Stature for Risk Management

Administration:

Risk Assessment Title: Mandalong Extraction Plan LW30-31 Environment
Revision: 1
Region: North
Site: Mandalong
Department: ZZZZ Whole Site
Equipment / Process: Community
Stature Risk Assessment No.: 1001284063
Study Lifecycle State: Risk Assessment in Progress
Potential Hazard No.:
PULSE Actions Required URL:
Site Risk Assessment Ref. No. (Optional):

1. Background

An Extraction Plan is required by the Department of Planning Industry and Environment as specified Development Consent SSD-5144 and Mining Lease conditions.
This Risk Assessment will identify and manage the risks associated with subsidence caused by the extraction for LW30-31 on the environment.

Subsidence prediction and assessment of impacts for LW30-31 Extraction Plan has been conducted by Ditton Geotechnical Services (DgS).
The predictions method is based on the DgS modified ACARP 2003 subsidence model and subsidence effects data from Mandalong Mine LW1 to 27.
The reliability of the subsidence model has been assessed using regression analysis techniques and estimates of the mean and standard deviation (error) of the data set.
The mean subsidence predictions represent the expected subsidence and the Upper 95% Confidence Limits represents the worst-case subsidence effects.

2. Objective

The following Hierarchy of Controls offers a framework for considering the effectiveness of controls. Note that the effectiveness of a control that is intended to reduce a risk decreases from top to bottom of the list. In other words, the closer the control type is to the top of the hierarchy, the more potentially effective the control.

·Eliminate the hazard or energy source (do not use the energy)
·Minimise or replace the hazard or energy source (reduce the amount of energy to a less damaging level or replace the energy with another that has less potential negative consequences)
·Control the hazard or energy using engineered devices (ex. Lock outs, chemical containers, mechanical roof support, gas monitors, etc.)
·Control the hazard or energy by using physical barriers (ex. machine guarding, fences or enclosures, etc.)
·Control the hazard or energy with procedures (ex. Isolation procedures, standard operating procedures, etc.)
·Control the hazard or energy with personal protective equipment (ex. hard hats, boots with toe caps, gloves, safety glasses, welding gear, etc.)
·Control the hazard or energy with warnings and awareness (ex. posters, labels, warning signs, verbal warnings, etc.)

To identify, assess and control the risks to the environment caused by mining longwall blocks 30-31

3. Potential Hazards

Predicted subsidence
and
Subsidence at the worst- case, Upper 95% Confidence Limits

4. Risk Assessment Boundary Definition

Extraction of LW30-31

5. Risk Assessment Methods

Risk Assessment Methods:

Workplace Risk Assessment and Control (WRAC): Yes

Fault Tree Analysis (FTA):

Safety Integrity Level Analysis to Australian Standard 61508 (SIL):

Bow Tie Analysis (BTA):

Failure Modes and Effects Analysis (FMEA):

Hazard and Operability Analysis (HAZOP):

6. Previous Risk Assessment and other documents to be used and/or referenced

Document Name	Title	Version	Referenced Document Date
Subsidence Prediction and Impact Assessment LW30-31, MAN-005/2 (Ditton Geotechnical Services, 2021)			
Flood Assessment Longwalls 1 to 33 (Umwelt, 2020)			
Extraction Plan LW25-31 - Water Management Plan (GHD, 2018)			
Extraction Plan LW25-31 - Biodiversity Management Plan (RPS, 2018)			
Extraction Plan LW25-31 - Heritage Management Plan (RPS, 2018)			
Extraction Plan LW25-31 - Land Management Plan (Centennial Mandalong, 2018)			
Extraction Plan LW30-LW33 Land and Agricultural Resource Assessment (SLR, 2020)			
Managing Risk of Subsidence, Guide: WHS (Mines and Petroleum Sites Legislation) (NSW Department of Industry - Resources Regulator, 2017)			
Development Consent SSD-5144			
Draft Guidelines for the Preparation of Extraction Plans V5			
Plans MG14065 and MG14066 Proposed workings LW30-31 - surface features and infrastructure			
EIS Mandalong Southern Extension Project			

