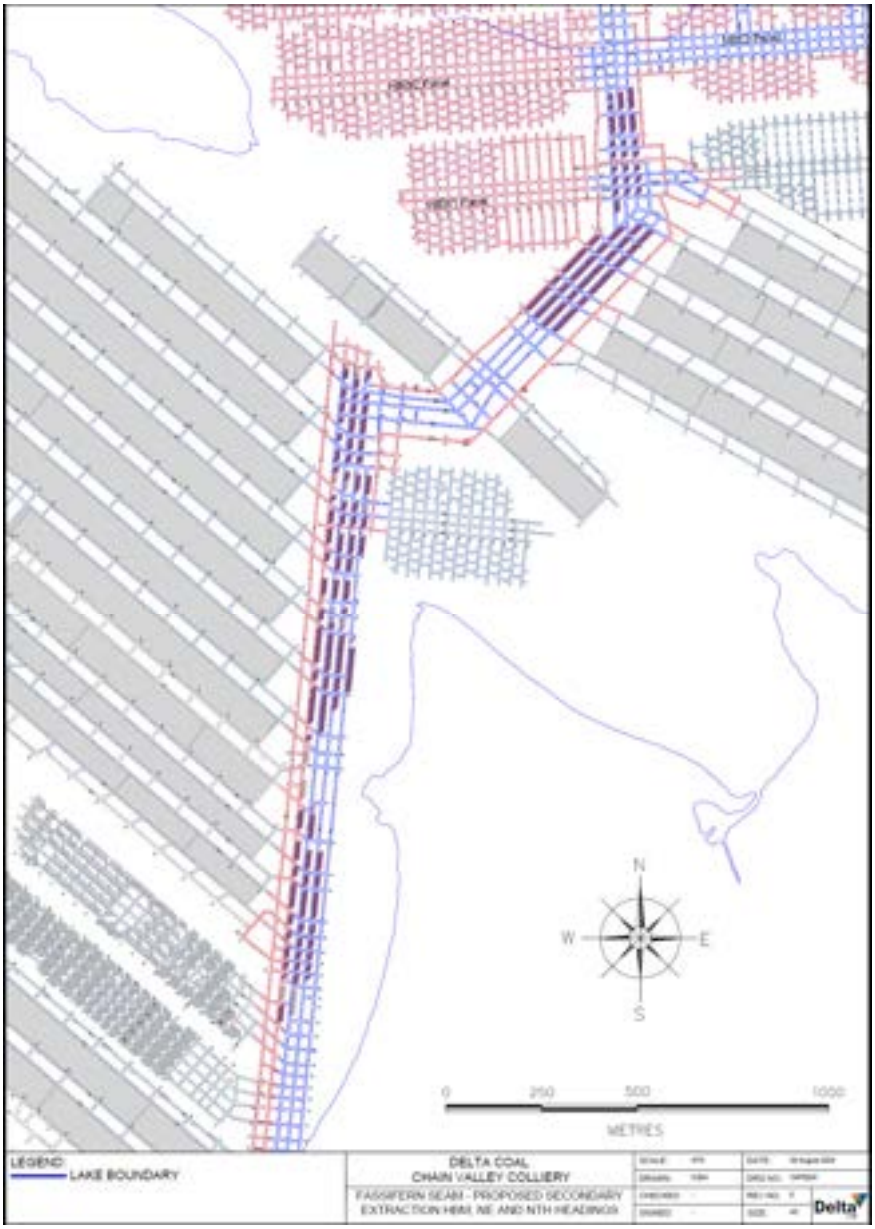


FIGURE 1.1. Plan Indicating Proposed Single-Sided Lifting (Mine Advice 2024a)

The mine site has now successfully undertaken single-sided lifting-off with two breaker-line supports (MRS's) in an inbye part of the mine (unrelated to the mining areas addressed in **Mine Advice 2024a**) and are now progressing to a trial of double-sided lifting using three MRS's in HBE1 Panel. Therefore,

this report contains a re-examination of the NE and North Main Headings for the use of double-sided lifting based on the same issues as were addressed in **Mine Advice 2024a**, the mine-site developed proposed lifting layout being shown in **Figure 1.2** noting that a single-sided lifting layout has been maintained in the HB Mains on the inbye side.

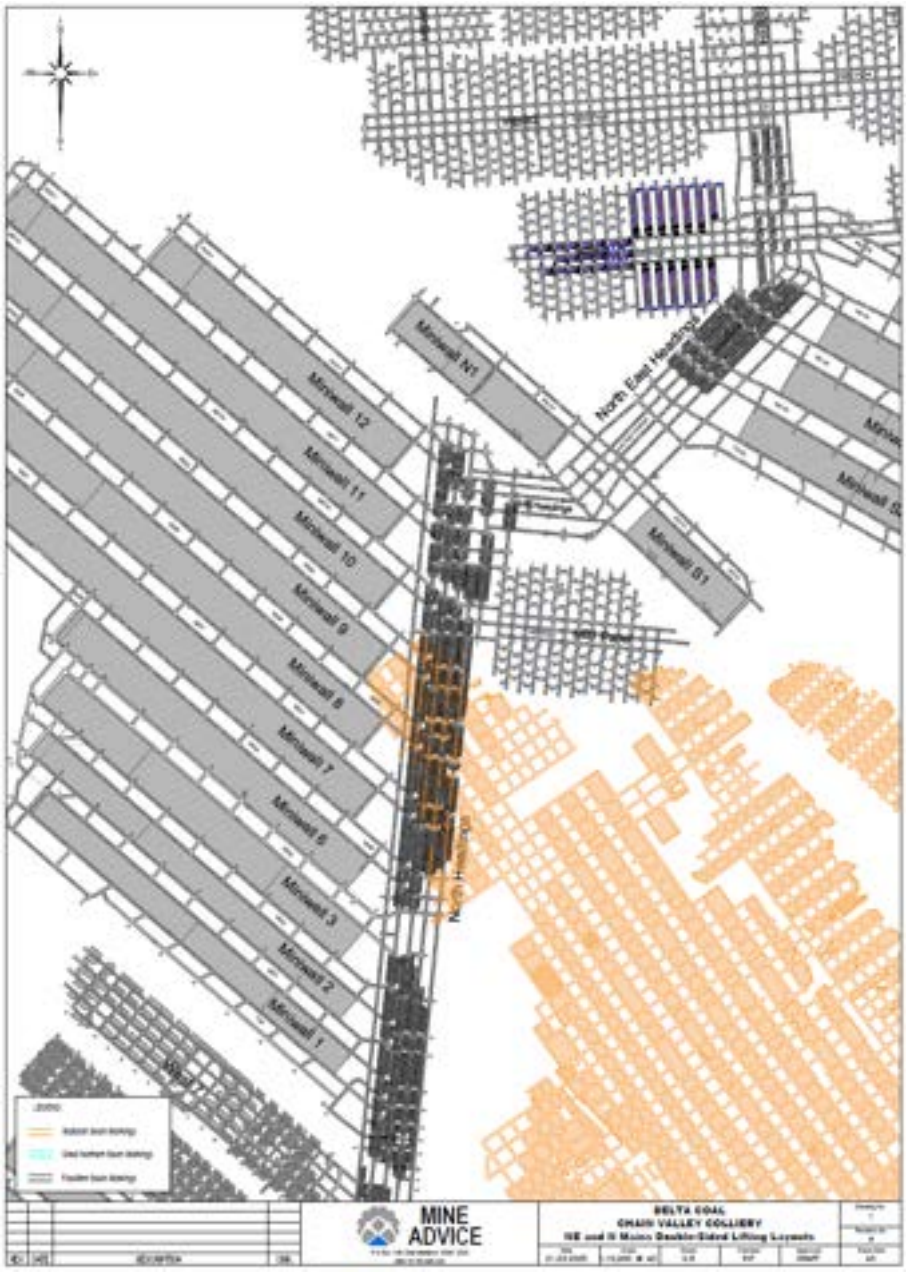


FIGURE 1.2. Mine Site Developed Double-Sided Lifting Layout, NE and North Headings

Without digressing into a detailed explanation, mining in this general area of Chain Valley is subjected to various restrictions that are intended to protect a range of surface infrastructure, landform and flora from the potential impacts of mining-induced subsidence (see **Figure 1.3**). The primary surface concerns in this area of the mine are:

(i) areas of sea grass in shallow water in close proximity to the high water mark, and

(ii) the high water mark itself,

with the proximity of secondary "*extraction*" beneath Lake Macquarie being controlled by Angles of Draw (AoD) of 26.5° and 35° respectively (see **Figure 1.3**).

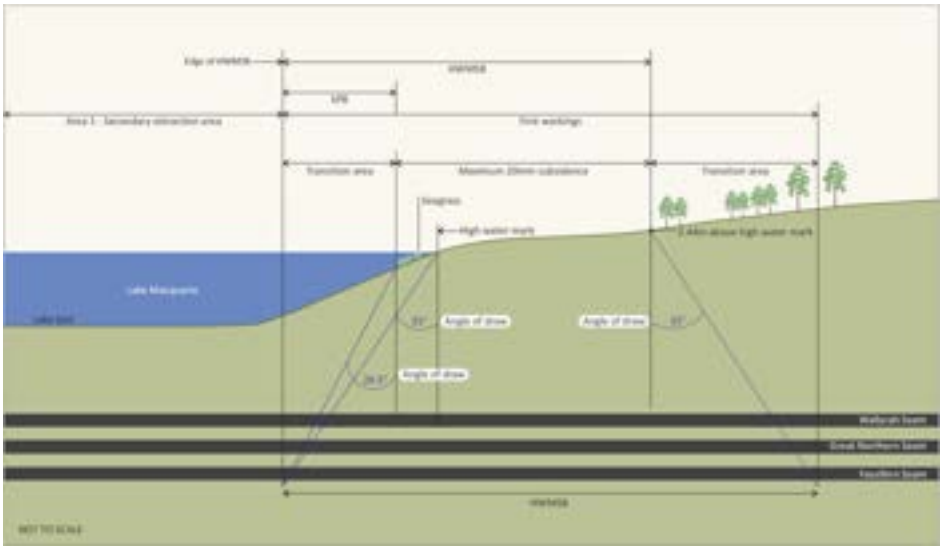


FIGURE 1.3. Current Prescribed Mining Limits in Proximity to the Lake Macquarie Foreshore

It is understood that maximum allowable subsidence at the lakebed above areas of secondary extraction is fixed at 780 mm, this presumably being to protect the mine workings from potential inundation from the lake via the development of mining-induced sub-vertical continuous fractures up from the working horizon through to the lakebed.

As per **Mine Advice 2024a**, the following matters need to be addressed in undertaking a comprehensive geotechnical assessment of the proposed secondary extraction:

- geological\geotechnical environment (including any potential influence of already extracted adjacent miniwalls – see **Figure 1.2**)
- coal pillar design – both prior to and post mining for completeness
- roof and rib support review for the proposed secondary extraction (specifically minimum requirements for implementation within a second workings TARP – to be developed by the mine)
- height of any mining-induced connective fracturing above the Fassifern Seam workings post-secondary extraction
- estimation of induced surface subsidence at the base of the overlying Lake Macquarie and any nearby shoreline areas (as are evident in **Figures 1.2** and **1.3**)
- potential subsidence impacts at:
    - the lakebed
    - areas of sea grass
    - the lake foreshore

  - minor cliffs
  - built features
- any monitoring requirements to confirm as-built vs as-designed system stability and behaviour

In addressing the above list, the following specific technical issues have been identified for detailed analysis:

- miniwall chain pillar stability in the context of outbye barrier pillar adequacy against the main headings where secondary extraction is being planned
- estimates of post-mining overburden "*settlement*", as opposed to "*subsidence*" within a subsidence "*trough*" as would be the case with full extraction over much broader areas (NB this includes any potentially adverse impact on overlying workings in either the Great Northern or Wallarah Seams that might otherwise further increase mining-induced surface subsidence due to the proposed secondary extraction in the underlying Fassifern Seam)
- pre-existing main headings pillar stability in the context of whether they are sufficiently stable to be reduced in dimension by second workings in the first instance
- on the basis that the proposed double-sided lifting layout shown in **Figure 1.2** is consistent with full extraction, the potential benefits of deliberately leaving remnant coal in place to assist in maintaining safe and manageable mining conditions during lifting-off operations
- design criteria for any remnant pillars that might be included in the lifting-layout to concert it from one of full to partial extraction
- estimates of maximum induced tilts, curvatures, and horizontal strains within the settlement footprint due to the proposed mining
- Angles of Draw (defined as the limit of 20 mm of measurable vertical subsidence) outside of the extracted coal footprint
- overburden fracturing estimates (if any) up from the coal seam into the overburden due to mining
- comments as to the impacts (if any) of mining-induced subsidence on the various listed features
- consideration of likely ground stress changes (both horizontally and vertically) due to the proposed secondary extraction, this being one of the necessary pre-cursors in considering the need or not for additional roof or rib support for secondary extraction purposes
- analysing roadway roof span changes in proximity to the area of lifting-off (where three MRS's will be in use) as part of determining whether secondary roof support is generally required to maintain roadway roof stability at acceptable levels during lifting-off or not
- an understanding of pre-existing roadway roof and rib stability in the planned lifting-off roadways, this having been assisted by the findings of a roadway roof stability review in the HBE3 area on the inbye side of this study area (**Mine Advice 2024b**). In addition, the study area was formally

inspected by the author on 20th September 2024 along with a review of mapping and/or monitoring results from same.

- safety-based operational implementation matters for mine site consideration – including safe work locations and monitoring for both on-going pillar system stability and/or roadway stability during lifting-off

In general terms, mine-layout geotechnical design needs to address up to four fundamental considerations as follows:

- safety
- reserve recovery
- rate/cost of production
- subsidence and associated impacts

In reality there is no mining strategy, either underground or open cut, that is able to safely recover all of the coal at low cost/high production rates with no subsidence-related impacts. Therefore, at least one of the listed considerations needs to be compromised to the benefit of the other three.

For this study, the salient question is the need to leave remnant coal in place to either (a) promote improved mining conditions for operational safety purposes, and/or (b) reliably maintaining levels of mining-induced subsidence to within prescribed maximum limits.

2.0 RELEVANT GEOTECHNICAL CHARACTERISATION

This section of the report contains details of assumed geological and/or geotechnical conditions of potential relevance to a pre-mining secondary extraction geotechnical assessment.

2.1 Cover Depth

Cover depth (uncorrected for the lower density of water in the lake as compared to that of fresh rock material) varies from 170 m at the inbye end of proposed secondary extraction in the NE Headings, to 200 m in the vicinity of 39 C/T in the North Headings, this being the outbye end of the secondary extraction area under consideration herein (see **Figure 1.2**).

2.2 Seam Thickness

The full Fassifern Seam thickness is in the order of 6 to 6.5 m however the nominal working section is only 3.2 m thick (to the top of the FC Ply - see **Figure 2.1**) with coal/stone bands left in place in the immediate roof and a sequence of coal/stone/claystone bands in the immediate floor below the development working section to the base of the coal seam. It is noted that in the area of interest, the Fassifern Seam is not subjected to roof or floor splits, hence a relatively consistent seam section is being assumed for assessment and design purposes.

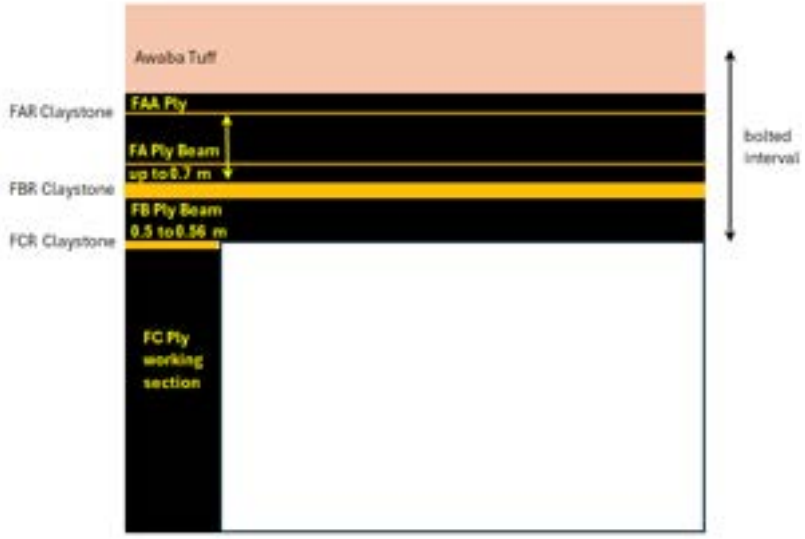


FIGURE 2.1. Idealised Roadway Roof Lithology and Working Section Summary

For coal pillar design purposes, the nominal roadway development height of 3.2 m will be taken as representing the coal pillar height unless known otherwise.

2.3 Significant Overburden Lithology

Whilst the geotechnical nature of the overburden is not typically a primary consideration for either first workings bord and pillar mining or partial extraction second workings (as in the case herein), in some instances the presence of thick, massive sandstone or conglomerate units can be of value if there is a need to justify mining panels being of "*sub-critical*" width for either subsidence control or operational safety reasons.

The general stratigraphic sequence above the Fassifern Seam to the base of the lakebed typically contains one or more massive conglomerate and/or sandstone units of varying thickness that historically have resulted in difficult caving conditions during full pillar extraction, particularly in the Great Northern Seam which is directly overlain in many areas by the Teralba Conglomerate. A general overburden lithological sequence above the Fassifern Seam to surface is shown in **Figure 2.2**

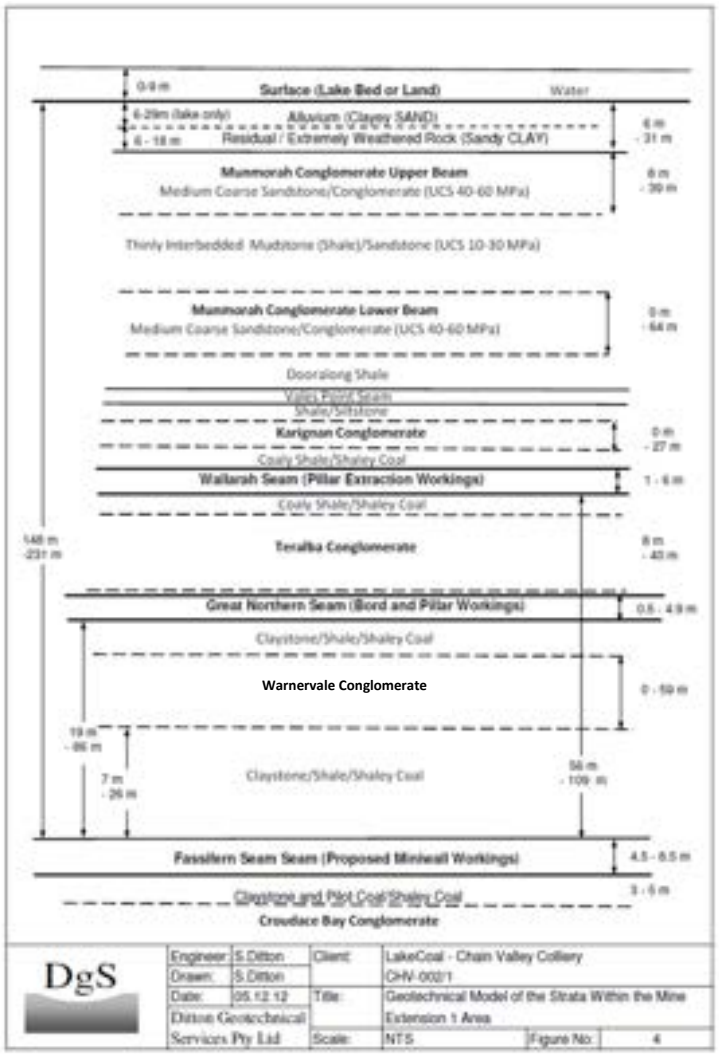


FIGURE 2.2. General Overburn Lithology and Naming Conventions (client-supplied)

Based on work conducted at mines adjacent to Chain Valley, it is found to be generally the case that when one massive conglomerate unit thins (as demonstrated by the thickness ranges for individual conglomerate units in **Figure 2.2**) another thickens up in the same vicinity.

Based on supplied thickness isopachs, the Teralba Conglomerate immediately above the Great Northern Seam has a minimum thickness in the order of 20 m and a maximum thickness in the order of 40 m within the study area. Conversely, the Karingal Conglomerate between the Fassifern and Great Northen Seams is either absent or not well developed within the study area.

2.4 Immediate Working Roof

In general terms, the immediate working roof consists of three coal plies (FB, FA and FAA) as shown in **Figure 2.1** with an exposure of these coal plies being shown in **Figure 2.3**.

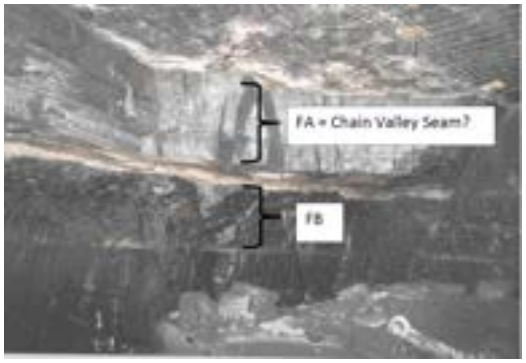


FIGURE 2.3. Immediate Roof Exposure Above the FC Ply

The significance of coal "*beams*" (as can be clearly identified in **Figure 2.3**) to both primary and secondary extraction roadway roof control (which was outlined in detail in **Mine Advice 2024b**) within the study area will be discussed in more detail later in the report.

2.5 Immediate Working Floor

Figure 2.4 contains Fassifern Seam roof, seam and floor sections from three boreholes relevant to the "*northern*" section of the mine (**BGS 2024**) proximate to the study area, with the intended normal roadway development section 3.2 m down from the base of the FCR Claystone being marked by red shading.

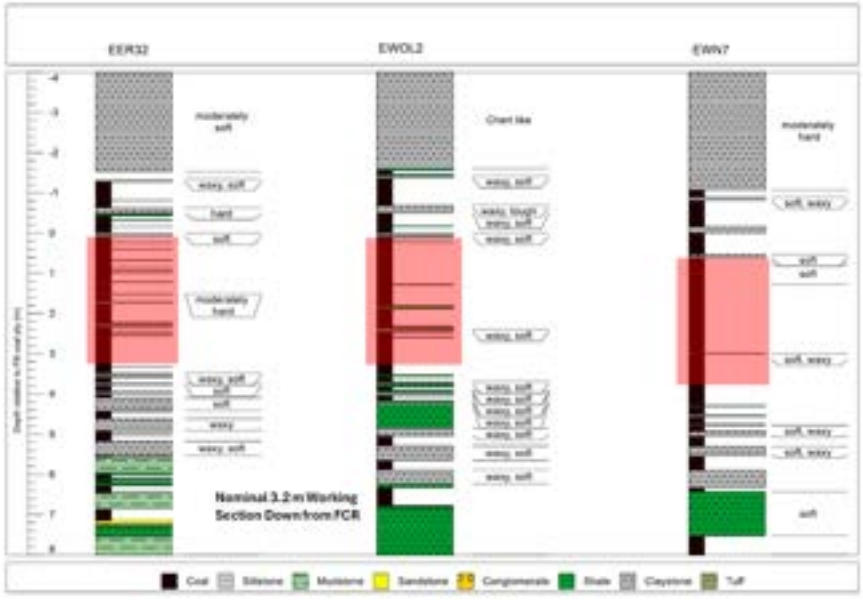


FIGURE 2.4. Various Seam Sections with Intended Development Working Section (sourced from BGS 2024)

The seam sections in **Figure 2.4** indicate that the initial 5 m of seam floor beneath the working section (and therefore beneath coal pillars as defined by the roadway development section) consists of varying thickness bands of coal (including the thin Upper and Lower Pilot Seams) and stone/clay materials underlain by a section of thicker shale/mudstones that are underlain by the Croudace Bay conglomerate, as per **Figure 2.2**.

2.6 Pre-Mining Horizontal Stresses

The likely magnitude and alignment of pre-mining horizontal stresses within the Chain Valley area were analysed in **Mine Advice 2024b** based on two *in situ* stress measurements taken in the North Headings at Chain Valley as reported by **Coffey Partners 2015**. These two measurements were taken in the roof the Fassifern Seam at a distance of at least 1.5 times the roadway width from the roadway excavation.

The back-analysis used a recently developed version of the **Nemcik *et al* 2005** *in situ* stress model as detailed in **Frith and Reed 2024,** and determined the two horizontal stress parameters that are directly linked to tectonic horizontal strain, namely:

- Tectonic Stress Factor for the major horizontal stress (TSF_H)
- Tectonic Stress Factor for the minor horizontal stress (TSF_h)

Source	TSF_H average (range)	Major to Minor Conversion Factor	TSF_h average (range)	Alignment of σ_H (GN)
Coffey Partners 2015	0.88 (0.82 to 0.93)	0.48 (0.4 to 0.56)	0.41 (0.35 to 0.46)	290°

TABLE 2.1. Summary of Tectonic Horizontal Stress Characteristics

Table 2.1 provides a summary of back-analysed values for TSF_H and TSF_h as well as the orientation of the major horizontal stress for references purposes.

2.7 Major Geological Structures

Mapped faults within the general Chain Valley/Mannering mine area are typically aligned either NW-SE or NNE-SSW based on supplied information or by reference to historical mine plans whereby the presence of operationally significant faults can be reasonably inferred from the shape and extent of the workings. The former is consistent with the orientation of the Newcastle Syncline, while the latter is consistent with the orientation of the Lochinvar Anticline, the Macquarie Syncline, the Offshore Uplift, and the long axis of the Newcastle Coafield more generally.

A review of mapped faults in nearby overlying Wallarah Seam workings confirms these general alignments and that many of the faults have displacements of 3 m and less. It is also the case that faults tend to be continuous along strike rather than being characterised by stepped/*en echelon* sections.

Ditton Geotechnical Services 2017 describe a normal fault with a 13 m displacement and a dip of 75°. **Lohe and Dean-Jones 1995** state that regional structures include NW and NE striking normal faults with throws typically in the range 0.5 m to 2 m. Low angle thrust faults may also be present on the NE strike.

In the context of this study, major geological faults are known to exist within the study area and represent a geotechnical hazard for two basic reasons:

(i) poor/potentially unstable local strata conditions during lifting-off if attempted in direct proximity to faults or within fault-affected conditions.

(iii) based on their orientation and characteristics, larger-scale faults can modify/reduce overburden stability above extraction panels thereby increasing the potential for elevated subsidence levels as compared to pre-mining predictions.

The potential impact of known faulting within the study area will be addressed later in the report.

2.8 Overlying Workings

The presence or absence of overlying workings in either the Great Northern and/or Wallarah Seams is of direct relevance to this study in the context of both (a) elevated levels of mining-induced subsidence as compared to that predicted for the Fassifern Seam workings only, and (b) whether the spanning ability of the overburden can credibly assist the on-going stability of remnant Fassifern Seam workings (to be discussed later in the report).

Figure 1.2 shows the general area of the Fassifern Seam workings plus the overlying Wallarah Seam workings (marked in orange) which consist of a localised area of relatively narrow extraction panels (in the order of 35 m wide) separated by chain pillars with a solid width in the order of 30 m based on supplied information. It is assumed that these workings were intentionally designed to limit surface subsidence impacts in and around the lake foreshore by (a) limiting overburden caving within extracted areas and (b) leaving stable chains pillars in place between extraction panels.

It is confirmed that there are no Great Northern Seam workings overlying the specific Fassifern Seam study area.

3.0 HAZARD IDENTIFICATION AND CONTROL

Geotechnical hazards associated with the proposed secondary extraction consist of safety, business and environmental risks, noting that safety and environmental risks represent business risks in broader terms. The various hazards also sub-divide into:

(i) global strata instability risks related to the panel layout including remnant pillars being inadequately stable during and/or after active mining, and

(ii) operational risks linked to ensuring effective strata control during mining, this being a combined function of both the installed ground support, tailoring the actual second workings layout to known geological conditions following first workings, and the enforcement of one or more operational controls, including pre-defined safe-standing zones.

Specific hazards directly linked to layout design and strata-control during operations are as follows:

1. Major pillar "*collapse*" (as opposed to a very gradual "*squeeze or creep*") either during or following active mining.

2. A sufficient reduction in local coal pillar stability or pillar system stability (i.e. including the floor) during active mining so that local roadway conditions (particularly roof and/or ribs) deteriorate as a direct consequence thereby increasing strata control safety hazards during active mining to unacceptable and/or unmanageable levels.

3. Uncontrolled roof falls in lifted-off areas during active mining with the potential to extend into areas where persons are required to be located (e.g. CM driver, cable-hand, shuttle car driver).

4. Generally changing local strata conditions in active roadways due to second workings and associated ground stress changes (horizontal and vertical).

5. Unacceptable surface and/or sub-surface mining-induced impacts.

This report specifically addresses the issue of large-scale panel and coal pillar stability both during and following the completion of second workings, as well as local strata control as related to the planned second workings and associated ground stress changes.

In terms of specific controls, it is a fundamental tenet of effective geotechnical design that if strata control "*problems*" develop during mining operations, they are "*manageable*" in the sense that:

- the onset of the problem can be identified early,
- the problem develops slowly over time, and
- the problem can be remediated safely or conversely the problem area can be abandoned well before persons are exposed to significantly elevated safety threats.

These three characteristics are the foundation of operational management plans and TARPS, both on development and as in the case of this report, during second workings.