7. Venue and Time

Date	Description	Location	Start Time	End Time	Comment
1. 13-Jan-2021	Scoping	Mandalong	8:30 AM	2:00 PM	
2. 04-Feb-2021	RA	Mandalong	10:00 AM	12:00 PM	

8. Risk Assessment Team Selection

Name	Position	Company	Industry Start Date	E-Mail Address	Role	Experience relevant to the role in the risk assessment	Pulse User No.	Attendance	
								1. 13-Jan-2021	2. 04-Feb-2021
Phil Enright	Mining Approvals Coordinator	Centennial Mandalong	23-Aug-1982	phil.enright@centennialcoal.com.au	Risk Assessment Owner	38	60001	P	P
Col MacDonald	Compliance Manager	Centennial Mandalong	06-Dec-1977	colin.macdonald@centennialcoal.com.au	Facilitator	43	80094	P	P
Jeffrey Dunwoodie	Environmental & Community Coordinator	Centennial Mandalong	02-Dec-2002	jeffrey.dunwoodie@centennialcoal.com.au	Team Member	18	80084	P	P
Stuart Macdonald	Safety Health Representative (SHR)	Centennial Mandalong	21-Jan-1985	stumac61@bigpond.com	Team Member	36	82111		P
Iain Hornshaw	Approvals Manager	Centennial Coal		iain.hornshaw@centennialcoal.com.au	Team Member	11	100066		P
Mark Harrower	Project Surveyor	Centennial Mandalong	14-Jan-1985	mark.harrower@centennialcoal.com.au	Team Member	36	80013		P
Dominic Neylan	Approvals Graduate	Centennial Coal		dominic.neylan@centennialcoal.com.au	Team Member	1			P
Kieran.Fiatarone	Environmental Graduate	Centennial Coal		kieran.j.fiatarone@centennialcoal.com.au	Team Member	1	100450		P

WRAC Analysis Worksheet

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
1. Surface Water	There is a risk to Mandalong from ::: Predicted subsidence affecting surface water ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ alter flow conveyance capacity ▪ changes to flood regime ▪ channel realignment ▪ localised channel instability ▪ ponding.	1.1.a. Mine design providing low levels of subsidence 1.1.b. Surface and underground exploration programs to determine geotechnical conditions 1.1.c. DgS Report - Subsidence Prediction and Impact Assessment 1.1.d. Flood modelling and assessment 1.1.e. Potential remnant ponding locations identified in flood modelling and assessment 1.1.f. Water Management Plan 1.1.g. Potential changes to surface water is documented and managed in PSMPs 1.1.h. Floodpath inspections are conducted twice per year and after flood events 1.1.i. Subsidence monitoring along Morans Creek and tributary	**D** (D)	1 (E)	**2 (L)**		
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting surface water ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ alter flow conveyance capacity ▪ changes to flood regime ▪ channel realignment ▪ localised channel instability ▪ ponding.	1.2.a. Mine design providing low levels of subsidence 1.2.b. Surface and underground exploration programs to determine geotechnical conditions 1.2.c. DgS Report - Subsidence Prediction and Impact Assessment 1.2.d. Flood modelling and assessment 1.2.e. Flood modelling based on maximum subsidence predictions at Upper 95% confidence limits 1.2.f. Potential remnant ponding locations identified in flood modelling and assessment 1.2.g. Water Management Plan 1.2.h. Potential changes to surface water is	**D** (D)	1 (E)	**2 (L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		documented and managed in PSMPs					
		1.2.i. Floodpath inspections are conducted twice per year and after flood events					
		1.2.j. Subsidence monitoring along Morans Creek and tributary					
2. Groundwater	There is a risk to Mandalong from ::: predicted subsidence affecting alluvial groundwater ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ change in alluvial groundwater quality (pH and EC) ▪ decline in alluvial groundwater level.	2.1.a. Mine design providing low levels of subsidence	**D** (D)	1 (E)	**2 (L)**		
		2.1.b. Alluvial aquifer located above massive conglomerate and sandstone strata, with no connective cracking to mine workings.					
		2.1.c. DgS Report - Subsidence Prediction and Impact Assessment					
		2.1.d. Groundwater bore monitoring network and quarterly sampling for water level and quality					
		2.1.e. Groundwater bores adjacent Extraction Plan Area					
		2.1.f. Water Management Plan					
		2.1.g. Extraction outside the alluvial floodplain.					
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting alluvial groundwater ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ change in alluvial groundwater quality (pH and EC) ▪ decline in alluvial groundwater level.	2.2.a. Extraction outside the alluvial floodplain.	**D** (D)	1 (E)	**2 (L)**		
		2.2.b. Mine design providing low levels of subsidence					
		2.2.c. Alluvial aquifer located above massive conglomerate and sandstone strata, with no connective cracking to mine workings.					
		2.2.d. DgS Report - Subsidence Prediction and Impact Assessment					
		2.2.e. Groundwater bore monitoring network and quarterly sampling for water level and quality					
		2.2.f. Groundwater bores adjacent Extraction Plan Area					
		2.2.g. Water Management Plan					

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
3. Land	There is a risk to Mandalong from ::: predicted subsidence affecting steep slopes ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ increased risk to public safety ▪ landslip ▪ overhang collapse ▪ rock roll-out ▪ slope instability ▪ surface cracking.	3.1.a. Mine design providing low levels of subsidence 3.1.b. DgS Report - Subsidence Prediction and Impact Assessment - Slope Instability and Erosion 3.1.c. No dwellings are located in vicinity of steep slope areas with rock rollout potential 3.1.d. Public Safety Management Plan 3.1.e. Land Management Plan 3.1.f. Steep slope inspections during active longwall subsidence zone 3.1.g. Subsidence Monitoring Program 3.1.h. Controlled access to property including locked gates on roads 3.1.i. Communication to land owners during mining	**D** (D)	4 (PI)	**14 (S)**	1. Subsidence warning signs to be placed prior to mining.	
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting steep slopes ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ increased risk to public safety ▪ landslip ▪ overhang collapse ▪ rock roll-out ▪ slope instability ▪ surface cracking.	3.2.a. Communication to land owners during mining 3.2.b. Controlled access to property including locked gates on roads 3.2.c. Mine design providing low levels of subsidence 3.2.d. DgS Report - Subsidence Prediction and Impact Assessment - Slope Instability and Erosion 3.2.e. No dwellings are located in vicinity of steep slope areas with rock rollout potential 3.2.f. Public Safety Management Plan 3.2.g. Land Management Plan 3.2.h. Steep slope inspections during active longwall subsidence zone 3.2.i. Subsidence Monitoring Program	**D** (D)	4 (PI)	**14 (S)**		
	There is a risk to Mandalong from ::: predicted subsidence affecting agricultural land capability :::	3.3.a. Mine design providing low levels of subsidence 3.3.b. Land and Agricultural Resource Assessment for LW30-33 (SLR)	**E** (D)	1 (E)	**1 (L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ impact on agricultural land use.	3.3.c. Flood modelling and assessment 3.3.d. Potential remnant ponding locations identified in flood modelling and assessment 3.3.e. Land Management Plan 3.3.f. Property Subsidence Management Plans 3.3.g. Land and Soil Capability - Class 5 and 7 3.3.h. Minimal domestic agriculture 3.3.i. No BSAL within Extraction Plan Area					
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting agricultural land capability ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ impact on agricultural land use.	3.4.a. Minimal domestic agriculture 3.4.b. Land and Soil Capability - Class 5 and 7 3.4.c. Mine design providing low levels of subsidence 3.4.d. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.4.e. Flood modelling and assessment 3.4.f. Potential remnant ponding locations identified in flood modelling and assessment 3.4.g. No BSAL within Extraction Plan Area 3.4.h. Property Subsidence Management Plans	**E** (D)	1 (E)	**1 (L)**		
	There is a risk to Mandalong from ::: predicted subsidence increasing erosion potential ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ increased extent of tunnel erosion ▪ land damage by erosion.	3.5.a. Mine design providing low levels of subsidence 3.5.b. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.5.c. Flood modelling and assessment 3.5.d. Minimal remnant ponding locations identified in flood modelling and assessment 3.5.e. No BSAL within Extraction Plan Area 3.5.f. Land Management Plan	**D** (Op)	1 (E)	**2 (L)**		