4.0 ASSESSMENT OF SECOND WORKINGS "*ENGINEERED*" CONTROLS

Minimisation of safety risks during mining operations to acceptable levels is achieved within a Hierarchy of Controls approach via "*isolation*", "*engineering*" and "*administrative*" controls as per **Figure 4.1**, noting that "*elimination*" and "*substitution*" controls cannot be practically applied to operational strata control and "*PPE*" is insufficient other than for the prevention of minor injuries. In terms of mining-induced impacts, administrative controls cannot be relied upon due to the time delay between mining taking place and associated problems manifesting and being identified either on surface or sub-surface.



FIGURE 4.1. Generic Hierarchy of Controls Representation

As the highest control level under this system, "*isolation*" is a critical strata control safety control in operations, particularly in and around a continuous miner that is forming-up new excavations, either as part of first or second workings. In particular this relates to (a) delineating safe work locations during active mining and (b) the integrity of roof/rib mesh (where present) in controlling small-scale roof/rib instability as may occur from time to time. In terms of mining-induced impacts, isolation can be readily applied as is clearly evident in **Figure 1.3** using limiting Angles of Draw.

"*Engineering*" controls include those that need to be analysed and assessed prior to mining including changing coal pillar stability and floor stability during the mining process. Roof and rib stability including the adequacy of installed roof and rib support is finalised once a production panel is fully driven so that actual vs predicted strata conditions can be objectively and meaningfully assessed, including the decision as to whether all planned lifting sequences (see **Figure 1.2**) can be safely mined according to local strata conditions. Therefore, whilst being generically an "*administrative*" control, there is nonetheless a requirement for "*engineering*" review during a second workings/extraction pre-mining review, all of which is already established in mining operations at Chain Valley.

"*Administrative*" controls are pre-dominantly workforce-based and include (a) delineating and adhering to safe work locations during active mining, (b) forming up second workings in the specified location to the specified maximum or indeed minimum dimensions, and (c) being aware of changing strata conditions both before and during active mining in order to effectively apply a Second Workings TARP (already developed by the mine – as TARP 00140) and/or make-safe as necessary, barring down potentially loose, unstable material being an example.

This section of the report directly addresses relevant "*engineering*" controls for the proposed secondary extraction, with the subsequent section providing commentary on the operational control of strata control risks both during and after the completion of second workings.

4.1 Identification of Different Study Zones

A review of the study area immediately requires that it be sub-divided into two separate "*zones*", primarily according to proximity to the lake foreshore (see **Figure 4.2**).

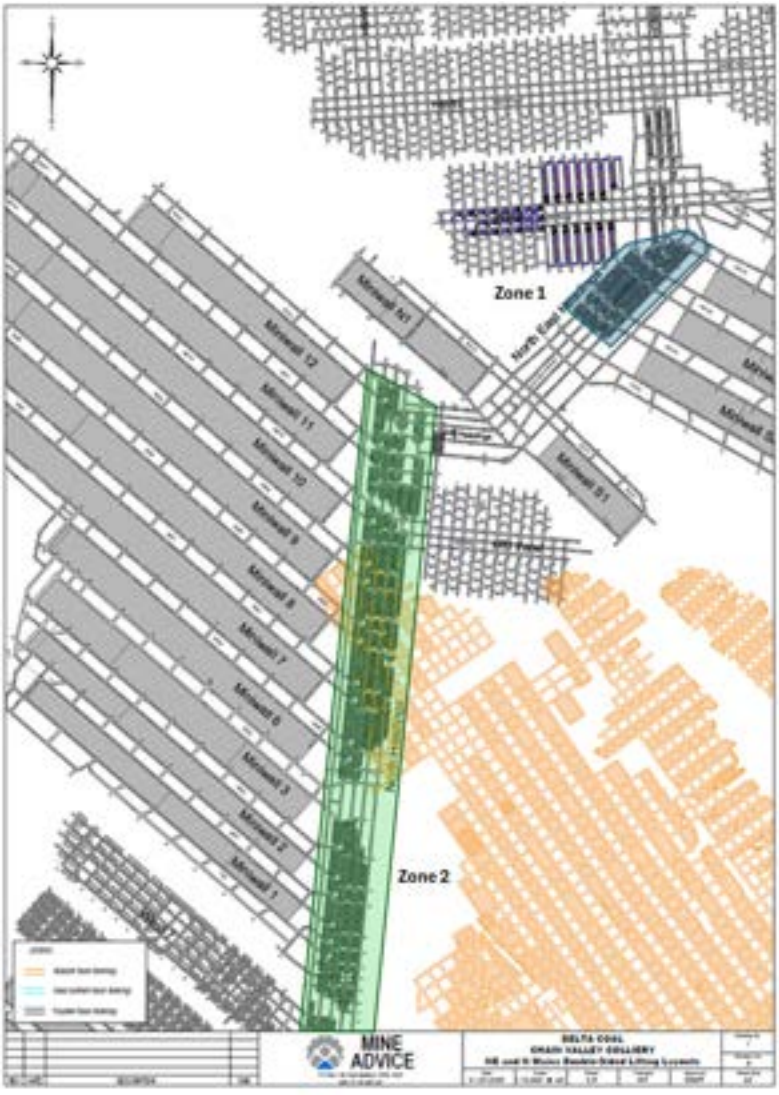


FIGURE 4.2. Zoning of Study Area

The two study zones are described as follows:

Zone 1 (NE Headings): no proximity to the lake foreshore – maximum cover depth of 170 m and no overlying workings.

Zone 2 (North Headings): proximity to the lake foreshore to the east – maximum cover depth of 200 m and one localised area with overlying Wallarah Seam workings as marked in **Figure 4.2**.

To meet the objectives of the study and potentially optimise mining layouts by maximising coal recovery, it is necessary to analyse the study area according to this proposed zoning sub-division.

4.2 General Design Process

The design process used for single-sided lifting-off through these same areas (**Mine Advice 2024a**) was to (a) evaluate remnant pillar stability both during and after the completion of second workings, followed by (b) estimating credible maximum levels of subsidence at the lakebed for compliance with the allowable maximum value of 780 mm. This process was used as the single-sided lifting layout supplied by the mine included discernible remnant pillars being left in place as can be seen in **Figure 1.1**.

The double-sided lifting layout in **Figure 1.2** contains almost no remnant pillars post the completion of second workings to the extent that it is fully consistent with a total extraction rather than partial extraction layout, which have fundamentally different risk profiles in terms of both operational safety and levels of induced subsidence. Therefore, a different design approach is being adopted herein, namely:

(i) estimate subsidence levels for the supplied double-sided lifting layout in **Figure 1.2**, this representing a worse-case scenario in terms of subsidence and related parameter magnitudes. The results of this will provide guidance as to whether remnant pillars need to be left in place for subsidence control reasons or not.

(ii) determine whether it is prudent in terms of operational safety during lifting-off to deliberately leave one or more remnant pillars in place or not? If so, what is the function of remnant pillars and any associated engineering design requirements.

(iii) to re-evaluate predicted levels of surface subsidence via the inclusion of any remnant pillars that are deemed necessary from either (i) or (ii).

Each of these will now be outlined in detail along with the corresponding findings.

4.3 Potential Impact of Panel Width:Depth (W/H) Ratio

For both surface subsidence prediction and estimating mining conditions during lifting-off, the impact of panel width to depth (W/H) ratio is fundamental, specifically whether any benefit is gained from the panel being sub-critical. A sub-critical panel will result in reduced levels of surface subsidence as compared to a super-critical panel, and similarly a sub-critical panel reduces pillar loading within the panel by causing some portion of the super-incumbent overburden load to be transferred to surrounding coal abutments rather than reporting to in-panel pillars both during and following second workings.

In general terms it is well established in the published literature that the stiffness of the overburden needs to be suitably low for coal pillars to be rapidly driven to a state of full collapse if they become over-loaded. An instructive way to address overburden stiffness is to use the established concepts of "*sub-critical*", "*critical transition*" and "*super-critical*" surface subsidence as illustrated in **Figure 4.3** with actual subsidence data being provided in **Figure 4.4**, this representation being known colloquially as a "*Holla*" curve after the late Lax Holla.

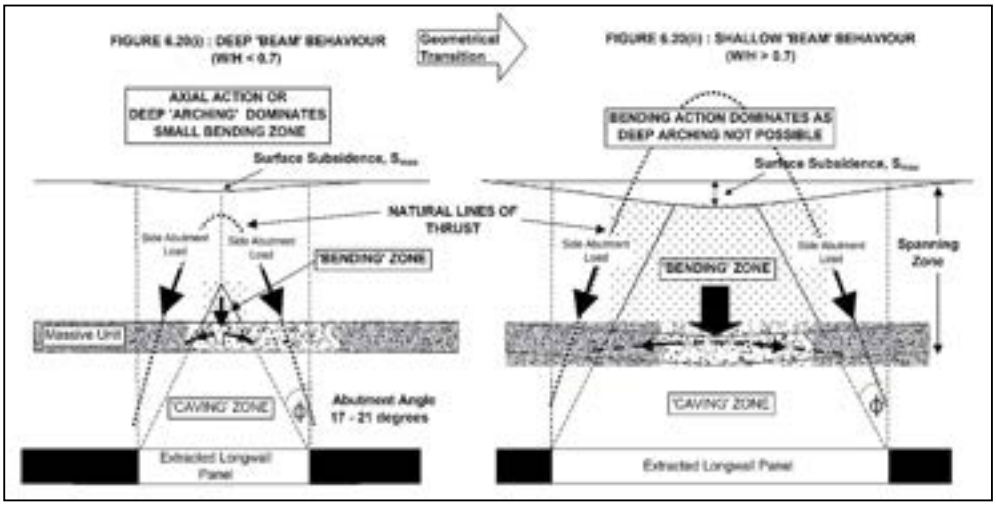


FIGURE 4.3. Schematic Representation of the Mechanics of Sub-Critical ("Deep" Beam) and Super-Critical ("Shallow" Beam) Subsidence Behaviour (Ditton and Frith 2003)

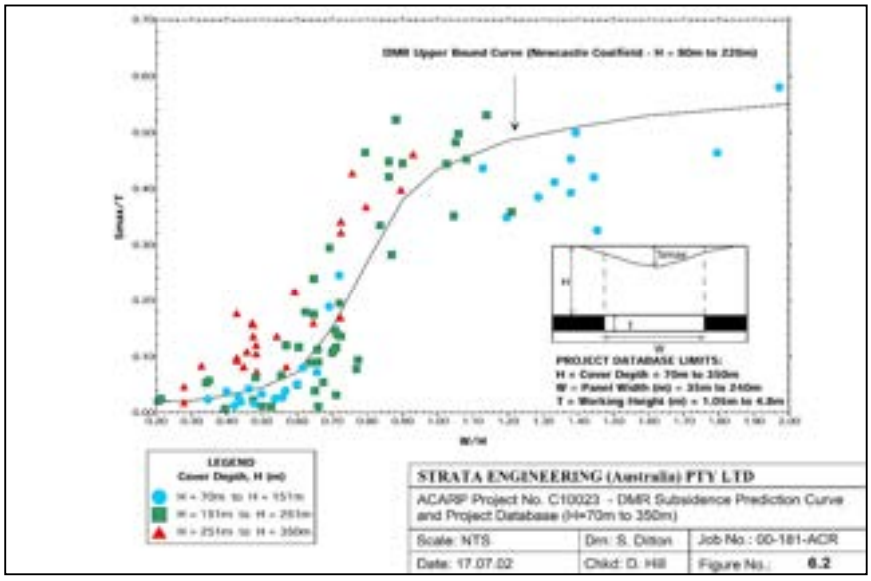


FIGURE 4.4. Measured S_{max} Values Analysed According to Extraction Height (T), Panel Width (W) and Cover Depth (H) (Ditton and Frith 2003)

The objective herein is to demonstrate that it is only in the super-critical panel range whereby the entire overburden to surface loses most (if not all) of its inherent stiffness and stability so that it effectively then behaves as a "*detached*" or "*kinematically unstable*" loading block (with no inherent stiffness) such that over-loaded coal pillars can hypothetically be driven to a state of full collapse.

Conversely, in the sub-critical range at least a portion of the upper overburden is being controlled by either the excavation geometry as a function of cover depth and/or the spanning capabilities of massive strata units. By definition this must retain a level of stiffness within part of the overburden on the basis that its natural settlement at surface under self-weight is being substantially restricted as compared to super-critical panel conditions whereby full collapse to surface can occur.

Case history	State	Depth, m (ft)	Pillar size, m (ft)	ARMPS SF	w/h ratio	Collapsed area, ha (acres)	Collapse size, m (ft)	Damage from airblast
A	WV	84 (275)	3 by 12 (10 by 40)	0.86	1.05	2.3 (5.7)	150 by 150 (500 by 500)	28 stoppings, 1 injury.
B1	WV	73 (240)	3 by 12 (10 by 40)	0.96	1.00	--	--	32 stoppings, fan wall out.
			3 by 18 (10 by 60)	1.10	1.00			
B2	WV	75 (245)	3 by 12 (10 by 40)	0.94	1.00	1.7 (4.1)	100 by 150 (350 by 500)	40 stoppings.
B3	WV	85 (280)	9 by 9 (30 by 30)	1.46	3.00	2.8 (6.8)	180 by 180 (600 by 600)	70 stoppings.
			6 by 12 (20 by 40)	1.47	2.00			
C1	WV	60 (195)	3 by 12 (10 by 40)	1.19	1.00	2.1 (5.2)	140 by 150 (450 by 500)	123 stoppings.
C2	WV	99 (325)	9 by 9 (30 by 30)	1.15	3.00	1.9 (4.6)	100 by 180 (350 by 600)	Minimal.
D	WV	69 (225)	6 by 6 (20 by 20)	1.15	1.82	1.7 (4.3)	100 by 160 (350 by 540)	37 stoppings.
			9 by 9 (30 by 30)	1.42	2.73			
E1	WV	91 (300)	3 by 12 (10 by 40)	0.79	1.42	7.4 (18.2)	240 by 290 (800 by 950)	Major damage.
E2	WV	91 (300)	3 by 12 (10 by 40)	0.71	1.11	6.7 (16.6)	220 by 275 (720 by 900)	Major damage.
F	OH	76 (250)	2 by 12 (7 by 39)	0.68	2.12	2.0 (4.9)	90 by 215 (300 by 700)	Minimal.
G	UT	168 (550)	12 by 12 (40 by 40)	0.95	2.29	7.9 (19.4)	150 by 490 (480 by 1,620)	Major damage, 1 injury
O	WV	--	--	1.03	2.50	1.8 (4.5)	120 by 150 (400 by 500)	--
R	CO	120 (400)	4 by 24 (12 by 80)	0.97	1.71	2.8 (6.8)	180 by 150 (600 by 500)	Minor damage.

NOTE.—Dash indicates no data available.

TABLE 4.1. Massive Pillar Collapses in US Coal Mines (Mark *et al* 1997)

Evidence for the controlling influence of panel W/H ratio on coal pillar system failures can be found in **Table 4.1** and also the un-published results of a study into pillar failures in Australian highwall mining involving large numbers of coal pillars with very low w/h ratios. The US failed cases in **Table 4.1** all have W/H ratio values > 0.9 but typically > 1.5, which fully mirrors the unpublished highwall mining collapsed cases being exclusively associated with W/H ratio values > 0.9. It is noted that failed cases information published by the University of New South Wales (UNSW) are insufficiently detailed to allow this same analysis.

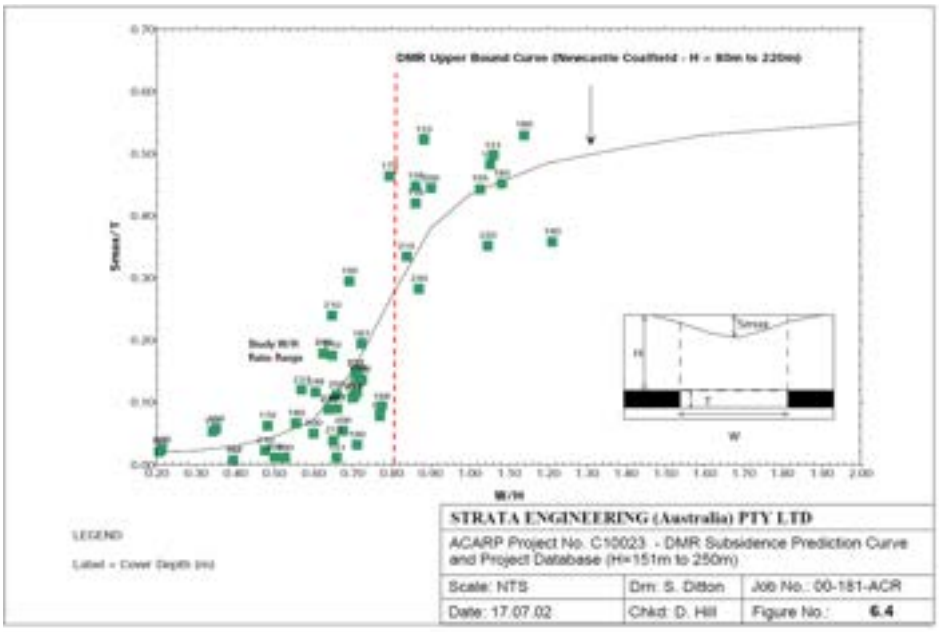


FIGURE 4.5. Measured S_{max} Values Analysed According to Extraction Height (T), Panel Width (W) and Cover Depth (H) for Depths Ranging from 151 m to 250 m (Ditton and Frith 2003)

The significance of a W/H value in the order of ≥ 0.9 is self-evident in **Figure 4.5** which contains measured surface subsidence data (S_{max}) above miniwall and longwall panels for cover depths in the range 151 m to 250 m in the Newcastle Coalfield. The red dotted line represents the approximate "*mid-point*" of the "*critical transition*" whereby values of W/H > 0.8 tend towards super-critical spans and values < 0.8 tend towards sub-critical spans solely on a panel geometry basis.

A minimum W/H value of 0.9 has been found in two separate studies on two different continents as being the lower limiting value for collapsed pillar cases. This strongly confirms (a) the important role of super-critical overburden behaviour and hence low overburden stiffness to surface in actual pillar collapses, and just as importantly (b) the potential additional stabilising influence of W/H values < 0.9 if coal pillars have been otherwise evaluated under full tributary area loading but are inadequate in terms of their as-designed stability.

Following on from the description of the influence of panel W/H ratio on overburden stiffness to surface according to different surface subsidence conditions, the influence of lithology on overburden stiffness for a given panel width can also be considered.

Two fundamental studies will be referred to in this regard, one relating to the influence of thick near-seam massive strata units on overburden periodic weighting and caveability as it directly impacts longwall face stability (**Frith and McKavanagh 2000**), the other related to the ability of massive strata units to influence surface subsidence magnitudes (**Ditton and Frith 2003**).

Without digressing into significant technical detail, the periodic weighting classification developed by **Frith and McKavanagh 2000** (see **Figure 4.6**) provides a useful first approximation as to how a massive strata unit may behave (i.e. collapse or span an opening) across an unsupported span based on its thickness, the panel width and its material type (specifically conglomerate or sandstone). The defined *"bridging shortwall"* outcome is likely to result in spanning of the unit and therefore, an inevitable reduction in surface subsidence due to overburden sag, from which the retention of significant overburden stiffness can be inferred.

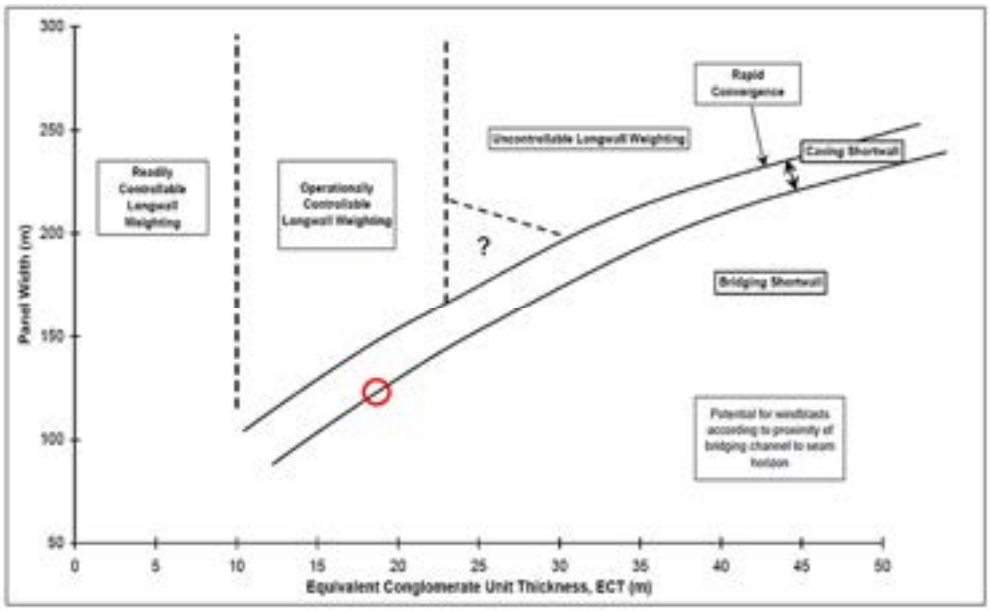


FIGURE 4.6. Periodic Weighting Classification (Frith and McKavanagh 2000)

The potential spanning ability of thick and massive strata units within the overburden was also recognised and defined by **Ditton and Frith 2003** in relation to the ability of certain strata units to reduce levels of surface subsidence over and above what W/H ratio considerations alone would suggest. **Figure 4.7** is provided as a reference source relating to what is termed as *"Subsidence Reduction Potential"* (or SRP).

As an example, for a panel width of 120 m the strata unit thickness above which spanning of that unit can be reasonably inferred is just under 20 m (marked as red circles in **Figures 4.6** and **4.7**). In other words, two different classification schemes developed to address different mining problems show a very close correlation in terms of the onset of strata unit spanning across an extraction panel of a known width.

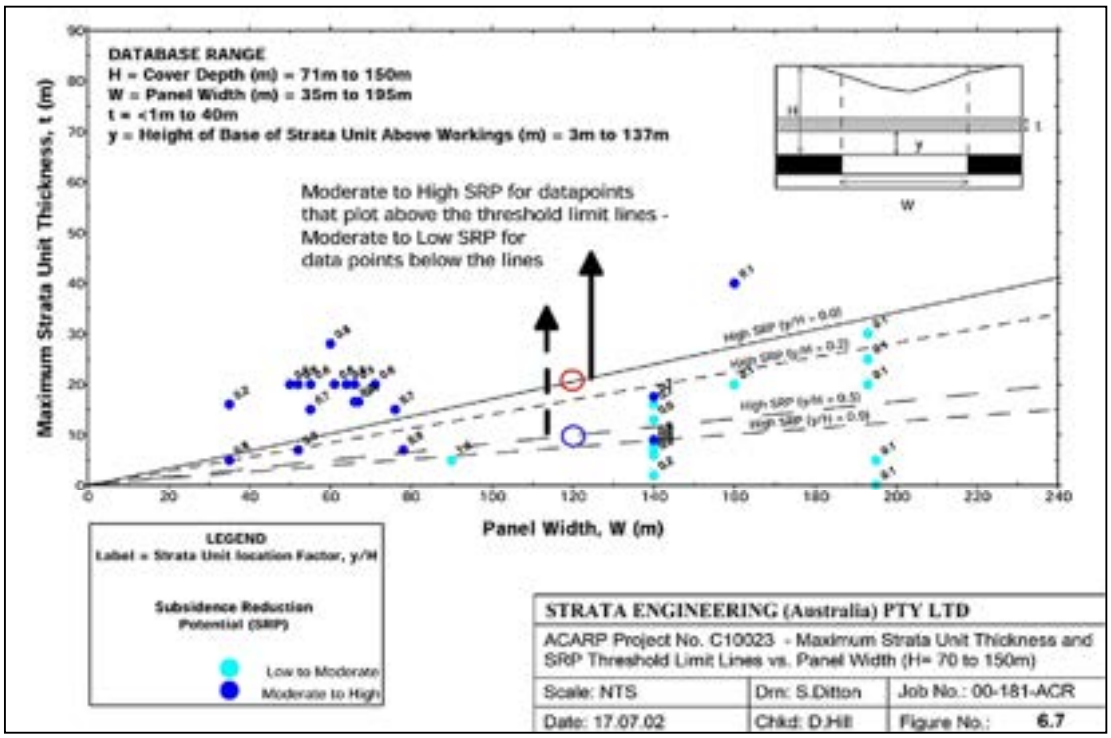


FIGURE 4.7. Subsidence Reduction Potential (SRP) According to Strata Unit Thickness, Location of Strata Unit above the Seam and Panel Width (Ditton and Frith 2003)

Figure 4.7 allows subsidence analysis to be taken a stage further as it brings in the varying location of a thick massive unit within the overburden, the higher the unit above the extraction horizon (as given by y/h in **Figure 4.7**), the lower the unit thickness required to develop "*high*" SRP. This makes sense when natural arching and consequent narrowing of the span above an extraction panel due to caving is considered (refer **Figure 4.3** for an illustration of this concept).

At a distance of half the cover depth above the extraction horizon (i.e. y/h = 0.5 as marked by a blue circle in **Figure 4.7**), the unit thickness required to modify surface subsidence across a 120 m wide panel is only 50% of that required when the unit is present in the immediate roof where y/h = 0).

With knowledge of the W/H ratio of a proposed panel of pillars combined with the thickness and location of any significant lithological units within the overburden, credible predictions can be made as to whether coal pillars will be loaded under full tributary area loading by a "*soft*" loading system (as is commonly assumed in pillar design), or conversely whether a portion of the overburden has the ability to re-distribute some level of load to adjacent barrier pillars or solid coal due to its inherent stiffness and retained stability. This is a very valuable panel layout aspect to bring into both the surface subsidence and also pillar stability assessment process.

4.4 Mining-Induced Subsidence and Associated Impacts (Supplied Lifting-Off Layout)

In order to reliably predict credible worse-case mining-induced subsidence scenarios and hence the need or not for additional remnant coal pillars to be left in place as compared to the lifting layout in **Figure 1.2**, it will be assumed for the sake of this analysis that the lifted area contains no remnant coal and hence is comparable to a miniwall or longwall panel whereby the overburden is free to move and collapse without any stabilising impact of remnant pillars.

The subsidence prediction methodology that has been applied is as follows:

(i) determine credible worst-case S_{max} based on panel W/H, assumed high SRP (justification being provided in **Section 4.5.2.2**), and t = nominal development height of 3.2 m (**Figure 4.8**)

(ii) determine credible worst-case S_{rib} (i.e. measured surface subsidence directly above the extraction panel ribline) based on S_{max} from (i) and panel W/H (**Figure 4.9**)

(iii) determine credible worst-case Angles of Draw based on S_{rib} (**Figure 4.10**)

Relevant subsidence predictions using this approach are contained in **Table 4.2**.