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		3.5.g. Property Subsidence Management Plans					
		3.5.h. Subsidence Monitoring Program					
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits increasing erosion potential ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ increased extent of tunnel erosion ▪ land damage by erosion.	3.6.a. Mine design providing low levels of subsidence	**D** (D)	1 (E)	**2 (L)**		
		3.6.b. Land and Agricultural Resource Assessment for LW30-33 (SLR)					
		3.6.c. Minimal remnant ponding locations identified in flood modelling and assessment					
		3.6.d. Flood modelling and assessment					
		3.6.e. Land and Soil Capability - Class 5 and 7					
		3.6.f. No BSAL within Extraction Plan Area					
		3.6.g. Land Management Plan					
		3.6.h. Property Subsidence Management Plans					
		3.6.i. Subsidence Monitoring Program					
4. Biodiversity	There is a risk to Mandalong from ::: predicted subsidence affecting threatened flora and fauna, wetlands and GDE's and aquatic ecology ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ decline in water level ▪ declining biodiversity ▪ physical erosion or damage to wetland soil ▪ significant increase in EC level ▪ significant increase in water nutrient levels.	4.1.a. Mine design providing low levels of subsidence	**D** (D)	2 (E)	**5 (L)**		
		4.1.b. Flood modelling and assessment					
		4.1.c. Biodiversity Management Plan					
		4.1.d. Biodiversity monitoring program					
		4.1.e. Water Management Plan					
		4.1.f. Land Management Plan					
		4.1.g. Subsidence Monitoring Program					
	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting threatened flora and	4.2.a. Mine design providing low levels of subsidence	**D** (D)	2 (E)	**5 (L)**		
		4.2.b. Flood modelling and assessment					
		4.2.c. Biodiversity Management Plan					

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	fauna, wetlands and GDE's and aquatic ecology ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ decline in water level ▪ declining biodiversity ▪ physical erosion or damage to wetland soil ▪ significant increase in EC level ▪ significant increase in water nutrient levels.	4.2.d. Biodiversity monitoring program 4.2.e. Water Management Plan 4.2.f. Land Management Plan 4.2.g. Subsidence Monitoring Program					
	There is a risk to Mandalong from ::: Cave dwelling threatened bats ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ Damage to caves and loss of roosting Habitat.	4.3.a. Biodiversity monitoring program 4.3.b. Subsidence Monitoring Program 4.3.c. Biodiversity Management Plan 4.3.d. Mine design providing low levels of subsidence	**D** (D)	2 (E)	**5 (L)**		
5. Heritage	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting European and Aboriginal cultural heritage sites ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ damage Aboriginal artifacts or significant cultural places ▪ damage European artifacts or significant cultural places.	5.1.a. Mine design providing low levels of subsidence 5.1.b. Heritage Management Plan 5.1.c. 28 heritage sites identified within Extraction Plan Area 5.1.d. One European heritage site identified within Extraction Plan Area (log landing site) 5.1.e. Subsidence Monitoring Program 5.1.f. Separate rock shelter monitoring program. 5.1.g. Grinding groove monitoring program	**C** (D)	3 (L)	**13 (S)**	2. Geotech to attend pre-mining phase 1 monitoring.	