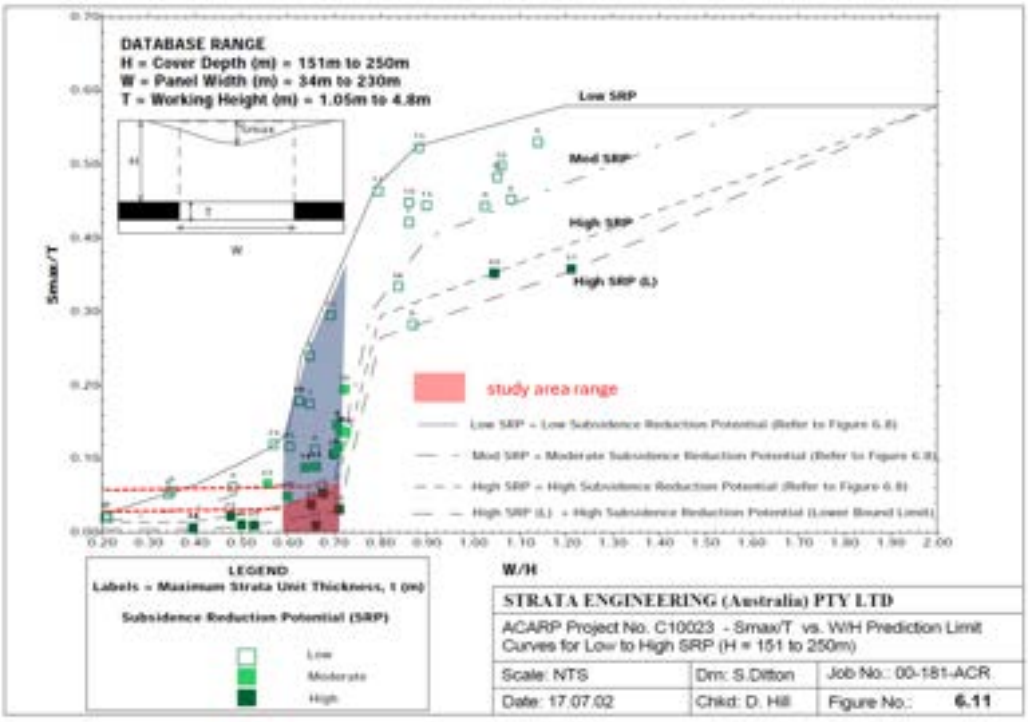


FIGURE 4.8. S_{max} Prediction Curves for Varying SRP and W/H for Cover Depths 151 m to 250 m (Ditton and Frith 2003)

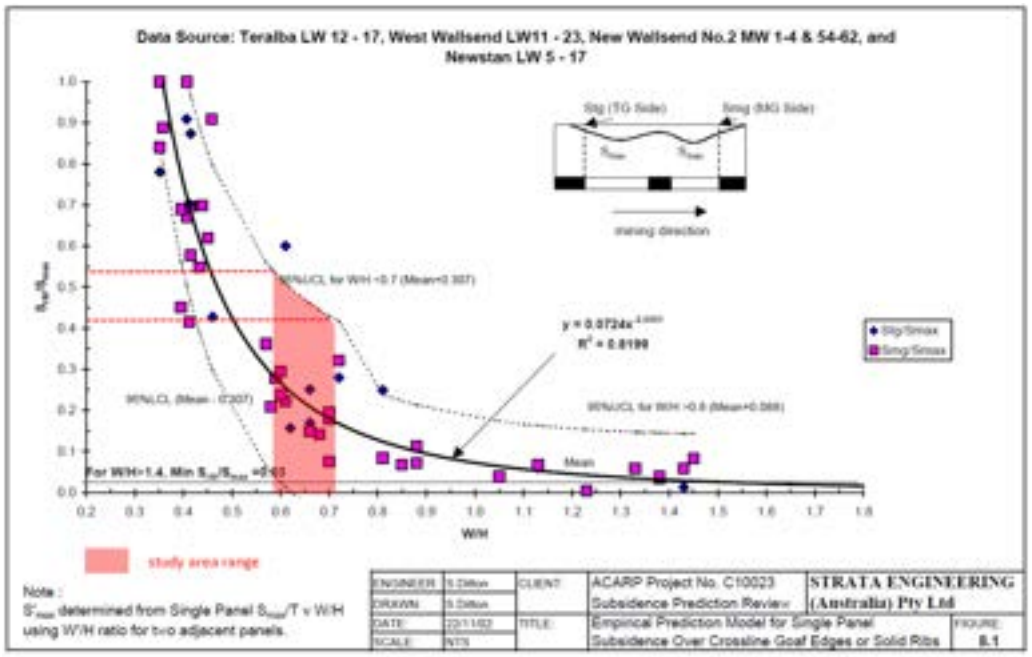


FIGURE 4.9. S_{rib} Prediction Curves as a Function of Panel W/H and S_{max} (Ditton and Frith 2003)

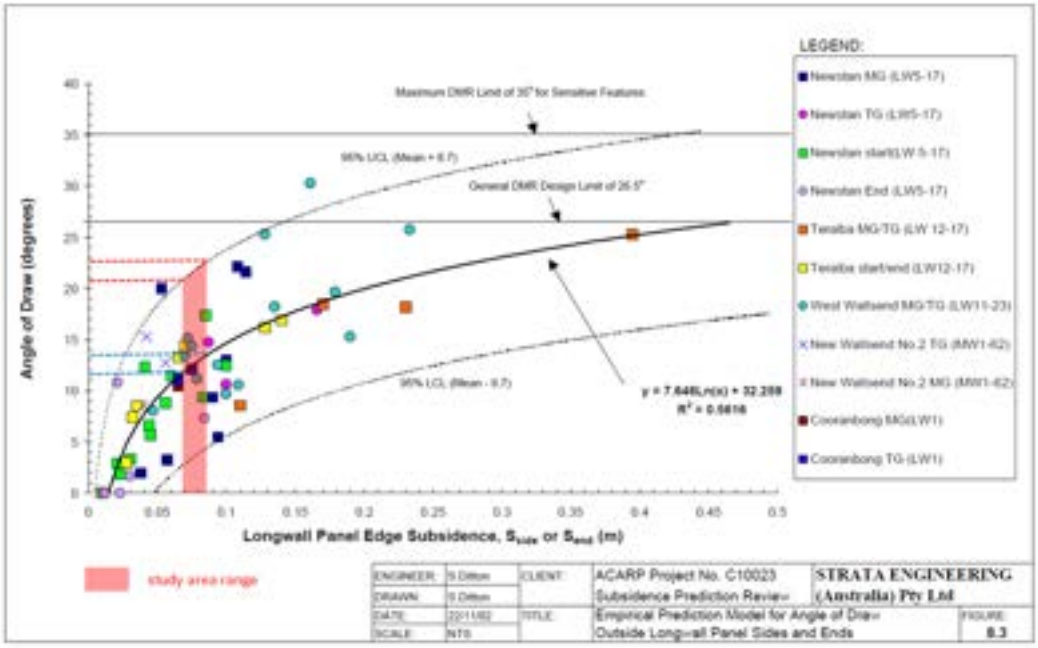


FIGURE 4.10. Measured Angle of Draw as a Function of S_{side} or S_{end}: S_{rib} in this case (Ditton and Frith 2003)

	Cover Depth (m)	Panel Width (m)	W/H Ratio (to base of lake)	S_{max} (mm) Figure 4.8	S_{rib} (mm) Figure 4.9	Angle of Draw (°) Likely/Worst-Case Figure 4.10
Zone 1 (4 rows)	170	118	0.69	192	87	14/23
Zone 2 (4 rows)	200	118	0.59	128	70	12/21
Zone 2 (5 rows)	200	142	0.71	192	87	14/23

Table 4.2. Summary of W/H and Relevant Mining-Induced Subsidence Parameters (Supplied Lifting-Off Layout in Figure 1.2)

Based on the mining-induced subsidence assessment assuming no remnant pillars and high SRP, the following conclusions are drawn:

- predicted values of S_{max} are < 200 mm which is substantially below the allowable maximum of 780 mm.
- Angles of Draw outside areas of secondary extraction are predicted to be < 23° in all cases, thereby ensuring that mining-induced subsidence > 20 mm does not extend to either the areas of seagrass (protected by a 26.5° AoD) or the foreshore high watermark (protected by a 35° AoD).
- predicted tilts, curvatures and horizontal strains outside of Angle of Draw are inevitably imperceptible with no credible damage potential to local surface or sub-surface features.

It is concluded that at face value the proposed double-sided lifting layouts as contained in **Figure 1.2**, maintain surface subsidence levels at the lakebed to well within the prescribed maximum limits, and will not cause adverse surface mining-induced impacts.

However, also shown in **Figure 4.8** via the blue shaded area is the change in S_{max} should high SRP be lost via instability and the subsequent collapse of the Teralba Conglomerate, the resultant S_{max} values potentially being > 780 mm. Any substantial overburden caving above or including the Teralba Conglomerate might also substantially de-stabilise the overlying standing Wallarah Seam workings which would likely add further to overall subsidence levels.

The question therefore is whether it is prudent to solely rely on the spanning of the Teralba Conglomerate post-secondary extraction and high SRP or not in maintaining mining-induced subsidence and associated sub-surface impacts below the regulated maximum limits? As will become apparent in the next section of the report, workplace safety considerations during lifting-off dictate that a central spine pillar should be left in place, which will have the additional benefit of substantially reducing if not eliminating any reliance on the spanning of one or more conglomerate units in order to maintain mining-induced subsidence levels below 780 mm.

4.5 Operational Safety During Lifting-Off and the Need for Remnant Pillars

Operational considerations that must be adequately accounted for in the pre-mining panel layout design and assessment process include:

1. First workings pillar system stability needs to be sufficient to allow pillar reduction during second workings to be undertaken in the first instance (NB this requirement is not as significant for partial extraction as compared to full pillar extraction whereby coal pillars at the goaf edge are likely to be subjected to substantial vertical abutment stress effects during second workings – as discussed in detail by **Galvin 2016**).

2. Safety is paramount (particularly during second workings when coal pillars are being substantially reduced in size), in particular minimising if not eliminating the potential for the following safety threats via fit-for-purpose panel layout designs:

    - windblasts due to large-area plate-like roof falls
    - highly stressed roof, rib, and/or floor conditions during second workings that might lead to elevated strata instability and injury potential in the active working area
    - persons being exposed to goaf falls/flushing into active mine workings during second workings.

    The primary objective of effective panel layout design is to ensure that any unplanned or unexpected mining conditions manifest slowly over time so that they can be identified early and responded to during operations via an operational TARP before any associated safety threats become significant. This is the fundamental principle behind the effective use of safety management plans in operations, as compared to incidents that occur with little or no warning so that appropriate actions cannot be taken in a safe and timely manner.

3. Remnant layouts are consistent with maintaining mining-induced surface and sub-surface impacts at either tolerable or regulated allowable levels (as already determined in **Section 4.4**).

The general engineering design process that has been applied to support any conclusion that the proposed secondary extraction meets all operational risk-based criteria, is as follows:

1. Coal pillar system stability and associated mode of pillar/pillar system deterioration (however unlikely) needs to be suitable for both (a) first workings development on the advance and (b) planned secondary extraction on the retreat.

2. The potential for pillar punching into underlying low strength floor measures, either during or following the completion of secondary extraction, is defined and its potential significance to operations and/or surface subsidence has been fully considered.

3. Quantify any additional stability benefits of panel dimensions between either barrier pillars (inside or outside of the panel) and/or solid coal around the panel in terms of the potential for sub-critical overburden behaviour.

Each of these panel layout considerations will now be discussed and justified in detail for the two study zones as defined in **Figure 4.2** and described previously.

4.5.1 Existing First Workings Pillars

The first coal pillar design consideration is stability during first workings and the extent to which coal pillars are suitably stable to permit some form of second workings. For this, two independent pillar design criteria have been applied, namely:

(i) Factor of Safety and associated Probability of Failure under the UNSW Pillar Design Procedure (UNSW PDP), in combination with

(ii) width to height ratio (w/h), which has a controlling influence on the mode/rate of post-peak pillar deterioration and is fundamental to maximising operational safety within the workings. In particular, w/h ratio is the dominant control as to whether pillars are prone to rapid and sudden structural collapse (w/h < 2 typically), or conversely slowly "*squeeze*" over time as the pillar work-hardens post its designated peak strength (w/h > 4) – see **Figures 4.11** and **4.12**.

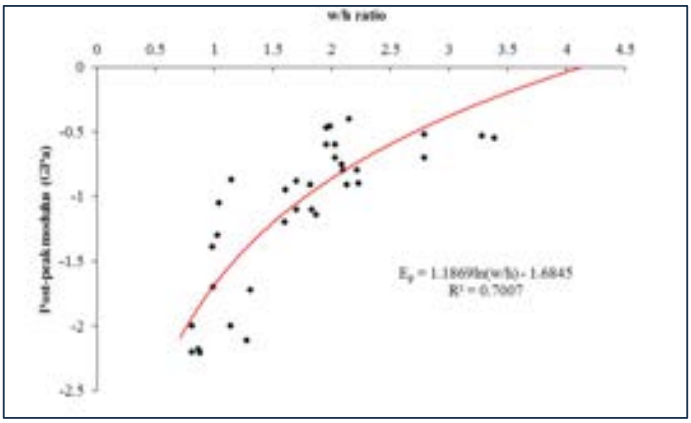


FIGURE 4.11. Relationship Between the Post-Peak Modulus and w/h Ratio of Pillars Based on Field Tests (Vardar *et al* 2017)

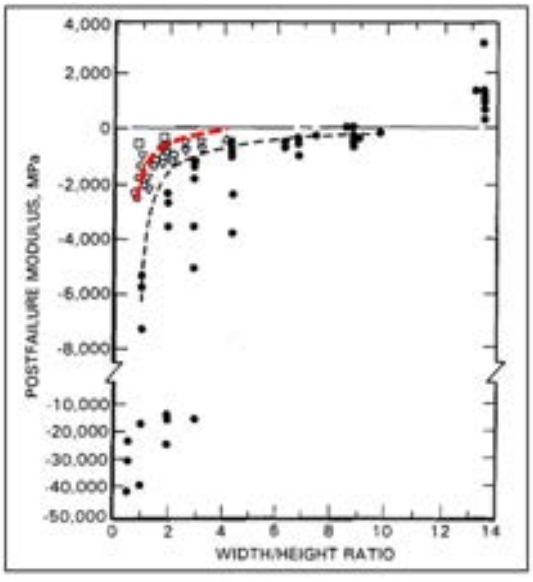


FIGURE 4.12. Post-Failure Stiffness of Coal Pillars as a Function of Width to Height (w/h) Ratio (Chase *et al* 1994) – NB open symbols represent *in situ* tests (Reed *et al* 2016)

The manifestation of a pillar stability assessment using both FoS and w/h is shown in **Figure 4.13**, noting that this general approach to the design of long-term stable coal pillars has been successfully applied at the Ensham Mine in QLD as an example, whereby minimum remnant pillar FoS values as low as 1.6 are deemed permissible in their EA approval conditions in areas with no major surface constraints.

A more detailed discussion of the significance and benefits of combining pillar FoS and w/h ratio for pillar design purposes is contained in **Reed *et al* 2016**, which also brings the condition and stability of the overburden between "*barrier*" pillars via the width to depth (W/H) ratio of the panel into the pillar design process, which is relevant herein as will be detailed later in the report.

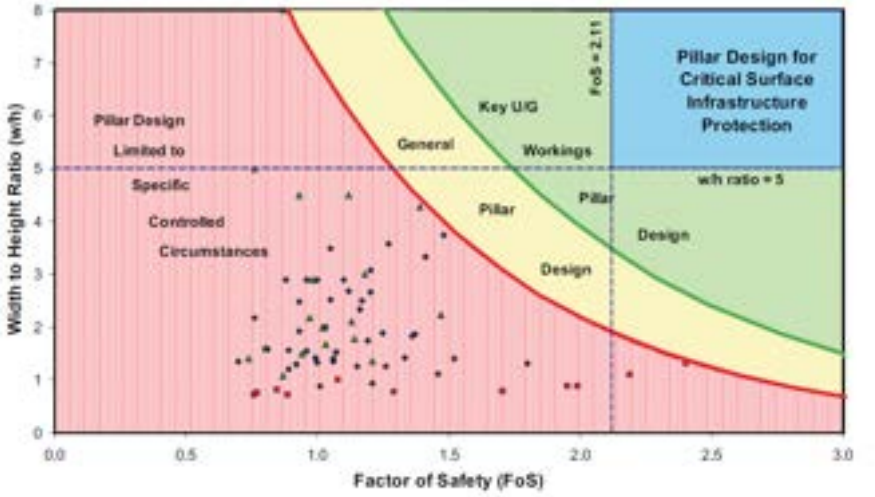


FIGURE 4.13. Design Criteria for Bord and Pillar Workings Based on Combining Factor of Safety and Pillar Width to Height Ratio (Hill 2005)

Table 4.3 contains pillar FoS (under the UNSW PDP) and w/h ratios for typical sized pillars within each study zone using an assumed nominal heading width of 5.5 m as per current roadway development practice and a nominal pillar height of 3.2 m, as used previously.

	Typical Pillar Dimensions (m - centres)	Maximum Cover Depth (m)	Factor of Safety (UNSW PDP)	width:height ratio
Zone 1	46.8 (mid to lower range within the zone) x 30	170	3.62	7.66
Zone 2	46.4 (mid to lower range within the zone) x 30 (minor variations exist within the zone)	200	3.07	7.66

TABLE 4.3. First Workings Pillar Stability Parameters by Zone

By reference to:

(a) the UNSW PDP whereby the Probability of Failure at 200 m cover depth is significantly less than 1 in 10 million (i.e. the FoS is >> 2.23), and

(b) pillars being in the "*squat*" range by virtue of w/h being >> 4,

it is concluded that the pre-existing coal pillars within the two defined zones are adequately stable for first workings and permit pillar reduction during second workings.

4.5.2 Operational Safety During Second Workings Linked to Layout Design

4.5.2.1 Significance of Partial As Compared to Full/Total Extraction

Unlike the single-sided lifting layouts that were analysed in **Mine Advice 2024a**, the mine-site proposed double-sided lifting layout for both Zones 1 and 2 herein leave little to no remnant coal in place post second workings, to the extent that they are considered as full/total rather than partial extraction lifting layouts. The significance of this generic difference in lifting layout "*type*" will be outlined using a more general discussion on the development of continuous miner pillar extraction methods over the past 30 to 40 years in Australia.

In terms of continuous miner (CM) pillar extraction, all methods attempt or should attempt to achieve the following:

- maximise coal extraction
- maximise roadway development rate (not relevant in this instance as pillars are already formed-up)
- maximise rate of secondary extraction
- use of double-sided lifting so as to make best use of primary roadway development
- promote safe working conditions, particularly in proximity to the lifting-off area

Inevitably, some of these required outcomes can conflict, which goes some way in explaining the numerous pillar extraction methods and variants that have been developed over time in attempts to use the layout to gain the best possible mining outcomes.

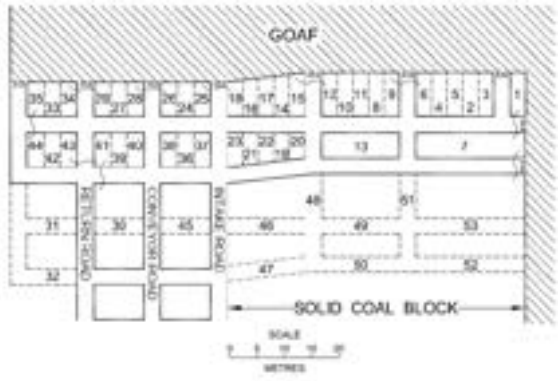


FIGURE 4.14. Pillar Extraction by the Old Ben Method – Newcastle Area Practice (AusIMM 2009)

A good example of a common conflict is in attempting to improve CM cutting efficiency against minimising the formation of intersections due to strata control concerns. **Figure 4.14** shows a typical "*Old Ben*" layout whereby many intersections are formed-up so as to minimise the distance between the CM and the shuttle car change point outbye of where lifting-off is occurring. This type of layout traditionally worked well in competent immediate roof conditions such as that commonly found within the Wallarah and Great

Northern Seams in the Newcastle Coalfield of NSW where this type of pillar extraction layout was commonly used.

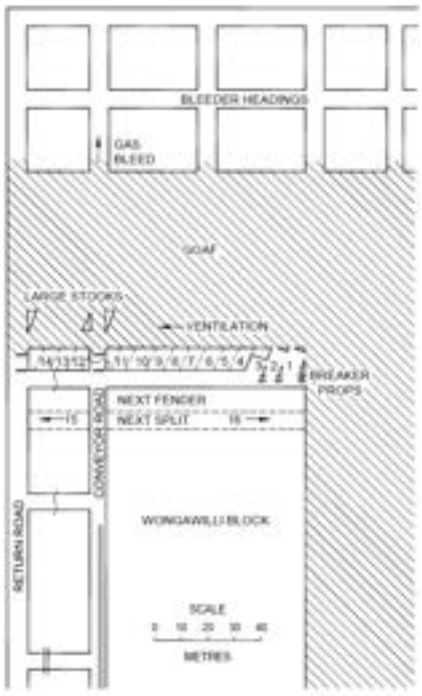


FIGURE 4.15. Wongawilli System of Pillar Extraction (AusIMM 2009)



FIGURE 4.16. Partial Extraction Layout, Cooranbong Colliery (Myors and Chaston 2001)

In contrast, it was found that forming up many intersections to improve CM cutting efficiency resulted in on-going intersection roof stability problems in less competent roof conditions at depth, which is why the Wongawilli Method came about and was named after the Wongawilli Seam with its known difficult roof conditions at higher cover depths. A downside of reducing the number of intersections is that the maximum distance from the CM to the shuttle car change point increases significantly as can be clearly seen in **Figure 4.15**, with production rates tending to reduce as this distance increases.

Historically, "*partial extraction*" was most commonly used to limit mining-induced subsidence impacts on surface and/or sub-surface features, as described in **AusIMM 2009**. However, it was also eventually realised by operations that partial extraction could be beneficially used to substantially improve safety during lifting-off, particularly in those environments prone to goaf "*hang-ups*" and hence, high abutment stress effects in proximity to the lifting-off area and/or occasional very large goaf falls that generated significant safety threats.

Myors and Chaston 2001 describe the development and introduction of such a system in the Great Northern Seam at Cooranbong Colliery in NSW, with the associated mining strategy being that of double-sided lifting in one direction leaving load-bearing remnant pillars in place (**Figure 4.16**) to control both immediate roof caving and mining-induce subsidence.

Of specific relevance to this report are the following comments taken from **Myors and Chaston 2001**:

> "*Pillar stripping at Cooranbong Colliery involves a remote control miner lifting a strip of coal up to 10 m wide from the side of the pillar. MRS's provide immediate goaf edge control. This leaves a 20 to 25m remnant coal pillar separating a 25m void. Once the miner has completed the cut out, it is flitted to the next lift in the cutting sequence and the stripping process continues*"
>
> *"Cooranbong needed a system that met the following criteria:*
>
> 1. *A safe system.*
> 2. *No goaf falls, thereby enhancing productivity and eliminating a significant safety hazard.*
> 3. *Physically demanding tasks to be performed by machines.*
> 4. *Continuous miner cutting time to be maximised and cost competitive coal delivered.*
> 5. *Flexible enough to accommodate variable mining conditions and geological constraints,*
> 6. *Limited subsidence to acceptable limits".*

They also note that total pillar extraction commonly recovered only 75% of the available in-panel coal for all manner of reasons, hence a planned in-panel reserve recovery for partial extraction in the order of 70% did not represent a major constraint to its use.

The reported partial extraction system from Cooranbong was judged by the author in 2001 as representing industry best-practice for continuous miner pillar extraction as it provided for significant improvements in both mine safety during lifting-off as well as associated productivity more generally, as evidenced by the statement below that is also taken from **Myors and Chaston 2001**.

> *"Southwest C delivered production continuity and reliability during both panel advance and retreat. The place changing and pillar stripping phases averaged 988 and 1214 tonnes per 8 hour shift respectively. The peak results were 1,908 and 2358 tonnes per 8 hour shift respectively. The success of this system is further reinforced when it is considered that the adjacent Old Ben panel averaged 250 and 350 tonnes per 7 hour shift for the same mining phases*"

However, as the Cooranbong system lifts-off in one direction only (as can be seen in **Figure 4.16**) the author worked with Cornwall Coal in Tasmania to develop a comparable partial extraction system with the same positive attributes as the Cooranbong system, but with lifting-off from both headings and cut-

throughs, the end-result being what is now known as the Duncan Method as now described. This method was subsequently adopted and successfully used by the Tasman Mine in NSW (see **Figure 4.17**).

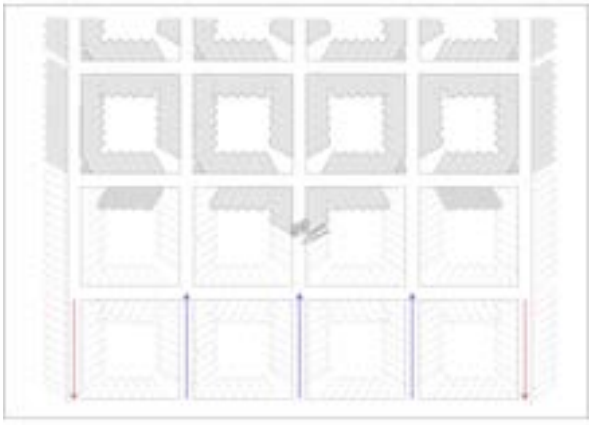


FIGURE 4.17. A Typical Five-Heading Duncan Method Partial Pillar Extraction Layout Used at Tasman Mine (Sutherland and McTyer 2011)



FIGURE 4.18. Looking Across a Four-Way Intersection at Stook X, the Intersection having Been Extracted on Three Sides (Sutherland and McTyer 2011)



FIGURE 4.19. CM Taking a Lift Within a Duncan Method Layout

The Duncan Method of mining as a form of partial extraction (see **Figure 4.17** for a typical layout) contains the following beneficial attributes:

(i) It is a non-caving mining method, therefore concerns related to periodic weighting, large-scale overburden fracturing, windblast (as defined by air velocities > 20 m/s) and large-magnitude surface subsidence due to overburden "*sag*" are substantially reduced as a direct consequence.

(ii) Due to the relatively low extraction spans formed up (generally no more than 26 m due to the leaving of mandatory stooks at intersections as can be seen in **Figure 4.17**), goaf falls are relatively small in plan area and height and typically occur inbye the lifting-off area. Thus, goaf overruns of MRSs and/or CM burials are substantially less likely than with full pillar extraction. This is a significant safety benefit over full pillar extraction.

(iii) As a non-caving method with load-bearing remnants left in place, roadway ground support regimes, particularly during secondary extraction, are far less intense than for a caving method such as longwall or Wongawilli pillar extraction (as an example of total extraction), all other factors being equal.

(iv) Vertical abutment stresses in the lifting-off area are reduced as compared to total extraction (see **Figures 4.18 and 4.19**) due to the leaving of "*designed*" remnant pillars in the goaf. Similarly, horizontal stress notching effects are minimised due to limited overburden caving and goaf formation.

(v) As the method is intended to be non-caving (other than minor goaf falls) and intentionally designed load-bearing remnants are regularly left in place, the need for lifting-off to be continuous until a full lifting sequence is complete is far less significant than in total extraction whereby time-dependent deterioration of strata conditions in the lifting-off area is largely inevitable.

(vi) Leaving load-bearing remnants in place allows planned lifts not to be taken if local conditions dictate. This was understandably discouraged during full extraction due to concerns about then causing subsequent goaf "*hang-ups*" due to unplanned remnant coal being left *in situ*. This led to coal being lifted under arduous conditions, whereas in partial extraction such risks do not ever need to be taken.

(vii) Partial extraction (including the Duncan Method) and bord-and-pillar more generally, are far more flexible in their ability to minimise the adverse mining influence of major geological structures, as they can often be avoided by modifying the mine layout. In contrast, major geological structures can be either a significant layout constraint or a major production risk in longwall mining.

(viii) Coal pillars are typically square on 40 to 50 m centres for double-sided lifting and 25 to 32 m centres for single-sided lifting according to seam/working section thickness. Even the largest of such pillars results in a relatively close shuttle-car change point outbye the CM throughout much of the pillar cycle, unlike longwall gate road chain pillars for example.

(ix) With the belt road being in the centre of the panel, it is not directly affected by horizontal stress concentrations, unlike a longwall belt road.

(x) All pillars are pre-formed for subsequent extraction, meaning that there is no need to drive splits during secondary extraction. This is a further safety benefit.

(xi) Bell-outs to install three MRSs for double-sided lifting (DSL) before a lifting run, that were otherwise troublesome to form-up and were commonly associated with MRS burials, are now pre-formed and fully-supported via the inbye intersection.

(xii) Due to the large size of first-workings pillars, it is straightforward to leave suitably stable protection pillars in place for surface infrastructure, if required.

Overall, it is considered that the Duncan Method represents a partial CM pillar extraction method that contains specific features addressing many of the safety and productivity concerns that characterised total CM pillar extraction in the past. As of 2024 it has been successfully used at Duncan Colliery (to cover depth as high as 350 m), Blackwood 3 and 4 Collieries, the Tasman and Abel mines in NSW and is currently being utilised for single-sided lifting at Myuna Colliery beneath Lake Macquarie in NSW.

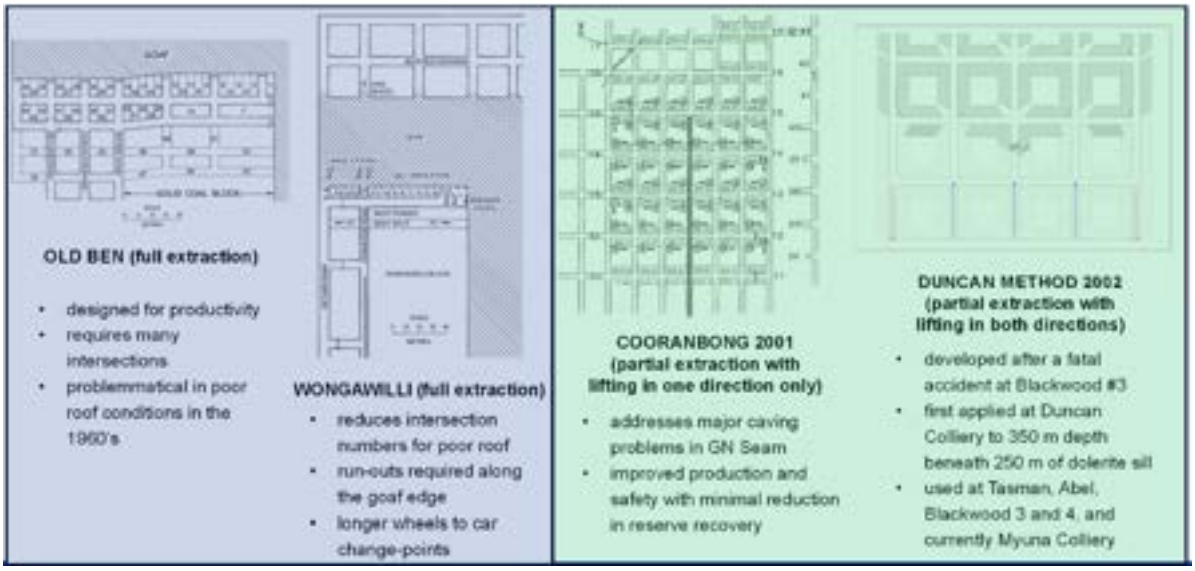


FIGURE 4.20. General Comparison Between Full and Partial Extraction Continuous Miner Lifting-Off Methods

The point of this discussion is not to promote Duncan Method mining *per se*, but to explain that partial extraction layouts have been developed since around 2000 to improve operational safety and rates of production during lifting-off without necessarily sterilising large amounts of coal that would have otherwise been extracted with total extraction mining. This is best exemplified in **Figure 4.20** whereby total extraction and partial extraction continuous miner pillar extraction represent historical (blue shading) and current best-practice mining (green shading) respectively.

4.5.2.2 Panel Width Considerations

Before considering the need and potential benefits of leaving more coal *in situ* than being contemplated by the proposed double-sided lifting layouts in **Figure 1.2**, it is of value to evaluate the potential impact of both panel geometry and overburden lithology in regard to the extent that it might provide significant protection against the lifting-off area being adversely influenced by significant vertical abutment loading from already extracted areas. In partial extraction this is effectively limited by the regular strategic leaving of load-bearing remnant pillars, whereas in total extraction it is at least in part controlled by panel width and caving considerations but to nowhere neat the same extent as remnant pillars in partial extraction.

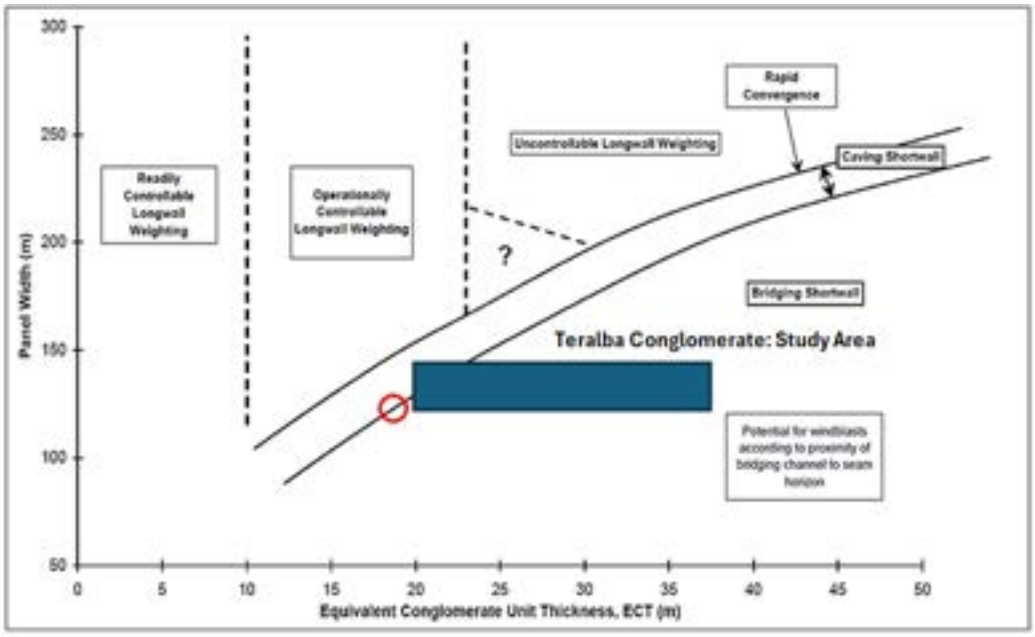


FIGURE 4.21. Periodic Weighting Potential: Teralba Conglomerate (Frith and McKavanagh 2000)

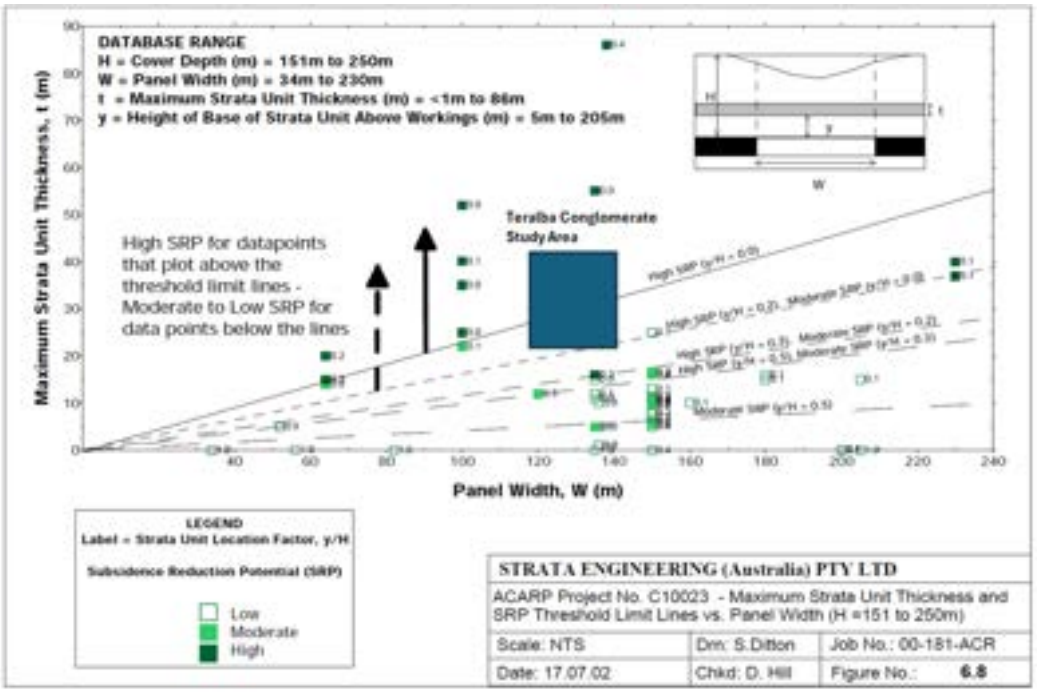


FIGURE 4.22. Subsidence Reduction Potential (SRP) According to Strata Unit Thickness, Location of Strata Unit above the Seam and Panel Width (Ditton and Frith 2003)

Data contained in **Table 4.2** demonstrates that in all instances the panel widths being contemplated (typically 118 m and as high as 142 m in one localised area within Zone 2) are less than cover depth, resulting in panel W/H ratios ranging from 0.59 to 0.71, as were used in the prediction of subsidence at the lakebed. These panel W/H ratios are below the minimum value associated with pillar collapses of 0.9, as described previously.

In terms of any additional stabilising influence of thick massive units within the overburden, the Teralba Conglomerate immediately above the Great Northen Seam is worth consideration, its minimum thickness in the study area being 20 m with a maximum thickness in the order of 40 m (as described previously in **Section 2.3**. Both the **Frith and McKavanagh 2000** and **Ditton and Frith 2003** methods (as per **Figures 4.6** and **4.7**) can be used in assessing the potential spanning ability and/or Subsidence Reduction Potential (SRP) of the Teralba Conglomerate above the study area.

The near-seam overburden weighting analysis in **Figure 4.21** indicates that for the range of projected thicknesses within the study area, the Teralba Conglomerate is generally consistent with a "*bridging shortwall*" classification (or permanent spanning), but in its thinner condition close to 20 m thickness it potentially falls into the "*caving shortwall*" classification. Based on the panel widths within the proposed double-sided lifting layouts, the caving of at least some sections of the Teralba Conglomerate above the GN Seam is a credible possibility.

The SRP analysis in **Figure 4.22** confirms that the Teralba Conglomerate has "*high SRP*" within the study area, but only by virtue of its location above the GN Seam (y/H = 0.2).

In conclusion, the presence of the Teralba Conglomerate immediately above the GN Seam provides for some level of confidence that the panel widths involved will be sub-critical following the completion of secondary extraction. However, the continued spanning of the Teralba Conglomerate without the assistance of remnant coal pillars is clearly subject to some level of material uncertainty, hence the consequences of it either remaining stable or conversely caving either during or post-secondary extraction requires further consideration as both an operational safety control, in addition to concerns relating to mining-induced subsidence as detailed in **Section 4.4**. The need for some form of remnant pillar system is a relevant consideration for several different reasons, as now addressed with respect to operational safety.

4.5.2.3 The Need for Remnant Pillars Within the Extraction Layout

Restricting panel widths in order to maintain subsidence levels below defined thresholds results in certain downside risks related to mining conditions and operational safety during lifting-off if suitably sized remnant pillars are not left in place within the lifting layout, as will now be explained.

Figure 4.23 illustrates what will inevitably occur as each heading is lifted-off progresses across the panel, as would logically be used in operations for the proposed layouts in **Figure 1.2**.

The inevitable consequence of not leaving remnant pillars in place is that as lifting-off is conducted from one side of the panel to the other, the abutment stresses being generated above the next lifting sequence incrementally increase, as illustrated schematically in **Figure 4.23**. In fact, this effect is potentially further exacerbated by the presence of the Teralba Conglomerate and its spanning ability at the panel widths involved as each subsequent lifting run is taken. The leaving of any thin fenders between lifts, as is almost inevitable, potentially further aggravates this effect by acting to temporarily delay the caving of the material up to the base of the Teralba Conglomerate, which if in a sufficiently large area also has windblast potential (see **Section 4.5.2.4**).

The effect described above goes against current best practice in continuous miner pillar extraction and represents a significant operational risk in terms of roadway roof, rib and floor control during lifting-off, potentially resulting in either (a) the need for secondary roof and/or rib support prior to lifting-off, and/or

(b) lifting-off being locally abandoned due to unacceptable mining conditions with remnant pillars needing to be left in place as a direct consequence.

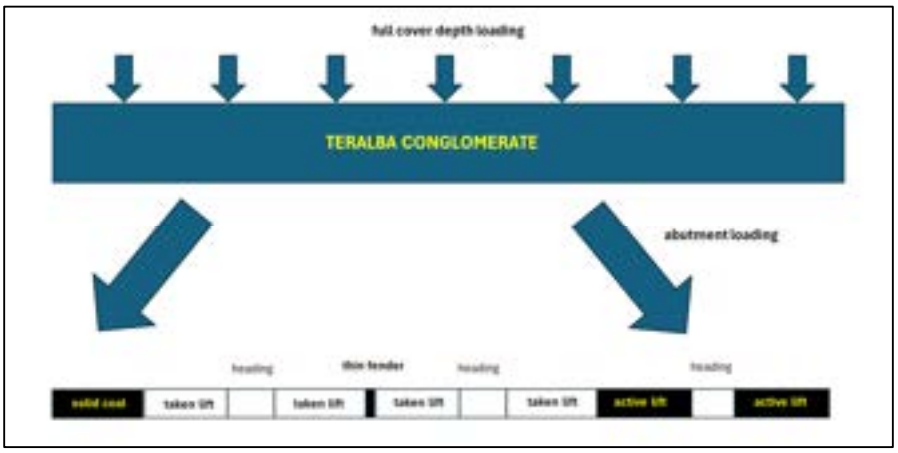


FIGURE 4.23. Impact of Sequential Taking of Lifts Across the Panel

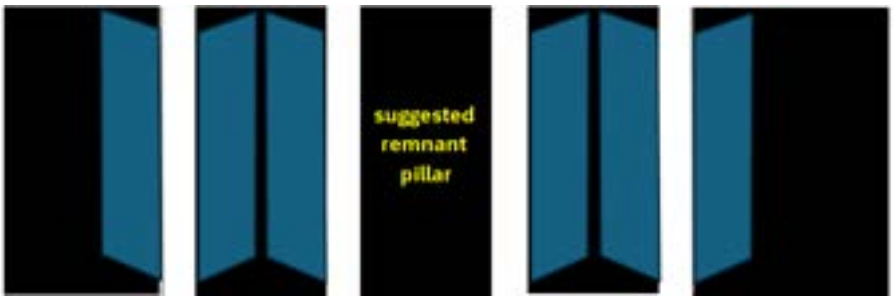


FIGURE 4.24. Suggested Remnant Pillar and Associated Lifting Layout

As a result of the described operational strata control concern during lifting-off, it is recommended that the proposed double-sided lifting layouts be modified, at least for current planning purposes, by intentionally leaving at least one coal pillar in place in order to achieve the following (see **Figure 4.24**):

(i) sub-divide the panel into two separate "*sub-panels*" in order to limit the vertical abutment stress effect illustrated in **Figure 4.23** to no more than the taking of a second row of lifts, rather than up to four. This reduces the maximum level of vertical abutment stress that crews will be exposed to and so need to manage via the TARP during operations.

(ii) provide a high w/h remnant pillar in order to substantially limit any collapse of the overburden up to the base of the Teralba Conglomerate, this being facilitated by remnant pillar w/h rather than FoS (NB development pillars have w/h values in the order of 7.7 as listed in **Table 4.3** so are well suited to this role). This has both operational safety and also post-mining overburden fracture development benefits.

(iii) reduce the level of subsidence at the lakebed to the lowest practical levels, thereby providing the highest practical level of confidence that the defined maximum S_{max} limit of 780 mm will not be exceeded in practice.

It is noted that the actual stability of such a remnant pillar post-mining is of no direct relevance to either operational safety or subsidence control as:

(a) by the time it is under its maximum loading condition it will be located several pillars into the already extracted area remote from where lifting-off is taking place,

(b) its w/h in excess of 7.5 is such that its inevitable mode of behaviour should it go into yield is that of a controlled squeeze rather than rapid collapse, and

(c) pillar stability (which includes the floor directly beneath the pillars) is not material to maintaining levels of subsidence to < 780 mm, as it is simply an additional control over and above panel width and the presence of the Teralba Conglomerate in reducing the likelihood of the maximum subsidence value being approached post mining to the lowest practical level.

As per the back-analyses of mining-induced subsidence above various miniwall panels at Chain Valley contained in **Section 4.2.4** of **Mine Advice 2024a**, for significant levels of surface subsidence to be developed, two criteria need to be exceeded:

(i) the total width across several panels needs to be sufficient to cause the stabilising impact of the Teralba Conglomerate to be lost so that remnant pillars are then loaded under full cover depth tributary area loading, AND

(ii) vertical stresses acting through remnant pillars need to be sufficient to cause en masse floor failure beneath remnant pillars

In reality these two issues work together in that spanning of the conglomerate tends to limit post-mining vertical stresses on remnant pillars, and remnant pillar stability acts to provide some level of stability to conglomerate units across more than one extraction panel. In other words, remnant pillars act to reinforce rather than suspend an otherwise unstable overburden, as described and justified in detail in **Frith and Reed 2018**. This explains why high levels of subsidence above miniwall panels at Chain Valley only occurred in conjunction with sufficient panels being extracted in a continuous series, as shown in **Figure 4.25**.

It has been determined that at the maximum cover depth of 200 m, the suggested remnant pillar has a post-mining Factor of Safety of at least 1.45, a w/h ratio in the order of 7.7 and a maximum post-mining vertical stress of 14.5 MPa (assuming no overburden caving above the Fassifern Seam). In the role of ensuring that the stability of the Teralba Conglomerate is maintained post-mining so that high Subsidence Reduction Potential (SRP) is reliably maintained, it is judged to be fit for purpose.

The consequence of leaving a solid pillar in place within the centre of the panel as depicted in **Figure 4.24** is that of only being able to extract six individual lifting sequences across the panel whereas eight are currently indicated in **Figure 1.2**, four being taken as double-sided lifting runs and two as single-sided. This is nonetheless a substantial improvement as compared to the single-sided lifting layout shown in **Figure 1.1** (from **Mine Advice 2024a**) whereby at best only four adjacent lifts are planned to be taken as single-sided only. Thus, despite the suggested layout compromise, overall reserve recovery is improved by around 50% and production rates should increase via the introduction of double-sided lifting as compared to limiting secondary extraction to that of single-sided lifting.

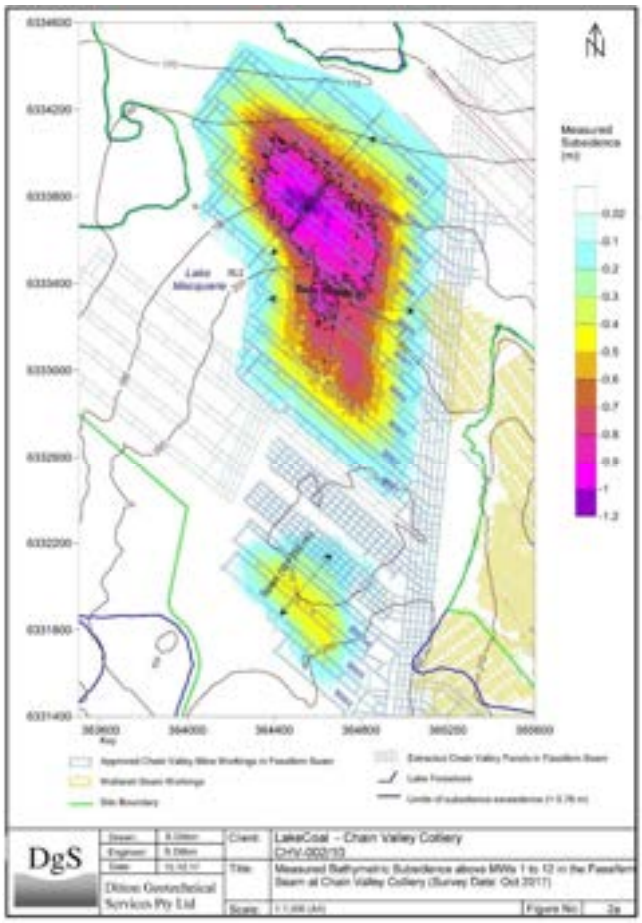


FIGURE 4.25. Bathymetric Measured Subsidence above MW's 1 to 12 at Chain Valley

4.5.2.4 Windblasts

Whilst windblasts (defined as any goaf-fall-induced air velocity > 20 m/s) have occurred during both longwall and pillar extraction, partial extraction limits the unsupported spans within the mined-out area to no more than around 26 m for double-sided lifting and 16 m for single-sided lifting.

There are three primary drivers for the development of large-area goaf falls that have the ability to generate a windblast during full extraction, a windblast being taken to be the almost instantaneous development of an air velocity in excess of 20 m/s with the potential to knock persons over and so cause injury:

(i) the presence of thick massive strata units which can span across an extracted area, thereby setting-up the potential for large plan-area, plate-like goaf falls that can displace large volumes of air beneath them.

(ii) the presence of mid-angled discontinuities within the overburden which may allow large, block-like goaf falls rather than smaller progressive goaf formation, as has occurred in proximity to igneous plugs for example.

(iii) the leaving of thin fenders in place with the ability to delay caving for a period of time, but ultimately cannot prevent very large area roof collapse in extracted areas.

The general rarity for either of the two geological conditions described in (i) and (ii) during total extraction, other than during the initial stages of extraction whereby spanning of the overburden is directly controlled by the retreat distance rather than the panel width, explains the statistical rarity of windblasts during total extraction, including longwall, other than occasionally during first caving at the start of an extraction panel.

The most reliable control against the threat of a windblast during longwall extraction is the thickness of readily caveable material beneath any strata unit that may cause a large plan-area goaf fall. If sufficiently thick, such readily caveable material results in the mine workings where persons are located being effectively "*sealed*" from the goaf area where windblast forming goaf falls may occur.

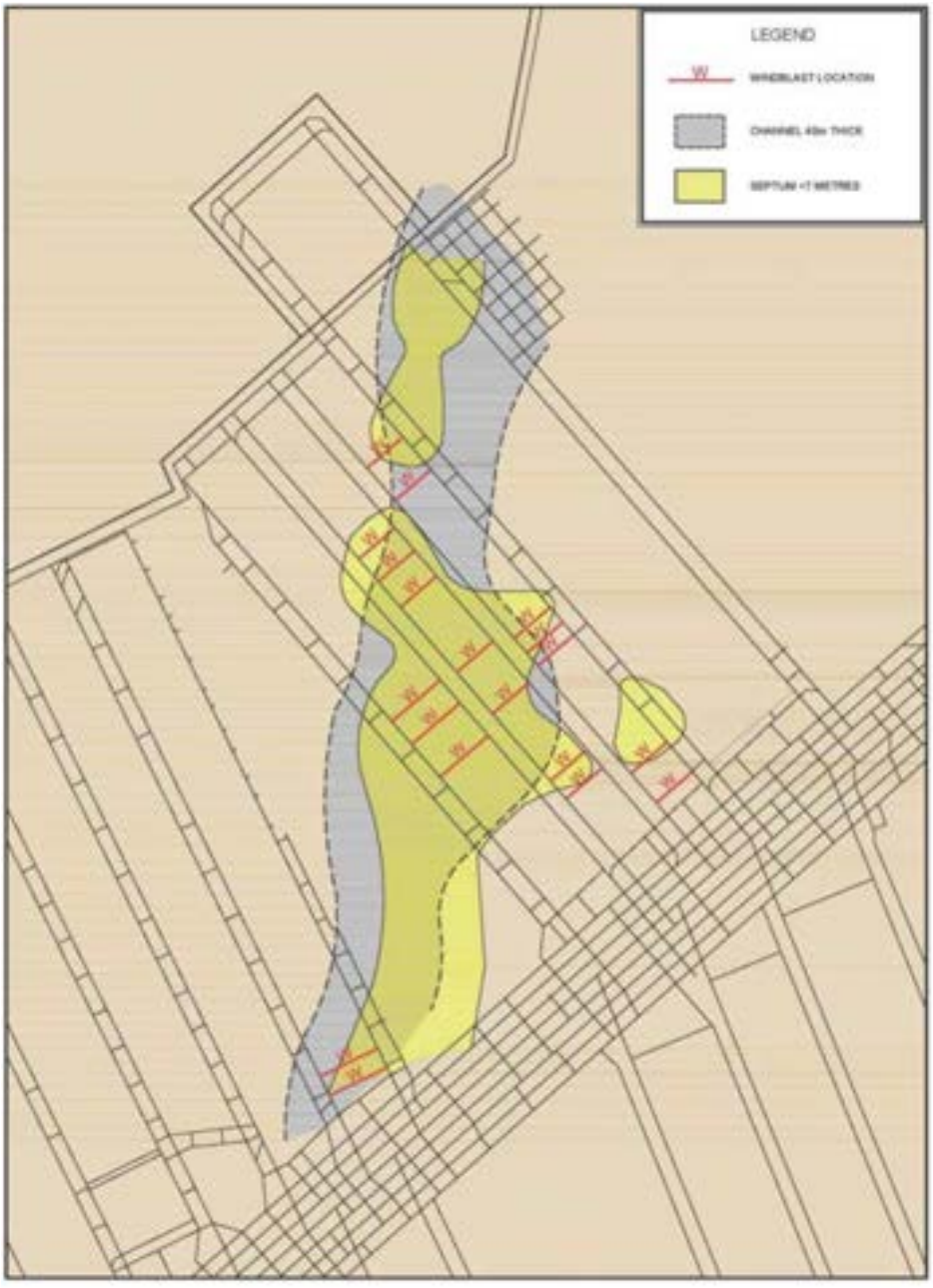


FIGURE 4.26. Windblast Locations, LW's 6 to 8, Newstan Colliery (Creech 2014)

Based on the windblast experiences during the extraction of the narrowed longwall panels LW's 6 to 8 at Newstan Colliery, the thickness of readily caveable material (7 m in the case of Newstan – see **Figure 4.26**) being around twice the gate roadway development height was found to be sufficient to effectively prevent windblasts developing either on the longwall face or in the adjacent gateroads despite large plan-area goaf falls occurring from the base of the overlying spanning conglomerate. **Creech 2014** was able to demonstrate this criterion via actual windblast locations.

In partial extraction the main control is not the thickness of readily caveable material beneath an otherwise spanning unit across the extraction panel, as one objective of partial extraction is to limit caving in the first instance. Moreover, the main windblast controls are (a) the stability and w/h of remnant pillars and (b) limiting the area of standing roof that has the ability to collapse as a single, large plan-area event.

Major pillar collapses such as that at the Coalbrook Mine in 1960 in South Africa were associated with very significant windblast events within the mine workings at the same time as pillar collapses were occurring. Therefore, remnant pillars with a suitably high w/h ratio that prevent very rapid overburden collapse act to prevent large scale windblasts within the mine workings. This windblast prevention mechanism is fully confirmed by **Galvin 2016**.

In regard to preventing windblasts due to roof caving from within areas of extraction, **Galvin 2016** makes the following statement:

> *Ideally, panels should be designed to be either sufficiently wide to induce caving very soon after the start of extraction and regularly thereafter, or else sufficiently narrow so that goaf falls do not occur or are very small in area* (emphasis added by author).

The relevant question for partial extraction becomes whether the associated areas of standing roof after lifting-off are sufficient to generate windblast air velocities if and when they collapse.

In this regard, **Sharma and Fowler 2004** summarise the windblast investigations at both Moonee and Newstan Collieries in the mid-to late 1990's and conclude that "*the mean overall mining-induced roof fall area, which corresponds to a peak windblast velocity of 20 m/s, i.e. a significant wind blast, is of the order of 2000 m*^{2}." In other words, on average the typical roof fall area that can generate a sufficient air velocity to knock someone over (i.e. via an air velocity of 20 m/s) is 2000 m^2.

Whilst the Teralba Conglomerate does not represent a windblast threat by virtue of its location above the Fassifern Seam, the proposed double-sided lifting layouts without remnant pillars could conceivably result in 2000m^2 or more of immediate roof remaining un-caved due to the inevitable small amounts of coal left in place as either Stook X or thin fenders between lifts. This scenario is an obvious windblast concern.

In regard to windblast propensity, in order to reduce the associated safety threat risk to ALARA there is significant benefit in leaving a central remnant pillar in place as shown in **Figure 4.24**, this effectively sub-dividing the panel into two much narrower extraction spans with higher inherent roof stability, as compared to removing the full panel width as envisaged in **Figure 1.2**.

4.6 Potential Impact of Adjacent Miniwalls

Mine Advice 2024a concluded as follows in regard to the potential impact of adjacent miniwalls on proposed lifting-off operations along the adjacent North Headings:

For a cover depth of 200 m, D = 73 m, from which it can be concluded that the North Headings, including B Heading, are all sufficiently remote from the outbye end of MW's 1 to 12 to be unaffected by any significant or meaningful vertical abutment stresses that have been generated outbye their recovery locations.

The use of double-sided rather than single-sided lifting does not in any way change the potential influence of the adjacent extracted miniwalls, hence the above finding can be equally applied herein.

4.7 Local Strata Control During Lifting-Off

4.7.1 General Comments

The impact of second workings, whether longwall, shortwall, full pillar extraction or some form of partial extraction as is the case herein, is to change (and generally increase) the ground stresses acting on mine roadways, and in some cases increase the roadway span. The proposed partial extraction layout under consideration herein is no different in this regard, and contains the following positive attributes:

(i) as a "*goaf*" does not typically form due to it being a largely non-caving method, significant horizontal stress concentrations adversely influencing roadway roof stability close to the area of active mining are highly unlikely to be generated.

(ii) vertical stress increases within the area of active mining are substantially limited by the leaving of load-bearing, high w/h ratio remnant pillars in areas already worked and being worked (see **Figure 4.24**). This acts to limit the potential for coal rib deterioration in particular, in and around the CM when lifting-off, which has attendant safety benefits.

As a general rule, providing that:

(a) actual lifting layouts take due account of locally poor strata conditions,

(b) coal ribs are checked and barred down both prior to and during lifting-off as necessary, and

(c) an adequate Stook X is left in place to protect the outbye intersection,

secondary extraction within an otherwise partial extraction layout can typically be undertaken without the routine need for secondary roadway roof and/or rib support, this being in significant contrast to longwall mining or any form of full extraction.

The specific location worth considering in more detail is where lifting-off is occurring and breaker-line supports (MRS's) are in use, this being the one area where roadway (i.e. heading) roof stability controls are changing, and persons are directly exposed to those active changes.

4.7.2 Roadway Roof Control

Figure 4.27 provides a schematic of various "*zones*" in and around the lifting-off area during single-sided lifting with two MRS's, the following comments being provided:

(i) the figure deliberately indicates that left and right-hand lifts are not directly opposite each other, but their centre-lines are offset by around 50% of the lift width. This allows the most effective use of MRS's in providing protection to persons against roof falls that can always occur in already taken lifts, whilst also maximising the room for the CM to be turned into the active lift.

(ii) outbye of where lifts have either been or are being taken, the heading can be classified as being "*normal*" with roof and rib stability being managed and controlled under a suitable second workings TARP and associated operational responses.

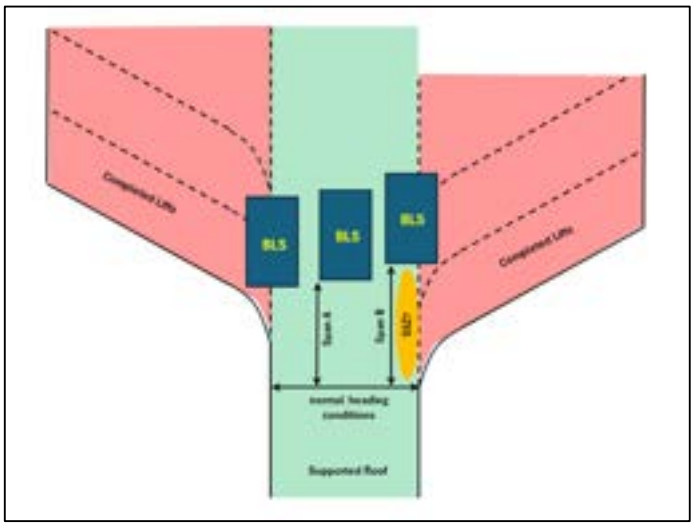


FIGURE 4.27. Schematic Arrangement for Double-Sided Lifting with Three MRS's (not to scale)

(iii) inbye of "*normal*" heading conditions with the RHS rib being lifted-off, the critical span from a roadway roof control perspective becomes those shown in **Figure 4.27** from the MRS's outbye back to the line of normal heading conditions. With the lifting CM having a narrow head of 3.2 m width with a maximum lift width of 4.2 m (in two passes), the two defined spans ahead of the MRS's should be no more than a normal heading width, hence heading roof stability immediately ahead of the MRS's can be adequately catered for by first workings roof stability as generated by the nature of the immediate roof strata and installed primary roof support.

(iv) the main area or zone of uncertainty is that shown in orange in **Figure 4.27** which depicts the area whereby roof falls in lifted-off areas could conceivably collapse into. An offset from unsupported lifts into the heading for safety reasons should be allowed for when defining safe work locations for lifting-off purposes.

(v) the breakaway for each lift should be maintained as tight as possible and MRS's kept as far outbye as practical mining considerations allow at all times in order to minimise the potential for roof losses in adjacent unsupported areas falling into areas of otherwise fully supported roof, as indicated in green in **Figure 4.27**.

In relation to specific roadway conditions within the study area, the site inspection revealed several relevant issues:

(a) roadways were driven with an in-place miner/bolter several years ago to a maximum width of 5.5 m and minimum primary roof support of 6 x 2.1 m bolts per 1 m supplemented with long tendons in intersections.

(b) at least one major roof cavity and adjacent visibly deteriorated roadways were observed towards the outbye end of Zone 3 in the North Headings.

(c) a substantial "*graben*" structure is located towards the outbye end of the NE Headings, with secondary extraction not being planned either in proximity to the major faults that form the graben or within the substantial visibly unaffected section between them.

To provide suitable background context, **Mine Advice 2024b** examined roadway roof control further inbye in the Herringbone Mains and adjacent production panels. These areas are generally characterised by (a) comparable FB Ply and FA Ply immediate roof beams, (b) heading widths of nominally 5.5 m, and (c) minimum primary roof support of 4 x 2.1 m bolts per 1.5 m. When this is objectively compared to the study area as described in point (a) previously, a substantial level of inherent conservatism can be reliably applied to pre-existing roadway roof stability in those areas supported with 6 x 2.1 m bolts per m which are also visibly undeteriorated – which is the vast majority of the study area.

On the assumption that continuous lifting-off will not be attempted from visibly deteriorated roadways and/or areas in close proximity to major geological structures/roof fall cavities, it is concluded that secondary extraction can be undertaken without the routine need for secondary roof support in the form of either additional roof bolts or long tendons.

4.7.3 Rib Control

During any form of secondary extraction using a continuous miner, rib instability, particularly "*small-scale*" skin instability between installed rib bolts as indicated in **Figure 4.28** is a significant operator safety hazard, even as part of partial extraction whereby vertical stress levels are being maintained at the lowest practical level in proximity to where lifting-off is taking place by virtue of the leaving of load-bearing remnant pillars as described earlier in the report.

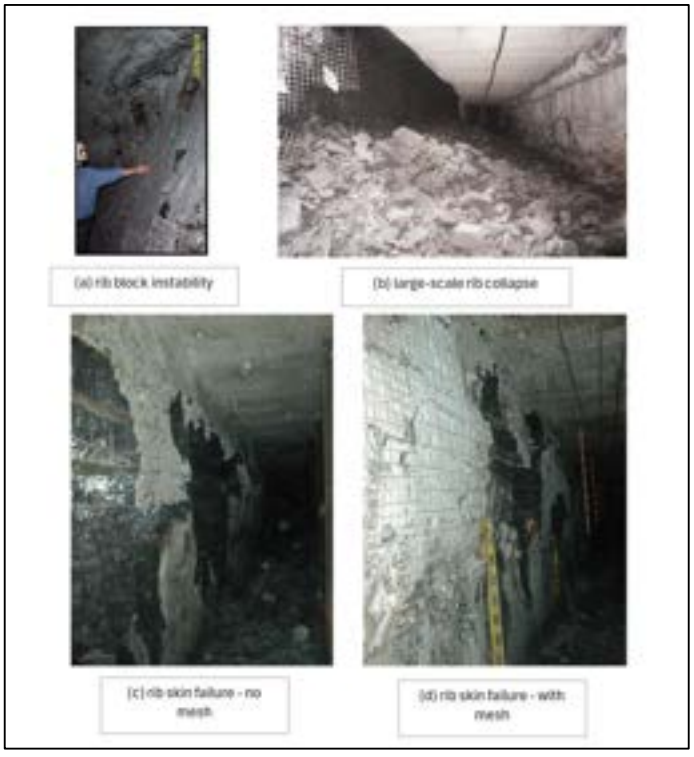


FIGURE 4.28. Different Scales of Coal Rib Spall

To put the term "*small-scale*" into better context, **Figure 4.28** provides actual examples of different levels of rib spall. "*Large-scale*" rib collapses as indicated in **Figures 4.28(a)** and **(b)** are controlled by both the level and effectiveness of the installed rib support as well as mapping of roadways for relevant geological features that could exacerbate rib collapse, particularly mid-angled structures.

Small scale rib instability with injury potential is illustrated in **Figures 4.28(c)** and **(d)** and is typically linked to relatively small pieces of coal detaching and falling out from around installed rib bolts, injury potential being directly linked to the height from which said pieces fall from as a general rule. It is rib instability at this "*smaller-scale*" that needs to be assessed and managed prior to and during second workings in terms of whether any localised areas require additional rib support as well as on-going rib assessment and/or barring down loose pieces both before and during lifting-off operations.

5.0 OPERATIONAL CONSIDERATIONS

To complete the necessary "*Hierarchy of Controls*" in order to minimise safety-based risks during second workings to "*as low as reasonably achievable*" (ALARA), a series of operational controls are also required. Such controls should be developed as part of a consultative process with site stakeholders, hence this report only lists and describes them briefly for general reference purposes, as follows:

- whether there is a need to replace defective/damaged ground support (particularly rib support) in order to ensure that the installed support is to prescribed minimum standards before commencing lifting-off.
- ensuring that all intersections are protected via an adequately wide "*Stook X*" where lifts are being taken on the immediate inbye side. For partial extraction, a minimum width for Stook X can be 1 m inbye the point where the intersection ends and the inbye heading starts.
- developing operating procedures for the three MRS's including sequencing and their required locations (a) prior to commencing a lift on the immediate outbye side and (b) bringing them past Stook X as unlike two MRS's, three cannot be brought past Stook X in a line across the heading due to the heading width being less than the combined with of three MRS's.
- defining and adhering to safe-standing zones in and around the CM during lifting operations.
- the need for on-going strata observations, inspections and potentially barring down loose material both before and during second workings, particularly ribs where persons are required to stand during lifting operations.
- the development and operational use of a secondary extraction Strata Control TARP, including identifying and responding as necessary to pre-existing and subsequently changing roof, rib, and floor conditions during operations.
- ensuring that for all planned lifts, the roadway height just inbye is within the operating height range of the MRS's. This is especially relevant in any areas where roadways have been cut to the base of the FA Ply rather than FB Ply (see **Figure 2.1**), which is most common on the immediate inbye and outbye sides of a number of intersections.

The above list is not necessarily exhaustive but provides an initial check-list for the primary operational controls that need to be developed and applied during planned secondary extraction in order to ensure that safety hazards during mining are maintained at ALARA.

To illustrate the criticality of operational controls in ensuring safe mining conditions during lifting-off, **Figure 5.1** contains a published accident plan from Clarence Colliery whereby a roof fall from within a previously lifted area fell and struck two workers who suffered significant injuries.

Specifically, the accident site depicted in **Figure 5.1** involved double-sided lifting-off and indicates at least six operational controls that could have been substantially improved to otherwise have prevented the accident in the first instance:

1. The three MRS's are located too far inbye and should have been moved at least 1 to 2 m further outbye – had they done so the piece of roof rock that fell would have been controlled by MRS #3 being set to the roof in that area (see **Figure 5.2** for a photo of the roof fall).

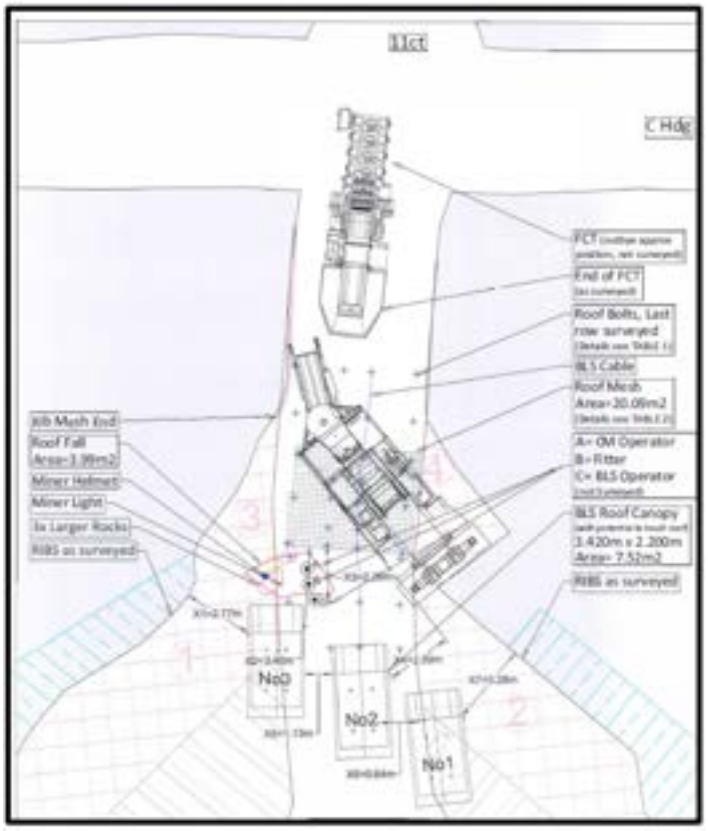


FIGURE 5.1. Roof Fall Accident Plan, Clarence Colliery (NSW Resources Regulator 2021)



FIGURE 5.2. Roof Fall Photograph (NSW Resources Regulator 2021)

2. The section of roof that fell was not meshed, hence an isolation barrier to protect CMW's from thin sections of roof falling was not in place – at Chain Valley it is understood that the roof is meshed on a mandatory basis.

3. The previous lift on the opposite side (marked "3" in **Figure 5.1**) had been broken away too far outbye, the result being that a significant partial lift had been formed on the outbye side of the MRS's – this is poor lifting-off practice and represents the specific area of unsupported roof where the fall that caused injuries to the two operators came from.

4. Three persons were in the area of the MRS's whilst lifting-off, namely the CM driver, the MRS operator and a fitter, with the CM driver and fitter being struck. The MRS operator was not struck as he moved towards MRS #2 during the fall. The fitter had no obvious reason for being present during lifting-off and even the MRS operator could have stood outbye for the duration of lifting-off.

5. The three individuals were not stood in the most reliable safe standing zone, which would have been adjacent to MRS#3 directly in front of MRS #2. Had they done so no-one would have been struck by the roof fall despite the various inadequacies in other controls.

6. The outbye end of the canopy of MRS #3 (see **Figure 5.2**) was not set against the roof, hence its effective supporting area was even further inbye than suggested in **Figure 5.1**.

The Clarence accident plan in **Figure 5.1** is a very useful training aid as it indicates several less than adequate (LTA) operational controls that in varying degrees undoubtedly contributed to the accident. The one control that on its own would have prevented the accident was the roof being fully meshed, this being an isolation control and standard mandatory practice at Chain Valley.

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DELTA COAL
CHAIN VALLEY COLLIERY

Assessment of Proposed Secondary Extraction, North Headings, NE Headings and Herringbone Mains, Fassifern Seam

OCTOBER 2024

REPORT: CHAIN VALLEY10/1

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REPORT ON : Assessment of Proposed Secondary Extraction, North Headings, NE Headings and Herringbone Mains, Fassifern Seam

REPORT NO : CHAIN VALLEY10/1

REFERENCE : Our proposal dated 26th August 2024

PREPARED BY : Russell Frith

REVIEWED BY : Guy Reed and the Client's Representative

DATE : 25th October 2024



.....
Russell Frith
Senior Principal Geotechnical Engineer

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1.0 INTRODUCTION

This report details the methodology and outcomes from a geotechnical assessment examining mine-site proposed single-sided lifting layouts in the North Headings, North East (NE) Headings and Herringbone (HB) Mains in the Fassifern Seam as shown in **Figure 1.1**. Also indicated in **Figure 1.1** (by a continuous blue line) is the high-water mark of the Lake Macquarie foreshore with the planned secondary workings being beneath Lake Macquarie.

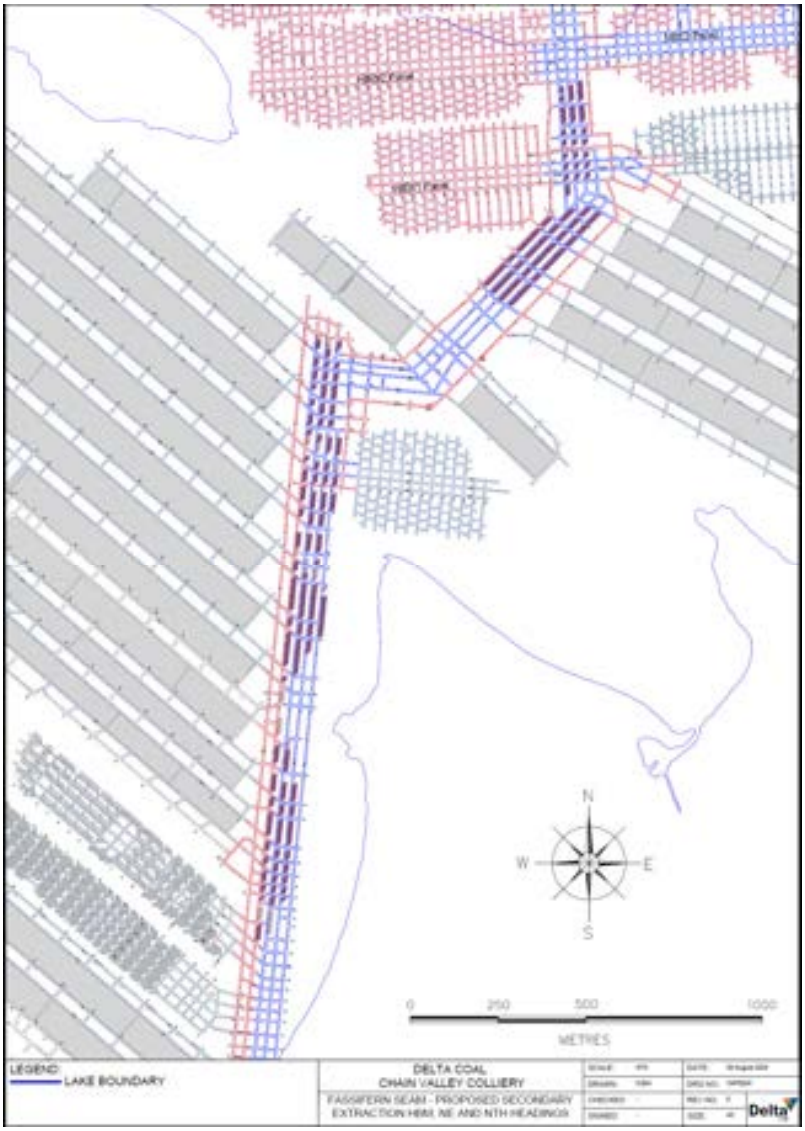


FIGURE 1.1. Plan Indicating Proposed Secondary Extraction (client-supplied)

Without digressing into a detailed explanation, mining in this general area of Chain Valley is subjected to various restrictions that are intended to protect a range of surface infrastructure, landform and flora from the potential impacts of mining-induced subsidence (see **Figure 1.2**). The primary surface concerns in this area of the mine are:

(i) areas of sea grass in shallow water in close proximity to the high water mark, and

(ii) the high water mark itself,

with the proximity of secondary "*extraction*" beneath Lake Macquarie being controlled by Angles of Draw (AoD) of 26.5° and 35° respectively (see **Figure 1.2**).

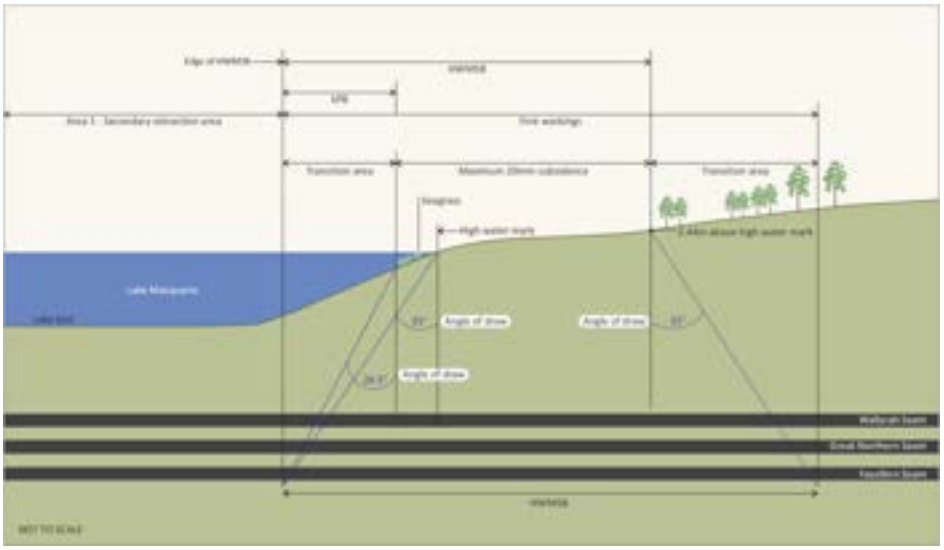


FIGURE 1.2. Current Prescribed Mining Limits in Proximity to the Lake Macquarie Foreshore

It is also understood that maximum allowable subsidence at the lake bed above areas of secondary extraction is set at 780 mm, this presumably being to protect the mine workings from potential inundation from the lake via the development of mining-induced sub-vertical continuous fractures from the working horizon through to the lake bed.

The supplied Scope of Work (SoW) listed the following matters to be addressed:

- geological\geotechnical environment (including any potential influence of already extracted adjacent miniwalls – see **Figure 1.1**)
- coal pillar design – both prior to and post mining for completeness
- roof and rib support review for the proposed secondary extraction (specifically minimum requirements for implementation within a second workings TARP – to be developed by the mine)
- height of any mining-induced connective fracturing above the Fassifern Seam workings post-secondary extraction
- estimation of induced surface subsidence at the base of the overlying Lake Macquarie and any nearby shoreline areas (as are evident in **Figures 1.1** and **1.2**)
- potential subsidence impacts at:
    - the lakebed
    - areas of sea grass
    - the lake foreshore

  - minor cliffs
  - built features

- any monitoring requirements to confirm as-built vs as-designed system stability and behaviour

In addressing the supplied SoW the following specific technical issues were identified for detailed analysis:

- miniwall chain pillar stability in the context of outbye barrier pillar adequacy against the main headings where secondary extraction is being planned
- pre-existing main headings pillar stability in the context of whether they are sufficiently stable to be reduced in dimension by second workings in the first instance
- post second workings stability of the remnant pillar system based on:
  (a) any beneficial spanning ability from overlying massive strata units and/or the geometry of the remnant workings more generally in terms of panel width to depth (W/H),
  (b) the remnant pillars themselves, and
  (c) the likely condition of the immediate floor beneath loaded remnant pillars.
- estimates of post-mining overburden "*settlement*" (as opposed to "*subsidence*" within a subsidence "*trough*" as would be the case with full extraction over much broader areas) due to long-term loading of the remnant pillar system (NB this includes any potentially adverse impact on overlying workings in either the Great Northern or Wallarah Seams that might otherwise further increase mining-induced surface subsidence due to the proposed secondary extraction in the underlying Fassifern Seam)
- estimates of maximum induced tilts, curvatures, and horizontal strains within the settlement footprint due to the proposed mining
- Angles of Draw (defined as the limit of 20 mm of measurable vertical subsidence) outside of the extracted coal footprint
- overburden fracturing estimates (if any) up from the coal seam into the overburden due to mining
- comments as to the impacts (if any) of mining-induced subsidence on the various listed features
- an analysis of likely ground stress changes (both horizontally and vertically) due to the proposed secondary extraction, this being one of the necessary pre-cursors in considering the need or not for additional roof or rib support for secondary extraction purposes
- analysing roadway roof span changes in proximity to the area of lifting-off (where two BLS's will be in use) as part of determining whether secondary roof support is generally required to maintain roadway roof stability at acceptable levels during lifting-off or not
- an understanding of pre-existing roadway roof and rib stability in the planned lifting-off roadways, this being assisted by the findings of a recent (**Mine Advice 2024**) roadway roof stability review in the HBE3 area on the inbye side of this study area. In addition, the study area was formally

inspected by the author on 20th September 2024 along with a review of mapping and/or monitoring results from same.

- safety-based operational implementation matters for mine site consideration – including safe work locations and monitoring for both on-going pillar system stability and/or roadway stability during lifting-off

It is being assumed for the sake of completeness that the mine site will be interested in any additional secondary extraction opportunities that might be identified that do not exceed the defined subsidence impact limits.

2.0 RELEVANT GEOTECHNICAL CHARACTERISATION

This section of the report contains details of assumed geological and/or geotechnical conditions of potential relevance to a pre-mining secondary extraction geotechnical assessment.

2.1 Cover Depth

Cover depth (uncorrected for the lower density of water in the lake as compared to that of fresh rock material) varies from 145 m at the inbye end of proposed secondary extraction in the Herringbone Mains, to 200 m in the vicinity of 39 C/T in the North Headings, this being the outbye end of the secondary extraction area under consideration herein (see **Figure 1.1**).

2.2 Seam Thickness

The full Fassifern Seam thickness is in the order of 6 to 6.5 m however the nominal working section is only 3.2 m thick (to the top of the FC Ply - see **Figure 2.1**) with coal/stone bands left in place in the immediate roof and a sequence of coal/stone/claystone bands in the immediate floor below the development working section to the base of the coal seam. It is noted that in the area of interest, the Fassifern Seam is not subjected to roof or floor splits, hence a relatively consistent seam section is being assumed for assessment and design purposes.

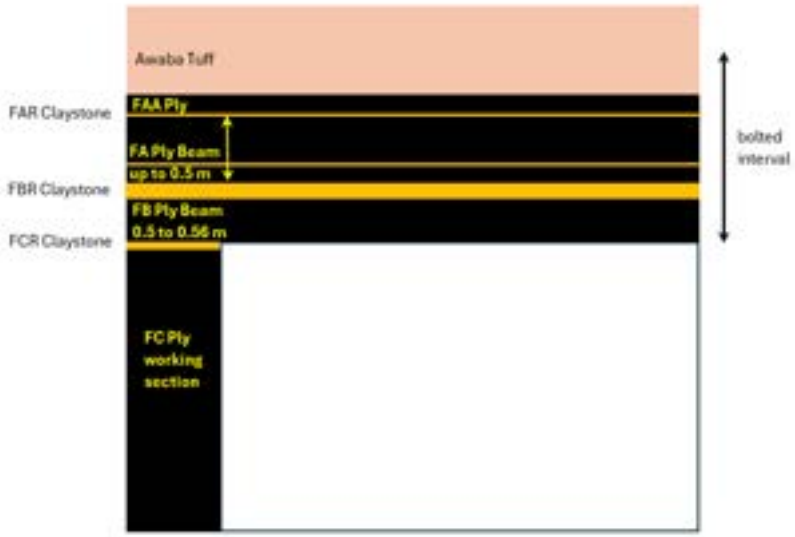


FIGURE 2.1. Idealised Roadway Roof Lithology and Working Section Summary

For coal pillar design purposes, the nominal roadway development height of 3.2 m will be taken as representing the coal pillar height on development unless known otherwise.

2.3 Significant Overburden Lithology

Whilst the geotechnical nature of the overburden is not typically a primary consideration for either first workings bord and pillar mining or partial extraction second workings (as in the case herein), in some instances the presence of thick, massive sandstone or conglomerate units can be of value if there is a need to justify mining panels being of "*sub-critical*" width such that Full Tributary Area (FTA) loading of remnant coal pillars does not necessarily apply.

The general stratigraphic sequence above the Fassifern Seam to the base of the lake bed typically contains one or more massive conglomerate and/or sandstone units of varying thickness that historically have resulted in difficult caving conditions during full pillar extraction, particularly in the Great Northern Seam which is directly overlain in many areas by the Teralba Conglomerate. A general overburden lithological sequence above the Fassifern Seam to surface is shown in **Figure 2.2**

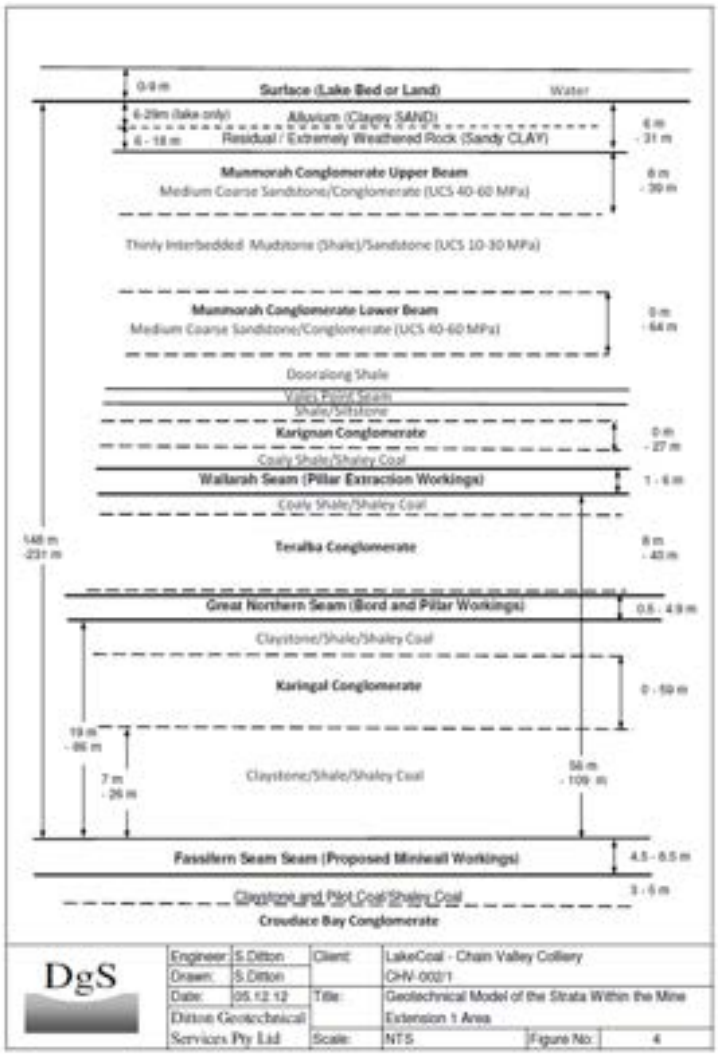


FIGURE 2.2. General Overburn Lithology and Naming Conventions (client-supplied)

Based on work conducted at mines adjacent to Chain Valley, it is found to be generally the case that when one massive conglomerate unit thins (as demonstrated by the thickness ranges for individual conglomerate units in **Figure 2.2**) another thickens up in the same vicinity.

Based on supplied thickness isopachs, the Teralba Conglomerate immediately above the Great Northern Seam has a minimum thickness in the order of 20 m and a maximum thickness in the order of 40 m within the study area. Conversely, the Karingal Conglomerate between the Fassifern and Great Northen Seams is either absent or not well developed within the study area.

2.4 Immediate Working Roof

In general terms, the immediate working roof consists of three coal plies (FB, FA and FAA) as shown in **Figure 2.1** with an exposure of these coal plies being shown in **Figure 2.3**.

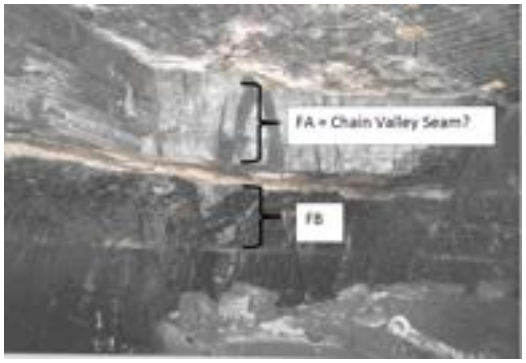


FIGURE 2.3. Immediate Roof Exposure Above the FC Ply

The significance of coal "*beams*" (as can be clearly identified in **Figure 2.3**) to both primary and secondary extraction roadway roof control (which was outlined in detail in **Mine Advice 2024**) within the study area will be discussed in more detail later in the report.

2.5 Immediate Working Floor

Figure 2.4 contains Fassifern Seam roof, seam and floor sections from three boreholes relevant to the "*northern*" section of the mine (**BGS 2024**) proximate to the study area, with the intended normal roadway development section 3.2 m down from the base of the B Ply (FBR Claystone) being marked by red shading.

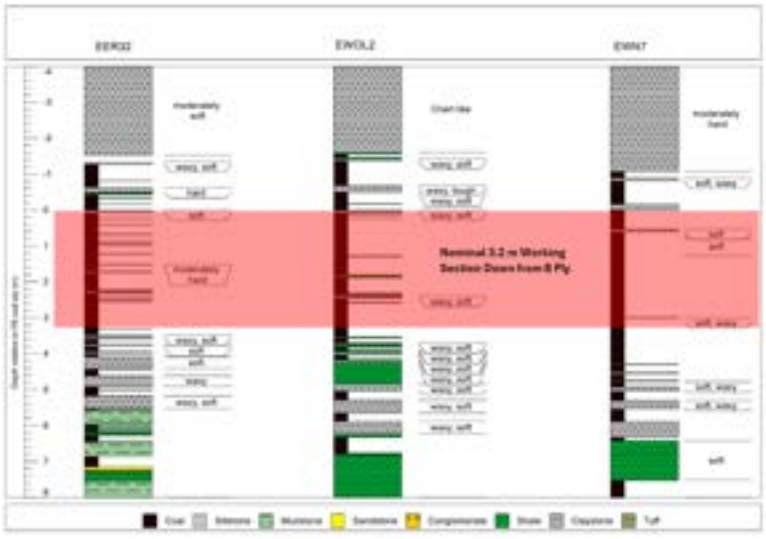


FIGURE 2.4. Various Seam Sections with Intended Development Working Section (sourced from BGS 2024)

The seam sections in **Figure 2.4** indicate that the initial 5 m of seam floor beneath the working section (and therefore beneath coal pillars as defined by the roadway development section) consists of varying

thickness bands of coal (including the thin Upper and Lower Pilot Seams) and stone/clay materials underlain by a section of thicker shale/mudstones that are underlain by the Croudace Bay conglomerate, as per **Figure 2.2**.

Due to the propensity for clay materials to degrade under the action of water, varying band thicknesses and the variability of groundwater within the coal seam over geological time, attempting to assign specific UCS values for each clay/stone band according to varying location in the mine can be fraught with difficulty and uncertainty, particularly if cored boreholes from within a study area are not available for detailed analysis. Therefore, as will be outlined later in the report the significance of this relatively low strength immediate floor sequence will be addressed by applying established general criteria for limiting average pillar stress with the potential for floor failure beneath the pillar and associated increased mining-induced subsidence at surface.

2.6 Pre-Mining Horizontal Stresses

The likely magnitude and alignment of pre-mining horizontal stresses within the Chain Valley area were analysed in **Mine Advice 2024** based on two *in situ* stress measurements taken in the North Headings at Chain Valley as reported by **Coffey Partners 2015**. These two measurements were taken in the roof the Fassifern Seam at a distance of at least 1.5 times the roadway width from the roadway excavation.

The back-analysis used a recently developed version of the **Nemcik *et al* 2005** *in situ* stress model as detailed in **Frith and Reed 2024,** and determined the two horizontal stress parameters that are directly linked to tectonic horizontal strain, namely:

- Tectonic Stress Factor for the major horizontal stress (TSF_H)
- Tectonic Stress Factor for the minor horizontal stress (TSF_h)

Source	TSF_H average (range)	Major to Minor Conversion Factor	TSF_h average (range)	Alignment of σ_H (GN)
Coffey Partners 2015	0.88 (0.82 to 0.93)	0.48 (0.4 to 0.56)	0.41 (0.35 to 0.46)	290°

TABLE 2.1. Summary of Tectonic Horizontal Stress Characteristics

Table 2.1 provides a summary of back-analysed values for TSF_H and TSF_h as well as the orientation of the major horizontal stress for references purposes.

2.7 Major Geological Structures

Mapped faults within the general Chain Valley/Mannering mine area are typically aligned either NW-SE or NNE-SSW based on supplied information or by reference to historical mine plans whereby the presence of operationally significant faults can be reasonably inferred from the shape and extent of the workings. The former is consistent with the orientation of the Newcastle Syncline, while the latter is consistent with the orientation of the Lochinvar Anticline, the Macquarie Syncline, the Offshore Uplift, and the long axis of the Newcastle Coafield more generally.

A review of mapped faults in nearby overlying Wallarah Seam workings confirms these general alignments and that many of the faults have displacements of 3 m and less. It is also the case that faults tend to be continuous along strike rather than being characterised by stepped/*en echelon* sections.

Ditton Geotechnical Services 2017 describe a normal fault with a 13 m displacement and a dip of 75°. **Lohe and Dean-Jones 1995** state that regional structures include NW and NE striking normal faults with throws typically in the range 0.5 m to 2 m. Low angle thrust faults may also be present on the NE strike.

In the context of this study, major geological faults are known to exist within the study area and represent a geotechnical hazard for two basic reasons:

(i) poor/potentially unstable local strata conditions during lifting-off if attempted in direct proximity to faults or within fault-affected conditions.

(iii) based on their orientation and characteristics, larger-scale faults can modify/reduce overburden stability above extraction panels thereby increasing the potential for elevated subsidence levels as compared to pre-mining predictions.

The potential impact of known faulting within the study area will be addressed later in the report.

2.8 Overlying Workings

The presence or absence of overlying workings in either the Great Northern and/or Wallarah Seams is of direct relevance to this study in the context of both (a) elevated levels of mining-induced subsidence as compared to that predicted for the Fassifern Seam workings only, and (b) whether the spanning ability of the overburden can credibly assist the on-going stability of remnant Fassifern Seam workings (to be discussed later in the report).

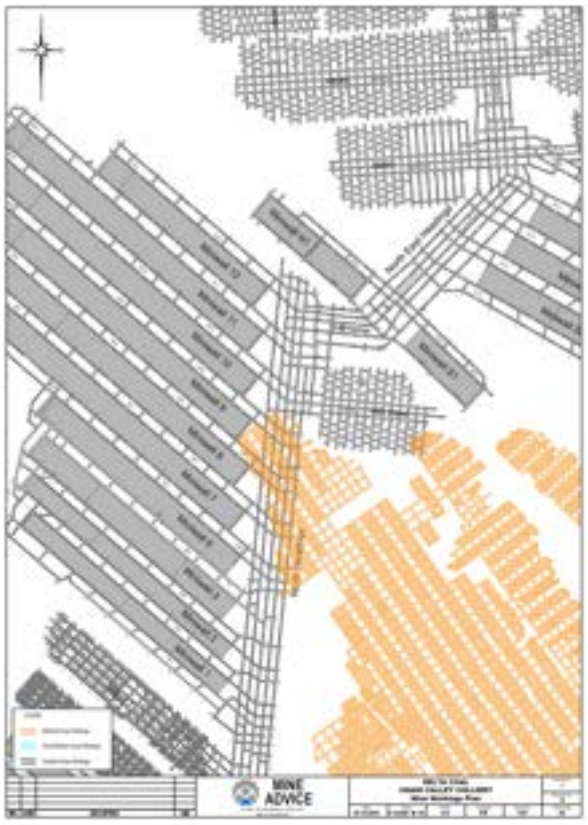


FIGURE 2.5. General Area of the Mine and Overlying Wallarah Seam Workings

Figure 2.5 shows the general area of the Fassifern Seam workings plus the overlying Wallarah Seam workings (marked in orange) which consist of a localised area of relatively narrow extraction panels (in the order of 35 m wide) separated by chain pillars with a solid width in the order of 30 m based on supplied information. It is assumed that these workings were intentionally designed to limit surface subsidence impacts in and around the lake foreshore by (a) limiting overburden caving within extracted areas and (b) leaving stable chains pillars in place between extraction panels.

It is confirmed that there are no Great Northern Seam workings overlying the specific Fassifern Seam study area.

3.0 HAZARD IDENTIFICATION AND CONTROL

Geotechnical hazards associated with the proposed secondary extraction consist of safety, business and environmental risks, noting that safety and environmental risks represent business risks in broader terms. The various hazards also sub-divide into:

(i) global strata instability risks related to the panel layout including remnant pillars being inadequately stable during and/or after active mining, and

(ii) operational risks linked to ensuring effective strata control during mining, this being a combined function of both the installed ground support, tailoring the actual second workings layout to known geological conditions following first workings, and the enforcement of pre-defined safe-standing zones.

Specific hazards directly linked to layout design and strata-control during operations are as follows:

1. Major pillar "*collapse*" (as opposed to a very gradual "*squeeze or creep*") either during or following active mining.

2. A sufficient reduction in local coal pillar stability or pillar system stability (i.e. including the floor) during active mining so that local roadway conditions (particularly roof and/or ribs) deteriorate as a direct consequence thereby increasing strata control safety hazards during active mining to unacceptable levels.

3. Uncontrolled roof falls in lifted-off areas during active mining with the potential to extend into areas where persons are required to be located (e.g. CM driver, cable-hand, shuttle car driver).

4. Generally changing local strata conditions in active roadways due to second workings and associated ground stress changes (horizontal and vertical).

5. Unacceptable surface and/or sub-surface mining-induced impacts.

This report specifically addresses the issue of large-scale panel and coal pillar stability both during and following the completion of second workings, as well as local strata control matters as related to the planned second workings and associated ground stress changes.

In terms of controls it is a fundamental tenet of effective geotechnical design that if strata control "*problems*" develop during mining operations, they are "*manageable*" in the sense that:

- the onset of the problem can be identified early,
- the problem develops slowly over time, and
- the problem can be remediated safely or conversely the problem area can be abandoned well before persons are exposed to significantly elevated safety threats.

These three characteristics are the foundation of operational management plans and TARPS, both on development and as in the case of this report, during second workings.

4.0 ASSESSMENT OF SECOND WORKINGS "*ENGINEERED*" CONTROLS

Minimisation of safety risks during mining operations to acceptable levels is achieved within a Hierarchy of Controls approach via "*isolation*", "*engineering*" and "*administrative*" controls as per **Figure 4.1**, noting that "*elimination*" and "*substitution*" controls cannot be practically applied to operational strata control and "*PPE*" is insufficient other than for the prevention of minor injuries. In terms of mining-induced impacts, administrative controls cannot be relied upon due to the time delay between mining taking place and associated problems manifesting and being identified either on surface or sub-surface.



FIGURE 4.1. Generic Hierarchy of Controls Representation

As the highest control level under this system, "*isolation*" is a critical strata control safety control in operations, particularly in and around a continuous miner that is forming-up new excavations, either as part of first or second workings. In particular this relates to (a) delineating safe work locations during active mining and (b) the integrity of roof/rib mesh (where present) in controlling small-scale roof/rib instability as may occur from time to time. In terms of mining-induced impacts, isolation can be readily applied as is clearly evident in **Figure 1.2** using limiting Angles of Draw.

"*Engineering*" controls include those that need to be analysed and assessed prior to mining including changing coal pillar stability and floor stability during the mining process. Roof and rib stability including the adequacy of installed roof and rib support is finalised once a production panel is fully driven so that actual vs predicted strata conditions can be objectively and meaningfully assessed, including the decision as to whether all planned lifting sequences (see **Figure 1.1**) can be safely mined according to local strata conditions. Therefore, whilst being generically an "*administrative*" control, there is nonetheless a requirement for "*engineering*" review during a second workings/extraction pre-mining review, all of which is already established in mining operations at Chain Valley.

"*Administrative*" controls are pre-dominantly workforce-based and include (a) delineating and adhering to safe work locations during active mining, (b) forming up second workings in the specified location to the specified maximum or indeed minimum dimensions, and (c) being aware of changing strata conditions both before and during active mining in order to effectively apply a Second Workings TARP (already developed by the mine – as TARP 00140) and/or make-safe as necessary, barring down potentially loose, unstable material being an example.

This section of the report directly addresses relevant "*engineering*" controls for the proposed secondary extraction, with the final section providing commentary on operational control of strata control risks during and after the completion of second workings.

4.1 Identification of Different Study Zones

A review of the study area immediately requires that it be sub-divided into different "*zones*" according to both the secondary extraction that is being proposed and proximity to the lake foreshore (see **Figure 4.2**).

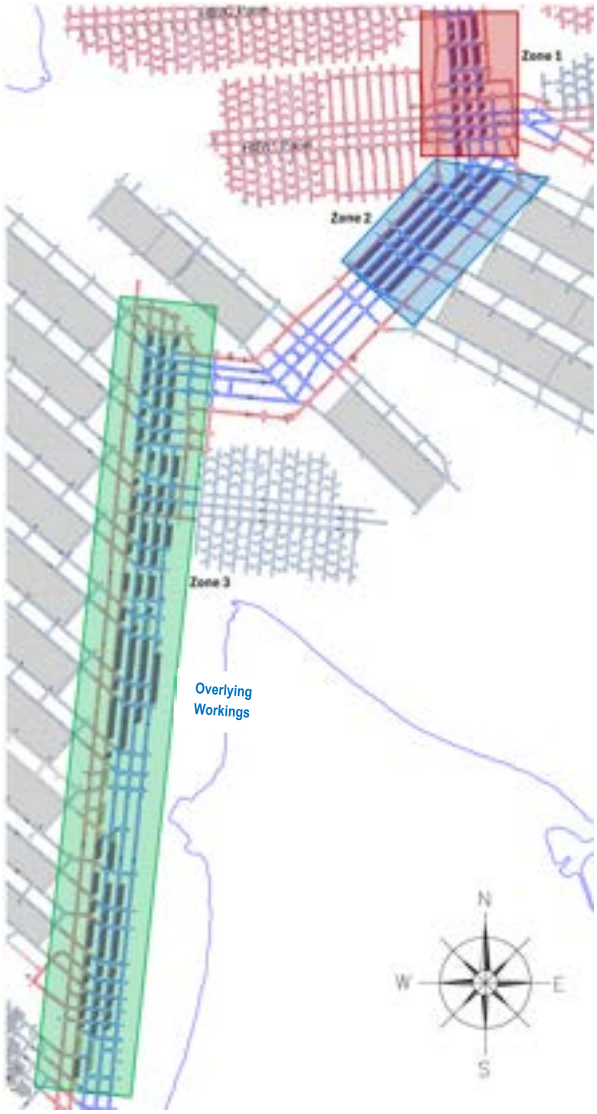


FIGURE 4.2. Zoning of Study Area

The three study zones are described as follows:

Zone 1 (Herringbone Mains): three lifting runs within three rows of pre-dominantly square pillars with the lake foreshore just to the north – maximum cover depth of 150 m and no overlying workings.

Zone 2 (NE Headings): three or four lifting runs within three to four rows of pre-dominantly "*long*" pillars with no proximity to the lake foreshore – maximum cover depth of 170 m and no overlying workings.

Zone 3 (North Headings): typically three lifting runs within varying length pillars with one localised area of four lifts within three pillars and several areas of individual pillar plunges only (similar to current herringbone mining practice) plus proximity to the lake foreshore to the east – maximum cover depth of 200 m and one localised area with overlying Wallarah Seam workings as marked (see **Figure 2.5** for more detail).

To meet the objectives of the study and potentially optimise mining layouts by maximising coal recovery, it is necessary to analyse the study area according to this proposed zoning sub-division.

4.2 Coal Pillar Dimensions and Pillar/Panel Stability

Mining constraints that must be adequately accounted for in the pre-mining panel layout design and assessment process include:

1. First workings pillar system stability needs to be sufficient to allow pillar reduction during second workings to be undertaken in the first instance (NB this requirement is not as significant for partial extraction as compared to full pillar extraction whereby coal pillars at the goaf edge are likely to be subjected to substantial vertical abutment stress effects during second workings – as discussed in detail by **Galvin 2016**).

2. Safety is paramount (particularly during second workings when coal pillars are being substantially reduced in size), in particular minimising if not eliminating the potential for the following safety threats via fit for purpose panel layout designs:

    - windblasts due to large-area plate-like roof falls
    - highly stressed roof, rib, and/or floor conditions during second workings that might lead to elevated strata instability and injury potential in the active working area
    - persons being exposed to goaf falls/flushing into active mine workings during second workings.

    The primary objective of effective panel layout design is to ensure that any unplanned or unexpected mining conditions manifest slowly over time so that they can be identified early and responded to during operations via an operational TARP before any associated safety threats become significant. This is the fundamental principle behind the effective use of safety management plans in operations, as compared to incidents that occur with little or no prior warning so that appropriate actions cannot be taken in a safe and timely manner.

3. Remnant layouts are consistent with maintaining mining-induced surface and sub-surface impacts at either tolerable or regulated allowable levels.

This section of the report outlines how the pre-existing first workings and planned secondary extraction have been analysed in terms of (i) the general stability of the workings, (ii) safety during both first and second workings, and (iii) the likely condition of remnant coal pillars and the entire panel more generally after the completion of mining.

The first coal pillar design consideration is stability during first workings and the extent to which coal pillars are suitably stable to permit some form of second workings. For this, two independent pillar design criteria have been applied, namely:

(i) Factor of Safety and associated Probability of Failure under the UNSW Pillar Design Procedure (UNSW PDP), in combination with

(ii) width to height ratio (w/h), which has a controlling influence on the mode/rate of post-peak pillar deterioration and is fundamental to maximising operational safety within the workings. In particular w/h ratio is the dominant control as to whether pillars are prone to rapid and sudden structural collapse (w/h < 2 typically), or conversely slowly "*squeeze*" over time as the pillar work-hardens post its designated peak strength (w/h > 4) – see **Figures 4.3** and **4.4**.

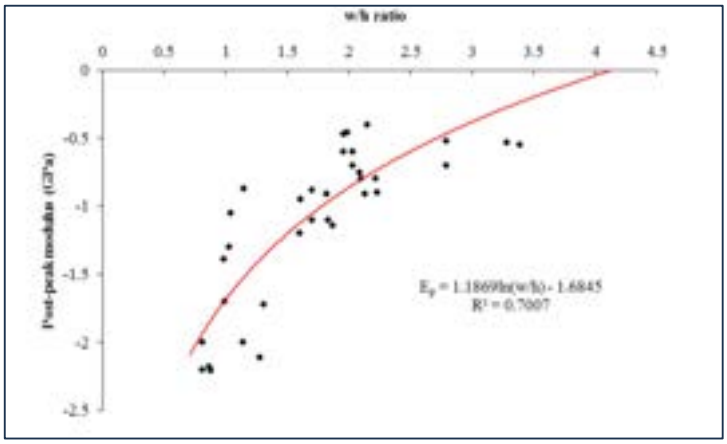


FIGURE 4.3. Relationship Between the Post-Peak Modulus and w/h Ratio of Pillars Based on Field Tests (Vardar *et al* 2017)

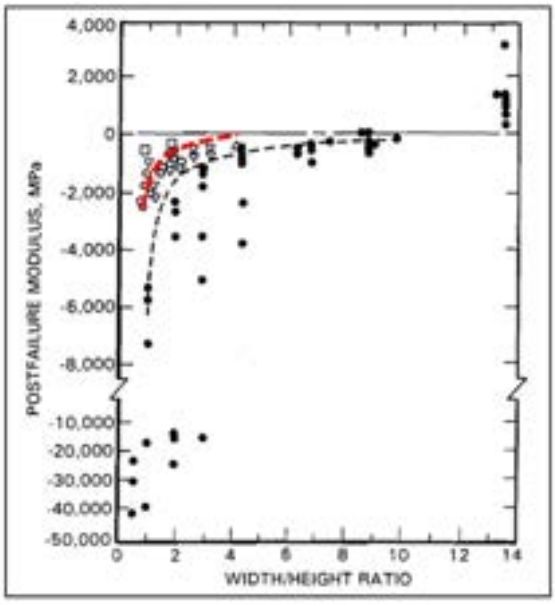


FIGURE 4.4. Post-Failure Stiffness of Coal Pillars as a Function of Width to Height (w/h) Ratio (Chase *et al* 1994) – NB open symbols represent *in situ* tests (Reed *et al* 2016)

The manifestation of a pillar stability assessment using both FoS and w/h is shown in **Figure 4.5**, noting that this general approach to the design of long-term stable coal pillars has been successfully applied at the Ensham Mine in QLD as an example, whereby minimum remnant pillar FoS values as low as 1.6 are deemed permissible in their EA approval conditions in areas with no major surface constraints.

A more detailed discussion of the significance and benefits of combining pillar FoS and w/h ratio for pillar design purposes is contained in **Reed *et al* 2016**, which also brings the condition and stability of the overburden between "*barrier*" pillars via the width to depth (W/H) ratio of the panel into the pillar design process, which is relevant herein as will be detailed later in the report.

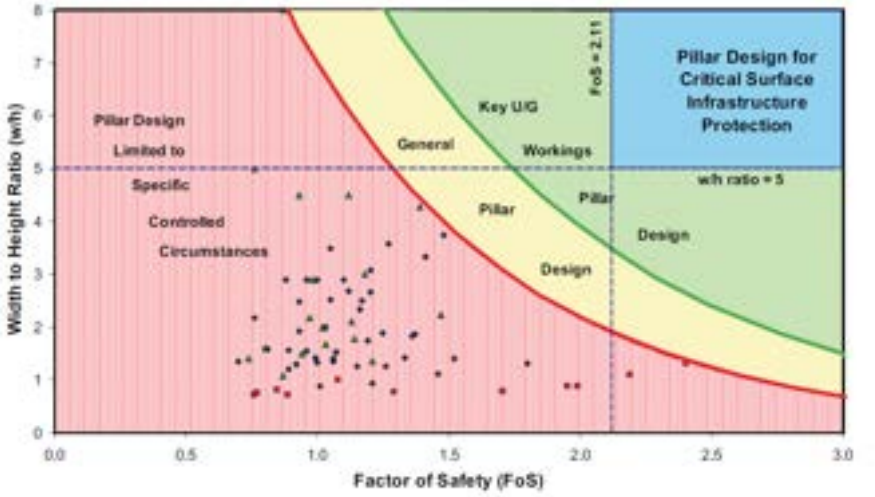


FIGURE 4.5. Design Criteria for Bord and Pillar Workings Based on Combining Factor of Safety and Pillar Width to Height Ratio (Hill 2005)

The general engineering design process that has been applied to support any conclusion that the proposed secondary extraction meets all of the required risk-based criteria as listed previously, is as follows:

1. Coal pillar system stability and associated mode of pillar/pillar system deterioration (however unlikely) needs to be suitable for both (a) first workings development on the advance and (b) planned secondary extraction on the retreat.

2. The potential for pillar punching into underlying low strength floor measures, either during or following the completion of secondary extraction.

3. Consideration of the additional stability benefits of panel dimensions between either barrier pillars (inside or outside of the panel) and/or solid coal around the panel.

Each of these panel layout considerations will now be discussed and justified in detail for each of the three study zones as defined and described previously.

4.2.1 First Workings Pillar Stability

Table 4.1 contains pillar FoS (under the UNSW PDP) and w/h ratios for typical sized pillars within each study zone using an assumed nominal heading width of 5.5 m as per current roadway development practice and a nominal pillar height of 3.2 m, as described previously.

	Typical Pillar Dimensions (m - centres)	Cover Depth (m)	Factor of Safety (UNSW PDP)	width:height ratio
Zone 1	30 x 30	150	3.38	7.66
Zone 2	46.8 (mid to lower range within the zone) x 30	170	3.62	7.66
Zone 3	46.4 (mid to lower range within the zone) x 30 (minor variations exist within the zone)	200	3.07	7.66

TABLE 4.1. First Workings Pillar Stability Parameters by Zone

By reference to:

(a) the UNSW PDP whereby the Probability of Failure at 200 m cover depth is significantly less than 1 in 10 million (i.e. the FoS is >> 2.23), and

(b) pillars being in the "*squat*" range by virtue of w/h being >> 4,

it is concluded that the pre-existing coal pillars within the three defined zones are adequately stable for first workings and permit pillar reduction of some form during second workings, the extent of which needs to be verified by an analysis of remnant pillar stability post second workings and any safety-based concerns that may emanate.

4.2.2 Remnant Pillar Stability (Remaining Pillars Only)

The "*generic*" remnant pillar layout has been analysed for pillar stability after the completion of secondary extraction within the three defined zones, the maximum lifting-off plunge depth perpendicular to the heading being taken to be 10.3 m (13.05 m from the centreline of the heading) as determined from a supplied lifting-off plan (**Figure 4.6**).

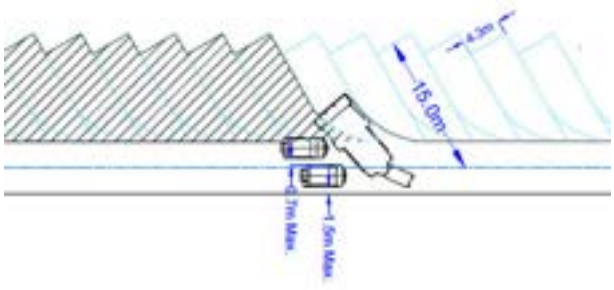


FIGURE 4.6. Client-Supplied Proposed Lifting-Off Geometry for Single-Sided Lifting

A typical remnant pillar has been characterised by fully lifting-off one side of the pillar to the maximum lifting depth of 13.05 m from the heading centreline (thereby accounting for any first workings heading width variations that may exist) with any stooks left outside the defined remnant pillar area being ignored for pillar stability purposes (as shown in **Figure 4.7**).

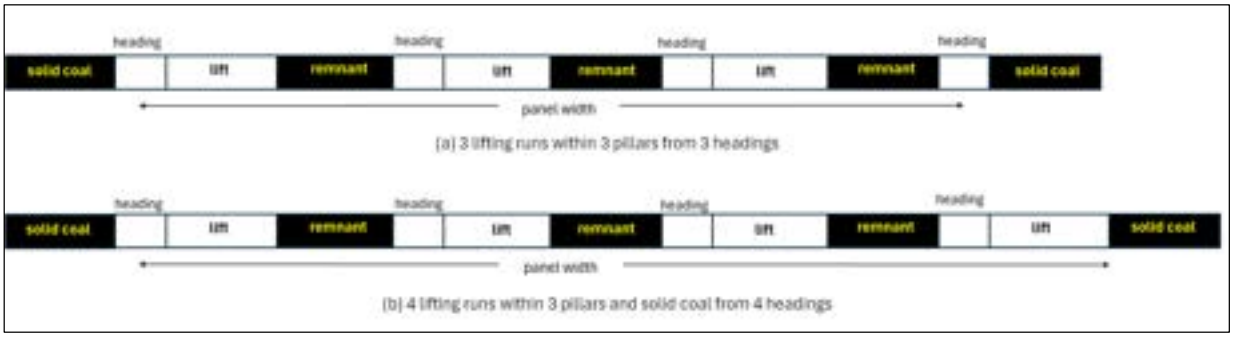


FIGURE 4.7. Client-Supplied Proposed Lifting-Off Geometries for Single-Sided Lifting

The results from analysing remnant pillars under full tributary area loading (ignoring the lower density of the lake and lake-bed sediments) are provided in **Table 4.2**.

	Typical First Workings Pillar Dimensions (m - centres)	Cover Depth (m)	Factor of Safety (UNSW PDP)	Minimum width:height ratio of Remnants	Panel Width (m)	Panel W/H Ratio (to base of lake)	Average Remnant Pillar Stress (MPa)
Zone 1	30 x 30	150	1.39	4.44	90	0.64	9.52
Zone 2 (3 lifts)	46.8 (mid to lower range within the zone) x 30	170	1.38	4.44	90	0.56	9.98
Zone 2 (4 lifts)		170	1.21	4.44	103.5	0.64	11.43
Zone 3 (3 lifts)	46.4 (mid to lower range within the zone) x 30 (minor variations exist within the zone)	200	1.17	4.44	90	0.47	11.76
Zone 3 (4 lifts)		200	1.03	4.44	103.5	0.54	13.46

Table 4.2. Summary of Remnant Pillar Stability under Assumed Full Tributary Area Loading to Surface

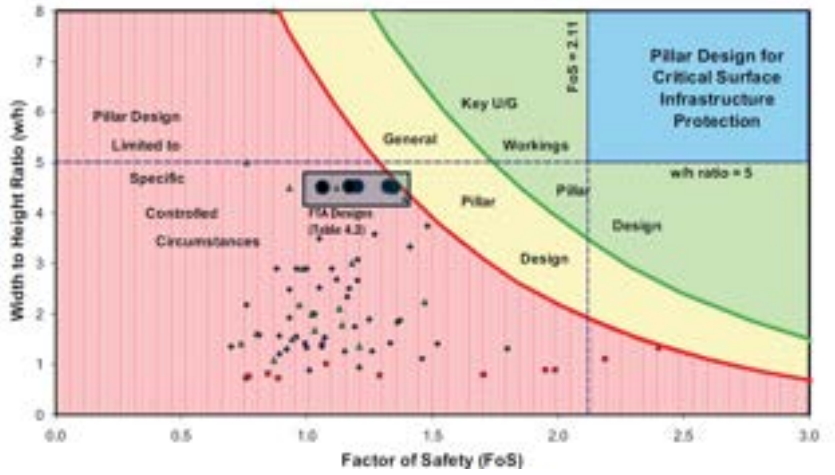


FIGURE 4.8. Full Tributary Area Remnant Pillars - Hill 2005 Representation (Table 4.2)

When plotted on the **Hill 2005** representation (**Figure 4.8**) the remnant pillar designs contained in **Table 4.2** for full tributary area (FTA) loading are classified as "*pillar design limited to specific control*

circumstances" and are consistent with known pillar failures. Hence further consideration is required before the proposed remnant pillar designs can be accepted for implementation into operations.

Hill 2005 provides the following description linked directly to the "*red*" zone in **Figure 4.8**:

> "*short-term production panels, with considerable local knowledge: design may be within the failed pillar database limit envelope under controlled circumstances*"

As a result it is concluded that other controls are necessary in order to produce a suitably robust remnant pillar stability design, one being an "*engineered control*" linked to panel width to depth (W/H) ratio, the other being "*administrative controls*" via the second workings TARP, including specific triggers under which pillar lifting must cease and additional coal be left in place as a direct consequence.

4.2.3 Beneficial Influence of Panel Width to Depth (W/H) Ratio

4.2.3.1 Technical Discussion

Having evaluated remnant pillar FoS and w/h ratio under FTA loading and found them to be insufficient on their own to justify remnant pillar design given both the safety implications of pillar deterioration and the need to limit mining-induced subsidence impacts, it is necessary and of potential benefit to address the role of the overburden in remnant pillar system stability.

In general terms it is well established in the published literature that the stiffness of the overburden needs to be suitably low for coal pillars to be rapidly driven to a state of full collapse if they become over-loaded.

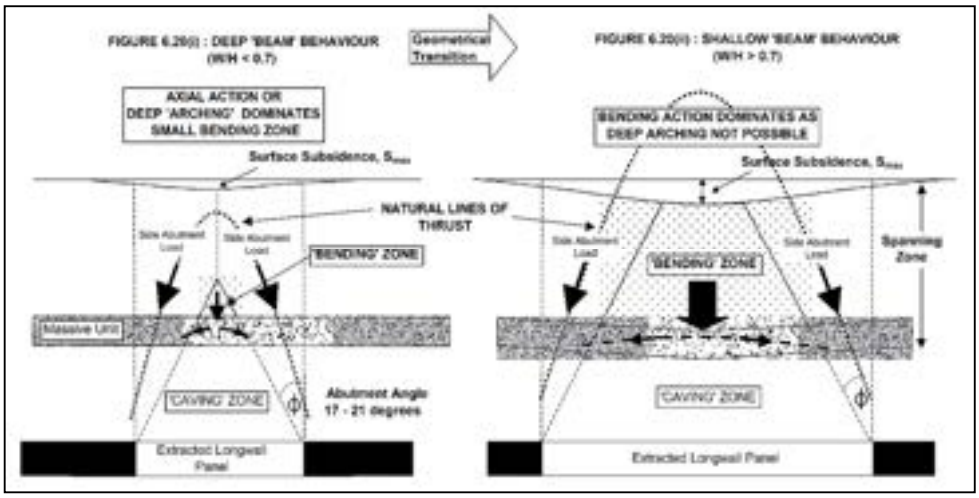


FIGURE 4.9. Schematic Representation of the Mechanics of Sub-Critical ("Deep" Beam) and Super-Critical ("Shallow" Beam) Subsidence Behaviour (Ditton and Frith 2003)

An instructive way to address overburden stiffness is to use the established concepts of "*sub-critical*", "*critical transition*" and "*super-critical*" surface subsidence as illustrated in **Figure 4.9** with actual subsidence data being provided in **Figure 4.10**, this representation being known colloquially as a "*Holla*" curve after the late Lax Holla.

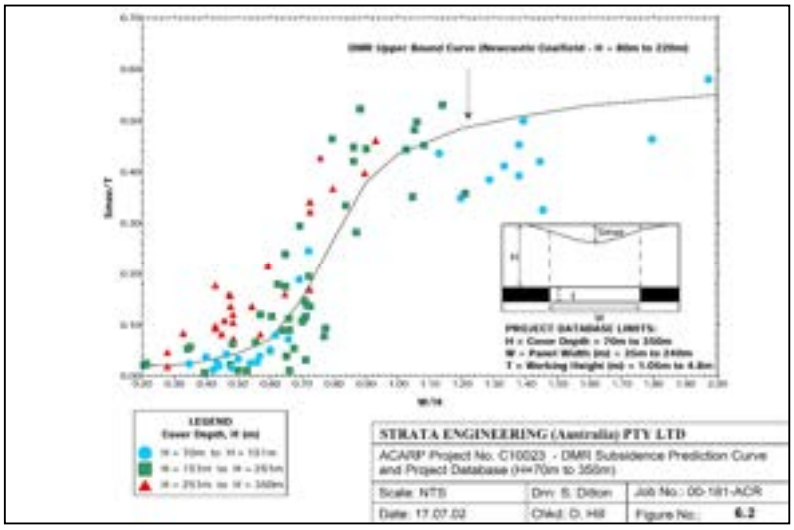


FIGURE 4.10. Measured S_{max} Values Analysed According to Extraction Height (T), Panel Width (W) and Cover Depth (H) (Ditton and Frith 2003)

The objective is to demonstrate that it is only in the super-critical range whereby the entire overburden to surface loses most (if not all) of its inherent stiffness and stability so that it effectively then behaves as a "*detached*" or "*kinematically unstable*" loading block (with no inherent stiffness) so that over-loaded coal pillars can be driven to a state of full collapse.

Conversely, in the sub-critical range at least a portion of the upper overburden is being controlled by either the excavation geometry as a function of cover depth and/or the spanning capabilities of massive strata units, which by definition must therefore retain a level of stiffness within part of the overburden in that its natural settlement at surface under self-weight is being substantially restricted as compared to super-critical panel conditions.

Case history	State	Depth, m (ft)	Pillar size, m (ft)	ARMPS SF	w/h ratio	Collapsed area, ha (acres)	Collapse size, m (ft)	Damage from airblast
A	WV	84 (275)	3 by 12 (10 by 40)	0.66	1.05	2.3 (5.7)	150 by 150 (500 by 500)	26 stoppings, 1 injury.
B1	WV	73 (240)	3 by 12 (10 by 40)	0.96	1.00	--	--	32 stoppings, fan wall out.
			3 by 18 (10 by 60)	1.10	1.00			
B2	WV	75 (245)	3 by 12 (10 by 40)	0.94	1.00	1.7 (4.1)	100 by 150 (350 by 500)	40 stoppings.
B3	WV	85 (280)	9 by 9 (30 by 30)	1.46	3.00	2.8 (6.8)	180 by 180 (600 by 600)	70 stoppings.
			6 by 12 (20 by 40)	1.47	2.00			
C1	WV	60 (195)	3 by 12 (10 by 40)	1.19	1.00	2.1 (5.2)	140 by 150 (450 by 500)	103 stoppings.
C2	WV	99 (325)	9 by 9 (30 by 30)	1.15	3.00	1.9 (4.6)	100 by 180 (350 by 600)	Minimal.
D	WV	69 (225)	6 by 6 (20 by 20)	1.15	1.62	1.7 (4.3)	100 by 160 (350 by 540)	37 stoppings.
			9 by 9 (30 by 30)	1.42	2.73			
E1	WV	91 (300)	3 by 12 (10 by 40)	0.79	1.42	7.4 (18.2)	240 by 290 (800 by 950)	Major damage.
E2	WV	91 (300)	3 by 12 (10 by 40)	0.71	1.11	6.7 (16.5)	220 by 275 (720 by 900)	Major damage.
F	OH	76 (250)	2 by 12 (7 by 39)	0.68	2.12	2.0 (4.9)	90 by 215 (300 by 700)	Minimal.
G	UT	168 (550)	12 by 12 (40 by 40)	0.95	2.29	7.9 (19.4)	150 by 490 (480 by 1,620)	Major damage, 1 injury.
O	WV	--	--	1.03	2.50	1.8 (4.5)	120 by 150 (400 by 500)	--
R	CO	120 (400)	4 by 24 (12 by 80)	0.97	1.71	2.8 (6.8)	180 by 150 (600 by 500)	Minor damage.

NOTE.—Dash indicates no data available.

TABLE 4.3. Massive Pillar Collapses in US Coal Mines (Mark *et al* 1997)

Evidence for the controlling influence of panel W/H ratio on coal pillar system failures can be found in **Table 4.3** and also the un-published results of a study into pillar failures in Australian highwall mining involving large numbers of coal pillars with very low w/h ratios. The US failed cases in **Table 4.3** all have W/H ratio values > 0.9 but typically > 1.5, which fully mirrors the unpublished highwall mining collapsed cases being exclusively associated with W/H ratio values > 0.9. It is noted that failed cases information published by the University of New South Wales (UNSW) are insufficiently detailed to allow this same analysis.

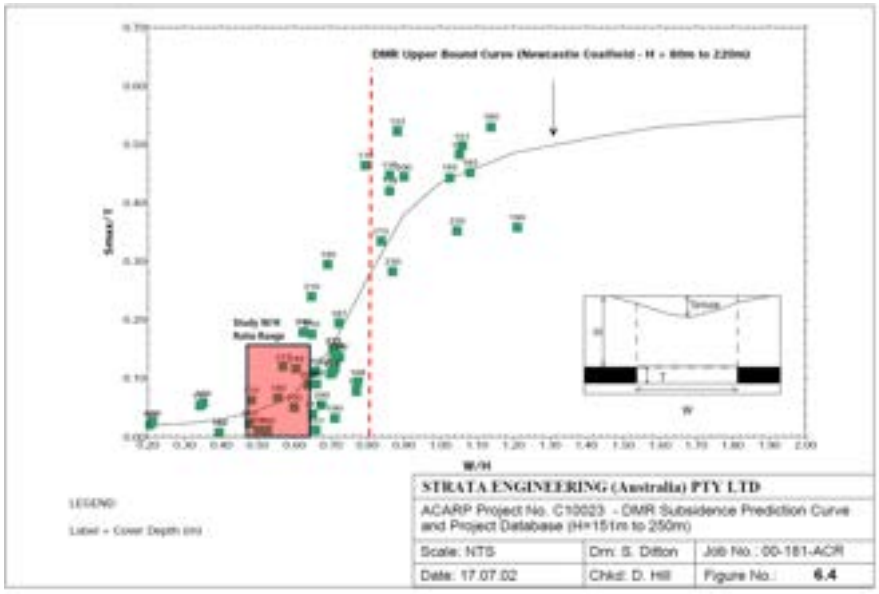


FIGURE 4.11. Measured S_{max} Values Analysed According to Extraction Height (T), Panel Width (W) and Cover Depth (H) for Depths Ranging from 151 m to 250 m (Ditton and Frith 2003)

The significance of a W/H value in the order of ≥ 0.9 is self-evident in **Figure 4.11** which contains measured surface subsidence data (S_{max}) above miniwall and longwall panels for cover depths in the range 151 m to 250 m in the Newcastle Coalfield. The red dotted line represents the approximate "*mid-point*" of the "*critical transition*" whereby values of W/H > 0.8 tend towards super-critical and values < 0.8 tend towards sub-critical.

A minimum W/H value of 0.9 has been found in two separate studies on two different continents as being the lower limiting value for collapsed pillar cases. This strongly confirms (a) the important role of super-critical overburden behaviour and hence low overburden stiffness to surface in actual pillar collapses, and just as importantly (b) the potential additional stabilising influence of W/H values < 0.9 when coal pillars have been otherwise designed under full tributary area loading and found to be inadequate.

Following on from the description of the influence of panel W/H ratio on overburden stiffness to surface according to different surface subsidence conditions, the influence of lithology on overburden stiffness for a given panel width can also be considered.

Two fundamental studies will be referred to in this regard, one relating to the influence of thick near-seam massive strata units on overburden periodic weighting and caveability as it directly impacts longwall face stability (**Frith and McKavanagh 2000**), the other related to the ability of massive strata units to influence surface subsidence magnitudes (**Ditton and Frith 2003**).

Without digressing into significant technical detail, the periodic weighting classification developed by **Frith and McKavanagh 2000** (see **Figure 4.12**) provides a useful first approximation as to how a massive strata unit may behave (i.e. collapse or span an opening) across an unsupported span based on its thickness, the panel width and its material type (specifically conglomerate or sandstone). The defined *"bridging shortwall"* outcome is likely to result in spanning of the unit and therefore, an inevitable reduction in surface subsidence due to overburden sag, from which the retention of significant overburden stiffness can be inferred.

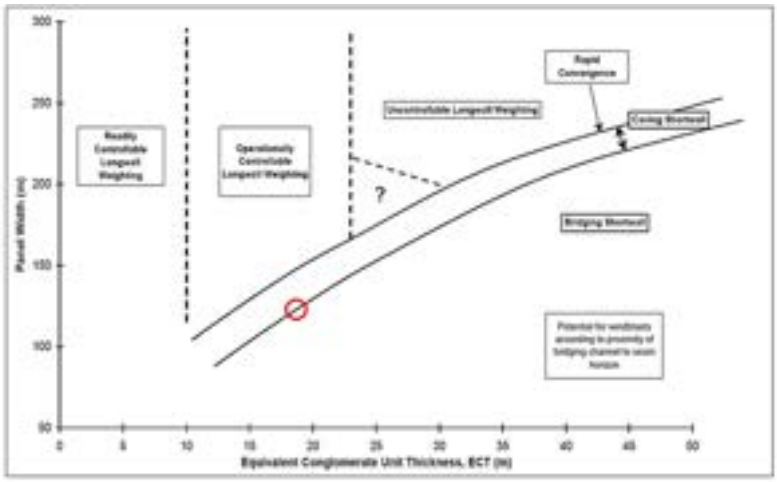


FIGURE 4.12. Periodic Weighting Classification (Frith and McKavanagh 2000)

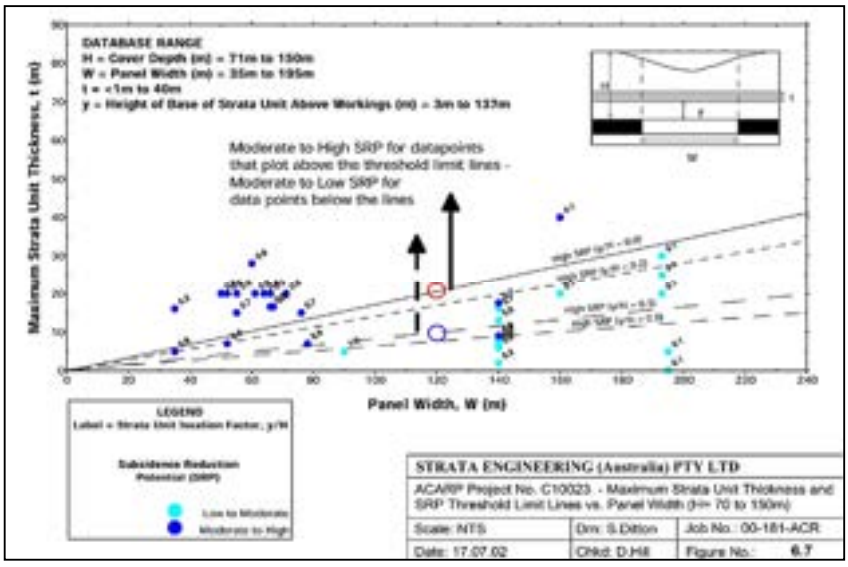


FIGURE 4.13. Subsidence Reduction Potential (SRP) According to Strata Unit Thickness, Location of Strata Unit above the Seam and Panel Width (Ditton and Frith 2003)

The potential spanning ability of thick and massive strata units within the overburden was also recognised and defined by **Ditton and Frith 2003** in relation to the ability of certain strata units to reduce levels of surface subsidence over and above what W/H ratio considerations alone would suggest. **Figure 4.13** is provided as a reference source relating to what is termed as *"Subsidence Reduction Potential"* (or SRP).

As an example, for a panel width of 120 m the strata unit thickness above which spanning of that unit can be reasonably inferred is just under 20 m (marked as red circles in **Figures 4.12** and **4.13**). In other words, two different classification schemes developed to address different mining problems show a very close correlation in terms of the onset of strata unit spanning across an extraction panel of a known width.

Figure 4.13 allows the analysis to be taken a stage further as it brings in the varying location of a thick massive unit within the overburden, the higher the unit above the extraction horizon (as given by y/h in **Figure 4.13**), the lower the unit thickness required to develop "*high*" SRP. This makes sense when natural

arching and consequent narrowing of the span above an extraction panel due to caving is considered (refer **Figure 4.9** for an illustration of this concept). At a distance of half the cover depth above the extraction horizon (i.e. y/h = 0.5 as marked by a blue circle in **Figure 4.13**), the unit thickness required to modify surface subsidence across a 120 m wide panel is only 50% of that required when the unit is present in the immediate roof where y/h = 0).

With knowledge of the W/H ratio of a proposed panel of pillars combined with the thickness and location of any significant lithological units within the overburden, credible predictions can be made as to whether coal pillars will be loaded under full tributary area loading by a "*soft*" loading system (as is commonly assumed in pillar design), or conversely whether a portion of the overburden has the ability to re-distribute some level of load to adjacent barrier pillars or solid coal due to its inherent stiffness and retained stability. This is a very valuable layout aspect to bring into the pillar design process.

4.2.3.2 Panel Width Considerations

The data contained in **Table 4.2** clearly demonstrates that in all instances the panel widths containing remnant pillars (90 m to 103.5 m) are substantially less than cover depth, resulting in panel W/H ratios to the base of the lake ranging from 0.47 to 0.64 (see **Figure 4.11**). These panel W/H ratios are well below the minimum value associated with pillar collapses of 0.9 as described previously. As such, the panel dimensions contain an inherent Safety Factor against pillar deterioration and/or collapse during or following mining in addition to that of the remnant pillars themselves as analysed in **Section 4.2.2**.

More specifically, panel W/H provides a transparent justification for reducing the tributary area loading of pillars, such a modification already being an established part of coal pillar design in the United States for both underground mines (ARMPS) and highwall mining (ARMPS-HWM). Specifically, ARMPS 2010 allows a reduction in pillar loading within a production panel for W/H values < 1, which is entirely consistent with the previous technical discussion on the subject herein. The relevant question becomes what level of reduced coal pillar loading can be justified as a direction function of panel W/H ratio being < 1?

When back-analysing failed pillar cases in the 1990's, UNSW only selected those cases whereby full tributary area loading to surface could be reasonably assumed so that pillar loading at failure could be calculated on a consistent basis using full cover depth. This was done by applying a minimum W/H value of 1 whereby the thickness of kinematically unstable overburden to surface (H) is equivalent to the panel width (W).

If this same principle is applied to the various remnant pillar designs in **Table 4.2**, it is argued that the actual panel width can be used to estimate the maximum (i.e. a conservative assumption as compared to applying a value of critical W/H > 1) overburden thickness that can ever be kinematically unstable. This is termed as "*modified tributary area*" (MTA) loading whereby engineering logic is applied in reducing the thickness of kinematically unstable overburden that has the ability to drive coal pillars to a fully failed state should they ever become overloaded.

Table 4.4 is a re-production of **Table 4.2** whereby tributary area loading of remnant pillars has been modified by using the panel width to estimate the maximum overburden thickness that is likely to be kinematically unstable directly above the working section.

	Typical First Workings Pillar Dimensions (m - centres)	Cover Depth (m)	Factor of Safety (UNSW PDP)	Minimum width:height ratio of Remnants	Panel Width (m)	Panel W/H Ratio (to base of lake)	Average Remnant Pillar Stress (MPa)
Zone 1	30 x 30	150	2.32	4.44	90	0.64	5.71
Zone 2 (3 lifts)	46.8 (mid to lower range within the zone) x 30	170	2.61	4.44	90	0.56	5.28
Zone 2 (4 lifts)		170	1.98	4.44	103.5	0.64	6.96
Zone 3 (3 lifts)	46.4 (mid to lower range within the zone) x 30 (minor variations exist within the zone)	200	2.61	4.44	90	0.47	5.29
Zone 3 (4 lifts)		200	1.99	4.44	103.5	0.54	6.94

Table 4.4. Summary of Remnant Pillar Stability under Assumed Modified Tributary Area Loading Controlled by Panel Width

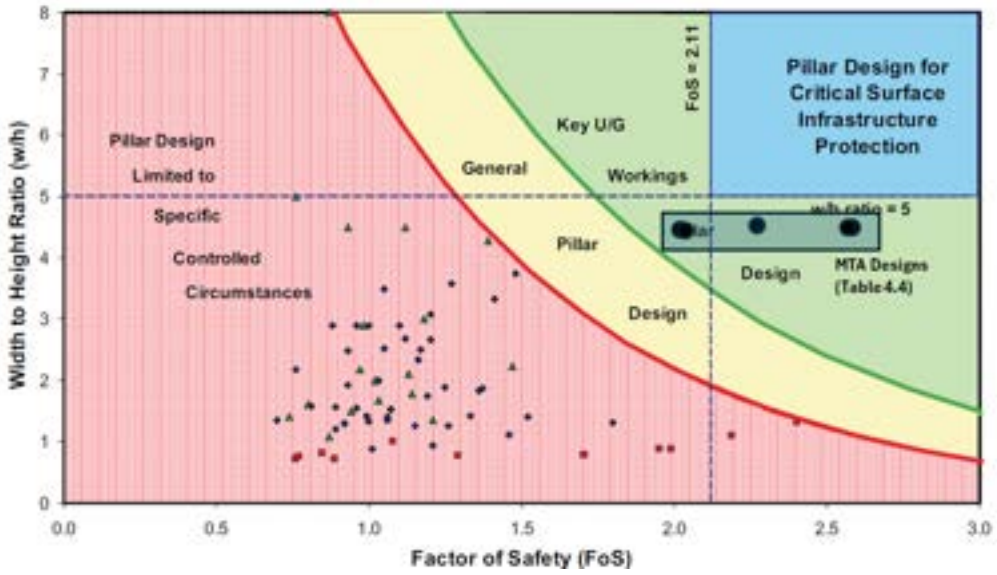


FIGURE 4.14. Modified Tributary Area Remnant Pillars - Hill 2005 Representation (Table 4.4)

Applying an "*effective depth*" equivalent to the panel width to remnant pillar design returns FoS values of 1.98 and greater, which when combined with a remnant pillar w/h of 4.44 returns a **Hill 2005** classification of "*pillar design for key underground workings*" (**Figure 4.14**). On this basis and re-iterating the importance of remnant pillar w/h being > 4 in terms of the likely mode and hence rate of pillar deterioration in the highly unlikely event that pillar system overloading occurs it is concluded that by panel geometry alone all of the various proposed remnant pillar designs are fit for purpose in regard to managing safety in the workings during lifting-off operations.

In terms of any additional influence of thick massive units within the overburden, the Teralba Conglomerate immediately above the Great Northen Seam is worth consideration, its minimum thickness in the study area being 20 m with a maximum thickness in the order of 40 m (as described previously in **Section 2.3**. Both the **Frith and McKavanagh 2000** and **Ditton and Frith 2003** methods (as per **Figures 4.12** and **4.13**) will be applied in assessing the potential spanning ability and Subsidence Reduction Potential (SRP) of the Teralba Conglomerate above the study area.

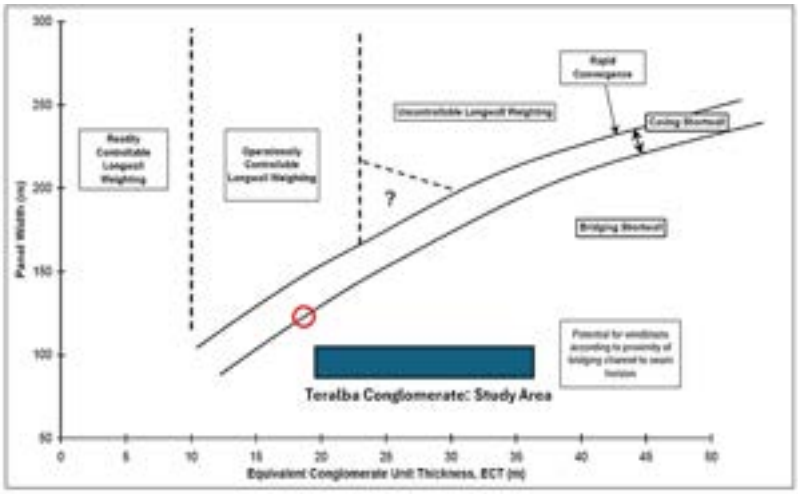


FIGURE 4.15. Weighting Potential: Teralba Conglomerate (Frith and McKavanagh 2000)

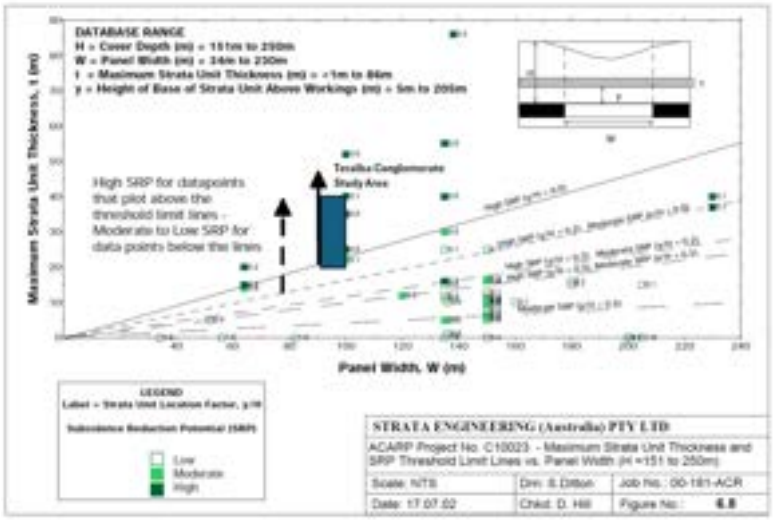


FIGURE 4.16. Subsidence Reduction Potential (SRP) According to Strata Unit Thickness, Location of Strata Unit above the Seam and Panel Width (Ditton and Frith 2003)

The near-seam overburden weighting analysis in **Figure 4.15** indicates that for the range of projected thicknesses within the study area, the Teralba Conglomerate is consistent with a "*bridging shortwall*" classification (or permanent spanning). It is noted that the location of the Teralba Conglomerate well above the working section in the Fassifern Seam means that there is no windblast potential associated with the spanning of this unit.

The SRP analysis in **Figure 4.16** confirms that the Teralba Conglomerate has "*high SRP*" within the study area, which will be utilised later when assessing mining-induced subsidence magnitudes.

4.2.4 Floor Stability Beneath Pillars

It is well established that increased levels of surface subsidence can develop over time if remnant coal pillars "*punch*" into soft immediate floor measures, with documented cases from both the Great Northern

Seam (**Galvin 2016**) and Fassifern Seam (**Ditton and Sutherland 2013**) as summarised in **Frith and Reed 2018**.

A practical method of preventing such long-term subsidence has developed over time whereby the vertical stress acting on remnant pillars is maintained below defined maximum limits. **Ditton and Sutherland 2013** outline the system used at the Tasman Mine working the Fassifern Seam as follows:

- for S_{max} < 150 mm: maximum remnant pillar stress = 10 MPa (reduced from 12 MPa as the first applied value)
- for S_{max} < 100 mm: maximum remnant pillar stress = 8 MPa (reduced from 9 MPa as the first applied value)

These two limits will be applied herein to provide initial estimates of the potential for *en masse* floor failure beneath remnant pillars that would inevitably adversely influence surface subsidence, noting that average pillar stress values in **Table 4.4** are well below the threshold limit of 8 MPa for S_{max} to be < 100 mm.

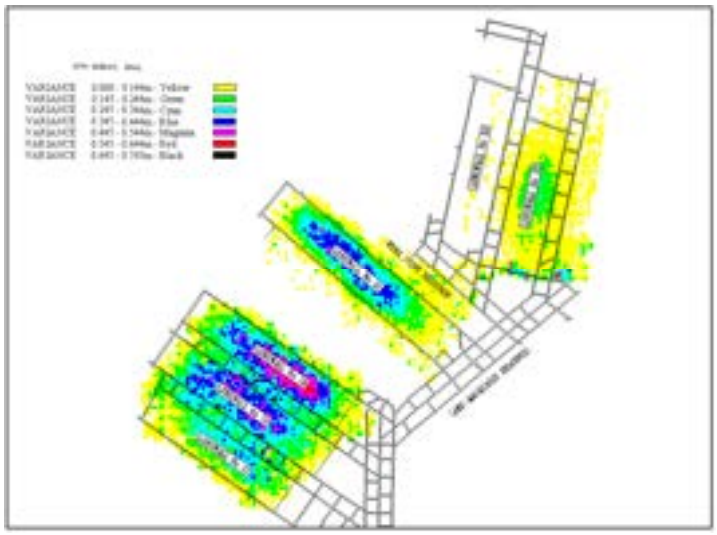


FIGURE 4.17. Bathymetric Surveys Above Fassifern Seam Longwalls at Wyee Colliery

Figure 4.17 shows the results of bathymetric surveys above longwall panels in the Fassifern Seam at the adjacent Wyee Colliery, the point of including this figure being to demonstrate that such surveys can distinguish isolated subsidence troughs up to 0.5 m in depth above extraction panels as well as lesser subsidence above the intervening chain pillars.

In stark contrast to **Figure 4.17**, **Figure 4.18** contains bathymetric surveys from above Chain Valley miniwall panels in the Fassifern Seam with the obvious development of a single, large subsidence trough across several contiguous panels (MW's 1 to 12) up to 1 m in depth but a much reduced subsidence trough (< 0.5 m) across only three adjacent panels (MW's 4, 5 and 5A) despite being of comparable individual panel geometries to those just to the North.

Specifically, it has been estimated that the remnant vertical stresses on these miniwall chain pillars range between 17 and 21 MPa, with FoS values being in excess of 1.8 and w/h ratios in the order of 7 and greater. These outcomes infer that (a) the core of each chain pillar is highly likely to have remained intact

so that (b) chain pillars must have punched into the immediate floor as part of causing the broader and deeper subsidence trough as is clearly evident above MW's 1 to 12.

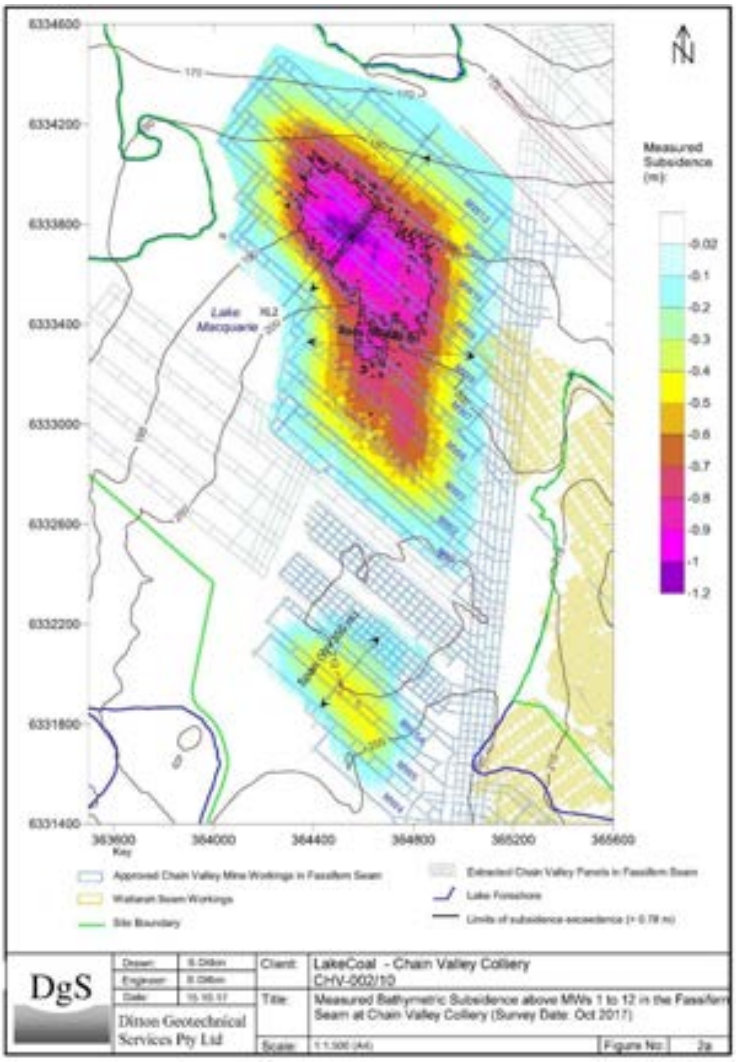


FIGURE 4.18. Bathymetric Measured Subsidence above MW's 1 to 12 at Chain Valley

The span across MW's 5 and 5A is estimated at 230 m, which for a cover depth of 200 m returns a panel W/H in excess of 1. At face value this should be sufficient to allow similar levels of subsidence to develop above these two panels as those measured above MW's 1 to 12, yet the actual measured subsidence is less than 50% of that above MW's 1 to 12. Without digressing into detail, the most obvious difference between the two areas is the stabilising influence of one or more thick, massive conglomerates within the relatively narrow span across MW's 5 and 5A, as compared to the much larger span across MW's 1 to 12.

Based on this back-analysis of measured subsidence from a series of Fassifern Seam longwalls/miniwalls of varying geometry, it is concluded that for floor instability to cause surface subsidence to the maximum possible extent as dictated by the vertical stress acting on remnant pillar(s), the stabilising and/or subsidence reducing influence of thick, massive conglomerates within the overburden needs to be eliminated via the panel span between areas of solid coal/barrier pillars. As will be discussed in more

detail in relation to subsidence predictions above the proposed areas of secondary extraction, this basic cause and effect model for the development of surface and sub-surface subsidence is fully applicable.

4.2.5 Potential Impact of Adjacent Miniwalls

With the previous section concluding that chain pillars have likely punched into the floor and the stabilising influence of conglomerates within the overburden has been lost within the MW 1 to 12 area, the question arises as to the level and extent of vertical abutment stresses outbye of these miniwall panels towards the North Headings where secondary extraction is being planned. Specifically, the question has been raised by the client as to whether the presence of those extracted miniwall panels can result in any potentially adverse impacts in relation to undertaking secondary extraction from within the North Headings or not?

A credible estimate of the distance from the goaf edge that vertical abutment stresses are generated can be found using the **Peng and Chiang 1984** relationship that is intrinsic to chain pillar design methods such as ALPS and ALTS, where $D = 5.13 \times H^{0.5}$ with D being the distance from the goaf edge.

For a cover depth of 200 m, D = 73 m, from which it can be concluded that the North Headings, including B Heading, are all sufficiently remote from the outbye end of MW's 1 to 12 to be unaffected by any significant or meaningful vertical abutment stresses that have been generated outbye their recovery locations.

4.2.6 Summary

Based on the various analyses outlined within this section of the report, it is concluded that the mine-site proposed secondary extraction layouts as shown in **Figure 4.2** are fully fit for purpose in the context of promoting safe and manageable mining conditions during lifting-off operations, as well as "*controlled*" remnant panel stability following the completion of secondary extraction and subsequent permanent sealing.

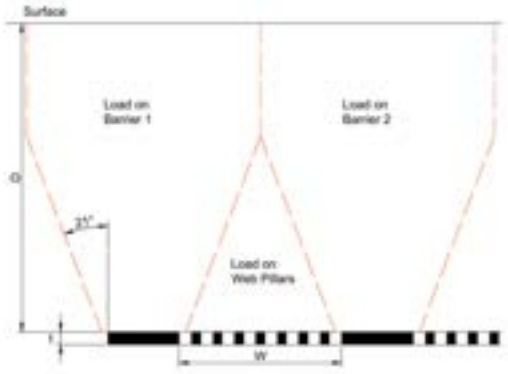


FIGURE 4.19. "Double Goaf Loading" of Intra-Panel Barrier Pillars (Worst Case Unequal Pillar Load Distribution) – Mine Advice 2018

As a final footnote to this section of the report, it is worth making comment as to the veracity of the analyses undertaken as compared to what is often the preferred academic approach of numerical modelling, both methods being thoroughly tested and reported in the public domain as part of the Hume Project's Environmental Impact Assessment submitted to the NSW Government in 2015.

The original Hume Project mine layout design work was conducted using the same basic approach as herein whereby one of the production pillar load cases utilised modified tributary area loading between barriers or areas of solid coal, this being justified on the basis of panel widths between barriers being maintained to ensure sub-critical overburden behaviour above the low w/h web pillars between said barrier pillars (see **Figure 4.19**).

Under independent peer review on behalf of the NSW government, concern was raised as to the credibility of the modified tributary area loading approach for the low w/h web pillars, with numerical modelling of the same scenarios being strongly recommended in order to provide independent verification.

Dr Keith Heasley in the USA was contracted to run a comprehensive suite of 2D and 3D LaModel analyses which were reported back to the Hume Project. Comparing the numerical modelling outputs to the original 2D analyses using a modified tributary area loading assumption, the following conclusions were arrived at (**Mine Advice 2018**):

> *The 2D and 3D numerical modelling study conducted by Dr Keith Heasley using LaModel has confirmed the following in relation to the proposed Hume EIS mine layout:*
>
> 1. *That the simple 2D design analyses using ARMPS-HWM upon which the EIS layout was based, were indeed worse-case scenarios in terms of the inferred stability of the low w/h ratio web pillars and adjacent intra-panel barrier pillars as a pillar system.*
>
> 2. *That when credible, but conservative assumptions in relation to the nature of the overburden were utilised in the design analysis, varying levels of overburden load were re-distributed from above web pillars to the adjacent barrier pillars. This confirmed that the proposed EIS mine layouts contain a range of coal pillar types that behave as a combined pillar system in promoting global mine stability, rather than as individual pillars.*

In other words, despite the supposed superiority of 2D and 3D numerical modelling as compared to simple empirical-based design using modified loading cases according to specific layout geometry, it eventuated that both approaches returned almost identical predictions in terms of post-mining remnant pillar stability and associated surface subsidence effects.

4.3 Mining-Induced Subsidence and Associated Impacts

In order to reliably predict absolute worse-case mining-induced subsidence scenarios, it will be assumed for the sake of analysis that all of the remnant pillars have "*punched*" into soft floor and that they are having no direct influence in restricting surface subsidence other than by eventually filling the as-mined void, the effect being one of reducing the effective extraction height as a direct function of in-panel reserve recovery.

Adopting such an approach is in no way a prediction of what is likely to occur, only a method by which predicted levels of mining-induced subsidence and associated impact parameters cannot be readily questioned based on concerns relating to the assessment of remnant pillar stability as outlined in **Section 4.2.2**. It also means that there is no credible basis for arguing that remnant coal pillars could be higher than assumed by virtue of post-mining collapse of the B Ply and/or A Ply roof coal to the top of the Fassifern Seam, so that both remnant pillar stability and mining-induced subsidence predictions are therefore unrealistically optimistic.

The subsidence prediction methodology that has been applied is as follows:

(i) determine credible worst-case S_{max} based on panel W/H, high SRP, and t = effective extraction height as determined from in-panel reserve recoveries (**Figure 4.20**)

(ii) determine credible worst-case S_{rib} based on S_{max} from (i) and panel W/H (**Figure 4.21**)

(iii) determine credible worst-case Angles of Draw based on S_{rib} (**Figure 4.22**)

Relevant predictions using this approach to subsidence prediction are contained in **Table 4.5**.

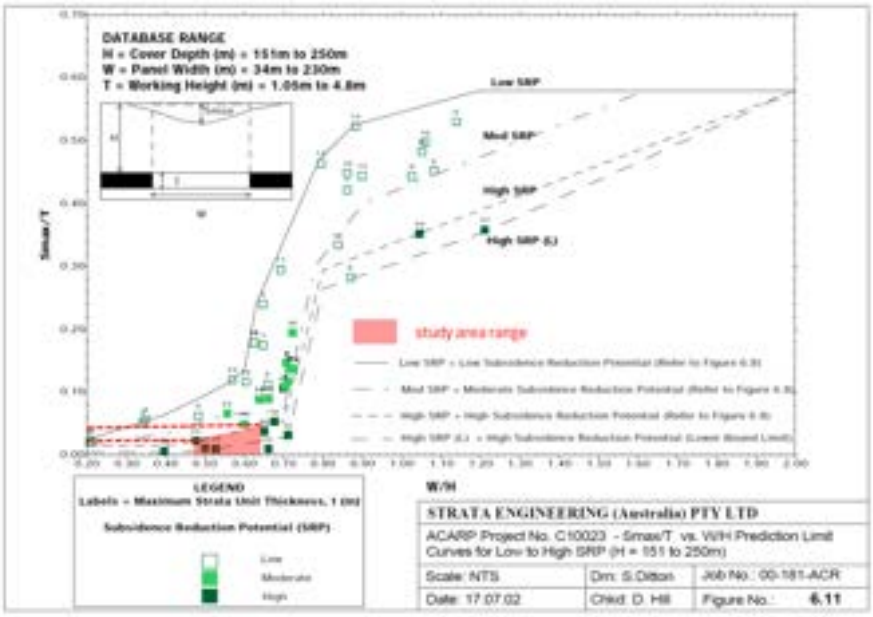


FIGURE 4.20. S_{max} Prediction Curves for Varying SRP and W/H for Cover Depths 151 m to 250 m (Ditton and Frith 2003)

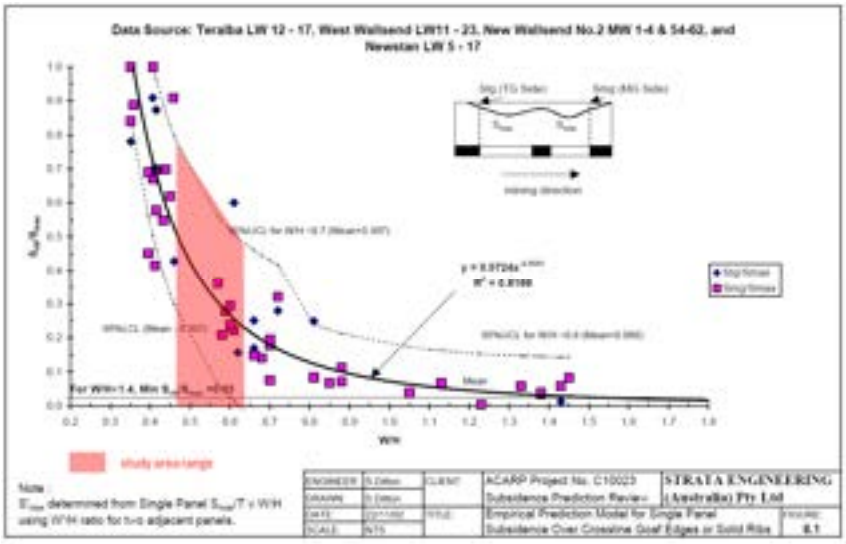


FIGURE 4.21. S_{rib} Prediction Curves as a Function of Panel W/H and S_{max} (Ditton and Frith 2003)

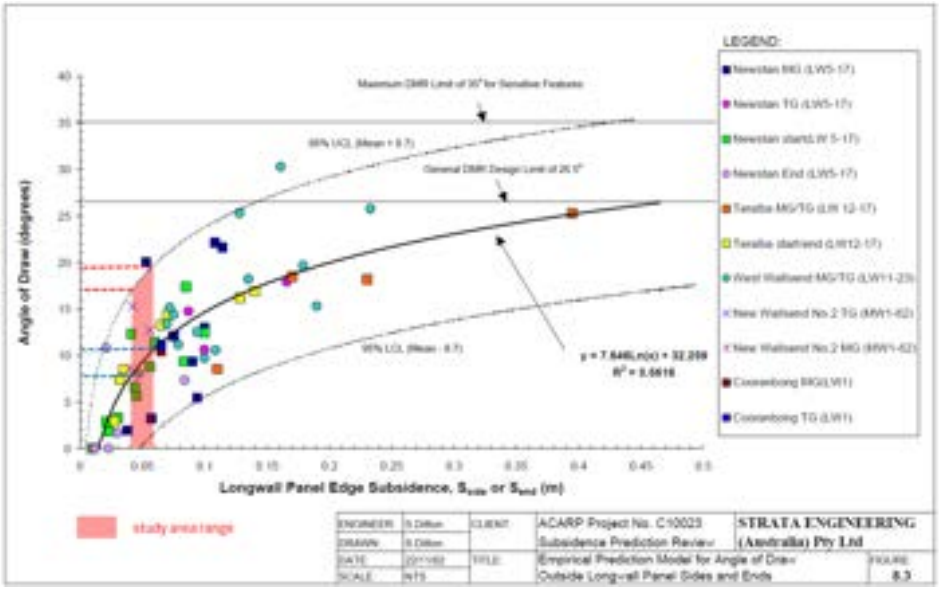


FIGURE 4.22. Measured AoD as a Function of S_{side} or S_{end}: S_{rib} in this case (Ditton and Frith 2003)

	Typical First Workings Pillar Dimensions (m - centres)	Cover Depth (m)	Panel Width (m)	Panel W/H Ratio (to base of lake)	Reserve Recovery (for a 3.2 m working height) %	Effective Extraction Height (for a 3.2 m working height) (m)	Predicted S_{max} (mm) S_{max}/t = 0.04 from Figure 4.19	Predicted S_{rib} (mm) - Figure 4.20	Predicted Angle of Draw (°) Likely/Worst-Case
Zone 1	30 x 30	150	90	0.64	0.61	1.96	80	40	8/17
Zone 2 (3 lifts)	46.8 (mid to lower range within the zone) x 30	170	90	0.56	0.58	1.86	74	41	8/17
Zone 2 (4 lifts)		170	103.5	0.64	0.64	2.03	81	61	11/19
Zone 3 (3 lifts)	46.4 (mid to lower range within the zone) x 30 (minor variations exist within the zone)	200	90	0.47	0.58	1.86	74	56	11/19
Zone 3 (4 lifts)		200	103.5	0.54	0.64	2.03	81	49	9/18

Table 4.5. Summary of W/H, In-Panel Reserve Recoveries, Effective Extraction Height and Relevant Mining-Induced Subsidence Parameters

Based on the mining-induced subsidence assessment the following conclusions are drawn, noting again the highly conservative assumptions that have been made throughout the analyses for reasons of risk-based prudence:

- predicted values of S_{max} are < 100 mm which is substantially below the allowable maximum of 780 mm.
- Angles of Draw outside areas of secondary extraction are predicted to be < 19° in all cases, thereby ensuring that mining-induced subsidence > 20 mm does not extend to either the areas of seagrass (protected by a 26.5° AoD) or the foreshore high watermark (protected by a 35° AoD).
- predicted tilts, curvatures and horizontal strains outside of Angle of Draw are inevitably imperceptible with no credible damage potential to local surface or sub-surface features.

- sub-vertical overburden fracturing above the Fassifern Seam workings can extend no further than the base of the Teralba Conglomerate given the prediction of spanning across areas of proposed secondary extraction post the completion of mining.

- spanning of the Teralba Conglomerate and low overburden settlements to surface acts to protect and preserve the integrity of the overlying Wallarah Seam workings post the completion of mining, thereby reducing the likelihood of surface subsidence being exacerbated by instability in the Wallarah Seam workings due to secondary extraction in the Fassifern Seam to an "*inconceivable*" level.

It is concluded that the proposed secondary extraction within the study area results in no credible adverse surface or sub-surface mining-induced impacts.

4.4 Local Strata Control During Lifting-Off

4.4.1 General Comments

The impact of second workings, whether longwall, shortwall, full pillar extraction or some form of partial extraction as is the case herein, is to change (and generally increase) the ground stresses acting on mine roadways, and in some cases increase the roadway span. The proposed partial extraction layout under consideration herein is no different in this regard, and contains the following positive attributes:

(i) as a "*goaf*" does not typically form due to it being a largely non-caving method, significant horizontal stress concentrations adversely influencing roadway roof stability close to the area of active mining are highly unlikely to be generated.

(ii) vertical stress increases within the area of active mining are substantially limited by the leaving of load-bearing, high w/h ratio remnant pillars in areas already worked (see **Figure 1.1**). This acts to limit the potential for coal rib deterioration in and around the CM when lifting-off, which has attendant safety benefits.

As a general rule, providing that:

(a) actual lifting layouts take due account of locally poor strata conditions,

(b) coal ribs are checked and barred down both prior to and during lifting-off as necessary, and

(c) an adequate Stook X is left in place to protect the outbye intersection,

secondary extraction within an otherwise partial extraction layout can typically be undertaken without the routine need for secondary roadway roof and/or rib support, this being in significant contrast to longwall mining or any form of full extraction.

The specific location worth considering in more detail is where lifting-off is occurring and breaker-line supports (BLS's) are in use, this being the one area where roadway (i.e. heading) roof stability controls are changing, and persons are directly exposed to those active changes.

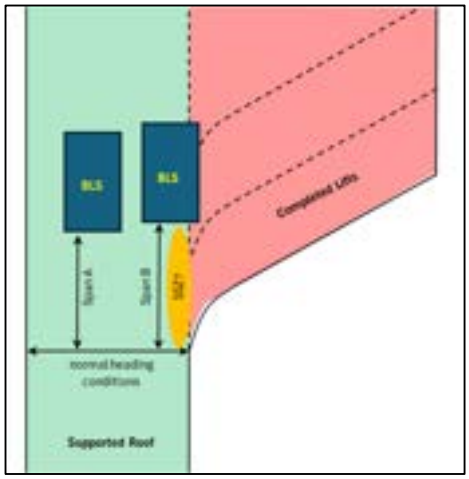


FIGURE 4.23. Schematic Arrangement for Single-Sided Lifting with Two BLS's (not to scale)

4.4.2 Roadway Roof Control

Figure 4.23 provides a schematic of various "*zones*" in and around the lifting-off area during single-sided lifting with two BLS's, the following comments being provided:

(i) outbye of where lifts have either been or are being taken, the heading can be classified as being "*normal*" with roof and rib stability being managed and controlled under a suitable second workings TARP and associated operational responses.

(ii) inbye of "*normal*" heading conditions with the RHS rib being lifted-off, the critical span from a roadway roof control perspective becomes those shown in **Figure 4.23** from the BLS's outbye back to the line of normal heading conditions. With the lifting CM having a narrow head of 3.2 m width with a maximum lift width of 4.2 m (in two passes), the two defined spans ahead of the BLS's should be no more than a normal heading width, hence heading roof stability immediately ahead of the BLS's can be adequately catered for by first workings roof stability as generated by the nature of the immediate roof strata and installed primary roof support.

(iii) the main area or zone of uncertainty is that shown in orange in **Figure 4.23** which depicts the area whereby roof falls in lifted-off areas could conceivably collapse into. An offset from unsupported lifts for safety reasons should be allowed for when defining safe work locations for lifting-off purposes.

(iv) the breakaway for each lift should be maintained as tight as possible and BLS's kept as far outbye as practical mining considerations allow at all times in order to minimise the potential for roof losses in adjacent unsupported areas falling into areas of otherwise fully supported roof, as indicated in green in **Figure 4.23**.

In relation to specific roadway conditions within the study area, the site inspection revealed several relevant issues:

(a) roadways were driven with an in-place miner/bolter several years ago to a maximum width of 5.5 m and minimum primary roof support of 6 x 2.1 m bolts per 1 m supplemented with long tendons in intersections.

(b) at least one major roof cavity and adjacent visibly deteriorated roadways were observed towards the outbye end of Zone 3 in the North Headings.

(c) a substantial "*graben*" structure is located towards the outbye end of the NE Headings, with secondary extraction not being planned either in proximity to the major faults that form the graben or within the substantial visibly unaffected section between them.

To provide suitable background context, **Mine Advice 2024** examined roadway roof control further inbye in the Herringbone Mains and adjacent production panels. These areas are generally characterised by (a) comparable FB Ply and FA Ply immediate roof beams, (b) heading widths of nominally 5.5 m, and (c) minimum primary roof support of 4 x 2.1 m bolts per 1.5 m. When this is objectively compared to the study area as described in point (a) previously, a substantial level of inherent conservatism can be reliably applied to pre-existing roadway roof stability in those areas supported with 6 x 2.1 m bolts per m which are also visibly undeteriorated – which is the vast majority of the study area.

On the assumption that continuous lifting-off will not be attempted from visibly deteriorated roadways and/or areas in close proximity to major geological structures/roof fall cavities, it is concluded that secondary extraction can be undertaken without the routine need for secondary roof support in the form of either additional roof bolts or long tendons.

4.4.3 Rib Control

During any form of secondary extraction using a continuous miner, rib instability, particularly "*small-scale*" skin instability between installed rib bolts as indicated in **Figure 4.24** is a significant operator safety hazard, even as part of partial extraction whereby vertical stress levels are being maintained at the lowest practical level in proximity to where lifting-off is taking place by virtue of the leaving of load-bearing remnant pillars as described earlier in the report.



FIGURE 4.24. Different Scales of Coal Rib Spall

To put the term "*small-scale*" into better context, **Figure 4.24** provides actual examples of different levels of rib spall. "*Large-scale*" rib collapses as indicated in **Figures 4.24(a)** and **(b)** are controlled by both the level and effectiveness of the installed rib support as well as mapping of roadways for relevant geological features that could exacerbate rib collapse, particularly mid-angled structures.

Small scale rib instability with injury potential is illustrated in **Figures 4.24(c)** and **(d)** and is typically linked to relatively small pieces of coal detaching and falling out from around installed rib bolts, injury potential being directly linked to the height from which said pieces fall from as a general rule. It is rib instability at this "*smaller-scale*" that needs to be assessed and managed prior to and during second workings in terms of whether any localised areas require additional rib support as well as on-going rib assessment and/or barring down loose pieces both before and during lifting-off operations.

5.0 OPERATIONAL CONSIDERATIONS

To complete the necessary "*Hierarchy of Controls*" in order to minimise safety-based risks during second workings to "*as low as reasonably achievable*" (ALARA), a series of operational controls are also required. Such controls should be developed as part of a consultative process with site stakeholders, hence this report only lists and describes them briefly for general reference purposes, as follows:

- whether there is a need to replace defective/damaged ground support (particularly rib support) in order to ensure that the installed support is to prescribed minimum standards before commencing lifting-off.
- ensuring that all intersections are protected via an adequately wide "*Stook X*" where lifts are being taken on the immediate inbye side. For partial extraction, a minimum width for Stook X can be 1 m inbye the point where the intersection ends and the inbye heading starts.
- developing operating procedures for the two BLS's including sequencing and their required locations prior to commencing a lift on the immediate outbye side.
- defining and adhering to safe-standing zones in and around the CM during lifting operations.
- the need for on-going strata observations, inspections and potentially barring down loose material both before and during second workings, particularly ribs where persons are required to stand during lifting operations.
- the development and operational use of a secondary extraction Strata Control TARP, including identifying and responding as necessary to pre-existing and subsequently changing roof, rib, and floor conditions during operations.
- ensuring that for all planned lifts, the roadway height just inbye is within the operating height range of the BLS's. This is especially relevant in any areas where roadways have been cut to the base of the FA Ply rather than FB Ply (see **Figure 2.1**), which is most common on the immediate inbye and outbye sides of a number of intersections.

The above list is not necessarily exhaustive but provides an initial check-list for the primary operational controls that need to be developed and applied during planned secondary extraction in order to ensure that safety hazards during mining are maintained at ALARA.

6.0 SUMMARY AND SECONDARY EXTRACTION OPTIMISATION POTENTIAL

A detailed geotechnical engineering analysis examining both safety management in the workings during active mining and mining-induced impacts on surface and sub-surface features has been undertaken, based on a mine-site proposed secondary extraction layout within the Fassifern Seam workings along sections of the Herringbone Mains, NE Headings and North Headings.

The analyses have reached the following conclusions:

1. It was necessary to sub-divide the study area into three distinct zones of varying pillar geometry and cover depth along with a further sub-division of taking either three or four lifts within any given area. The results for each specific zone and sub-division are reported separately in the report.

2. A combination of pillar Factor of Safety (FoS), pillar width to height ratio (w/h), panel width to depth ratio (W/H) and the inferred spanning ability of the Teralba Conglomerate fully confirms that in all cases the proposed post-lifting remnant pillar system is fit for purpose in terms of both (a) ensuring operationally manageable strata conditions during and post-mining, and (b) maintaining mining-induced subsidence impacts to within tolerable and/or acceptable levels.

3. The existing barrier pillars at the outbye end of MW's 1 to 12 are adequate in protecting the adjacent main headings from associated vertical abutment stress effects. As such, secondary extraction layouts along the North Headings in particular can be developed without consideration of the adjacent extracted miniwall panels. This has specific relevance to potential lifting-off out of B Heading along the North Headings which is not included in the current proposed lifting layout.

4. There is no credible basis for mining-induced sub-vertical fractures above the Fassifern Seam to reach the base of Lake Macquarie and so cause a mine inrush/inundation hazard, this being based on (a) the post-mining stability of the remnant pillar system and (b) the spanning ability of the Teralba Conglomerate immediately above the Great Northern Seam.

5. Subsidence predictions have been based on an absolute worse-case approach whereby it has been assumed that the remnant pillar system has structurally failed and provides no support to the overburden other than as re-consolidated broken coal that fully fills the mining void. Predicted S_{max} values are all < 100 mm and maximum predicted Angles of Draw are 19°, both being within prescribed tolerable levels of 780 mm and no more than 26.5° respectively.

6. Existing mine roadways within the study area are deemed to be generally suitable for subsequent single-sided lifting-off using two BLS's without the need for routine secondary roof and/or rib support by virtue of (a) minimal changes in ground stresses with partial extraction, and (b) the high level of pre-existing roof stability in roadways that can be reliably inferred. As with all continuous miner-based second workings, rib stability remains an ever-present safety-based threat due to the need for persons at times to work in close proximity to the ribs.

7. Final lifting-off layouts will need to take account of (a) pre-existing areas of deteriorated roadway conditions, (b) mapped faults and (c) roof fall cavities, these all being relatively uncommon within the study area.

8. There is no obvious wind blast threat to be addressed in operations by virtue of the very low extraction spans that are planned to be formed-up (< 16 m).

9. A series of generic recommendations have been made in regard to operational controls that should be developed at a mine site level so as to complement the various engineered controls that have been evaluated herein.

10. In terms of monitoring to confirm the accuracy of surface subsidence predictions, a post-mining bathymetric survey would at least confirm the presence or absence of high magnitude subsidence of the lake bed above the study area, and land-based surveys in and around the foreshore would confirm whether Angle of Draw effects had extended beyond the foreshore or not along with any associated surface lowering effects over time.

Based on the study outcomes, it is estimated that secondary extraction layouts consisting of five adjacent lifting runs could be justified to the same risk-based environmental impact limits using the same approach as that herein. Initial analyses return the following prediction parameters for Zone 3:

- panel width = 133.05 m
- remnant pillar FoS = 1.2 (which in combination with a w/h of 4.44 is sufficient for mine safety purposes)
- remnant pillar w/h ratio = 4.4
- Teralba Conglomerate maintains its spanning ability a 133.05 m wide panel
- panel W/H = 0.7 which remains as sub-critical
- predicted S_{max} = in the order of 120 mm
- maximum Angle of Draw no more than 21°

Four and up to five lifting run layout designs can be applied in a number of locations within the study area to substantially increase the recoverable coal reserves, albeit depending on the required operational costs in making such roadways suitable for future lifting-off purposes. B Heading in the North Headings is an obvious example whereby similar lifting could be taken to that already indicated in C, D, E and in localised areas, F Heading.

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Appendix 16 Expert Endorsement Letter

Department of Planning, Housing and Infrastructure

Our ref: SSD-5145-PA-170

Mr. Nigel Birt
Technical Services Manager
Chain Valley Colliery
PO Box 7115
Mannering Park NSW 2259

15 December 2025

Subject: SSD 5465 - Schedule 4, Condition 7A – Endorsement of Suitably Qualified and Experienced Person

Dear Mr. Birt

I refer to your letter dated 18 November 2025 requesting the Secretary's approval of a suitably qualified and experienced person to prepare an Extraction Plan specified in Schedule 4, Condition 7A of the Chain Valley Colliery development consent (SSD-5465 (as modified)).

The Department of Planning, Housing and Infrastructure (the Department) have reviewed the nominations and based on the information provided, are satisfied that the proposed persons are suitably qualified and experienced as required by Schedule 4, Condition 7A of SSD 5465 (as modified).

Consequently, as nominee of the Planning Secretary, I approve the appointment of Mr Russell Frith to prepare the Subsidence Prediction Report and Mr Nigel Birt to complete administrative changes to the Extraction Plan as required by Schedule 4, Condition 7A of SSD 5465.

If you have any questions, please contact Melissa Dunlop on 02 8229 2941 or via email at melissa.dunlop@dpie.nsw.gov.au.

Yours sincerely,

JEvans

Jessie Evans
Director
Energy and Resource Assessments