WRAC Analysis Sorted by RR

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
3. Land	There is a risk to Mandalong from ::: predicted subsidence affecting steep slopes ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ increased risk to public safety ▪ landslip ▪ overhang collapse ▪ rock roll-out ▪ slope instability ▪ surface cracking.	3.1.a. Mine design providing low levels of subsidence 3.1.b. DgS Report - Subsidence Prediction and Impact Assessment - Slope Instability and Erosion 3.1.c. No dwellings are located in vicinity of steep slope areas with rock rollout potential 3.1.d. Public Safety Management Plan 3.1.e. Land Management Plan 3.1.f. Steep slope inspections during active longwall subsidence zone 3.1.g. Subsidence Monitoring Program 3.1.h. Controlled access to property including locked gates on roads 3.1.i. Communication to land owners during mining	**D** (D)	4 (PI)	**14 (S)**	1. Subsidence warning signs to be placed prior to mining.
3. Land	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting steep slopes ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ increased risk to public safety ▪ landslip ▪ overhang collapse ▪ rock roll-out ▪ slope instability ▪ surface cracking.	3.2.a. Communication to land owners during mining 3.2.b. Controlled access to property including locked gates on roads 3.2.c. Mine design providing low levels of subsidence 3.2.d. DgS Report - Subsidence Prediction and Impact Assessment - Slope Instability and Erosion 3.2.e. No dwellings are located in vicinity of steep slope areas with rock rollout potential 3.2.f. Public Safety Management Plan 3.2.g. Land Management Plan 3.2.h. Steep slope inspections during active longwall subsidence zone 3.2.i. Subsidence Monitoring Program	**D** (D)	4 (PI)	**14 (S)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
5. Heritage	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting European and Aboriginal cultural heritage sites ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ damage Aboriginal artifacts or significant cultural places ▪ damage European artifacts or significant cultural places.	5.1.a. Mine design providing low levels of subsidence 5.1.b. Heritage Management Plan 5.1.c. 28 heritage sites identified within Extraction Plan Area 5.1.d. One European heritage site identified within Extraction Plan Area (log landing site) 5.1.e. Subsidence Monitoring Program 5.1.f. Separate rock shelter monitoring program. 5.1.g. Grinding groove monitoring program	**C** (D)	3 (L)	**13 (S)**	2. Geotech to attend pre-mining phase 1 monitoring.
4. Biodiversity	There is a risk to Mandalong from ::: predicted subsidence affecting threatened flora and fauna, wetlands and GDE's and aquatic ecology ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ decline in water level ▪ declining biodiversity ▪ physical erosion or damage to wetland soil ▪ significant increase in EC level ▪ significant increase in water nutrient levels.	4.1.a. Mine design providing low levels of subsidence 4.1.b. Flood modelling and assessment 4.1.c. Biodiversity Management Plan 4.1.d. Biodiversity monitoring program 4.1.e. Water Management Plan 4.1.f. Land Management Plan 4.1.g. Subsidence Monitoring Program	**D** (D)	2 (E)	**5 (L)**	
4. Biodiversity	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting threatened flora and fauna, wetlands and GDE's and aquatic ecology ::: 	4.2.a. Mine design providing low levels of subsidence 4.2.b. Flood modelling and assessment 4.2.c. Biodiversity Management Plan 4.2.d. Biodiversity monitoring program 4.2.e. Water Management Plan 4.2.f. Land Management Plan	**D** (D)	2 (E)	**5 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ decline in water level ▪ declining biodiversity ▪ physical erosion or damage to wetland soil ▪ significant increase in EC level ▪ significant increase in water nutrient levels.	4.2.g. Subsidence Monitoring Program				
4. Biodiversity	There is a risk to Mandalong from ::: Cave dwelling threatened bats ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ Damage to caves and loss of roosting Habitat.	4.3.a. Biodiversity monitoring program 4.3.b. Subsidence Monitoring Program 4.3.c. Biodiversity Management Plan 4.3.d. Mine design providing low levels of subsidence	**D** (D)	2 (E)	**5** **(L)**	
1. Surface Water	There is a risk to Mandalong from ::: Predicted subsidence affecting surface water ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ alter flow conveyance capacity ▪ changes to flood regime ▪ channel realignment ▪ localised channel instability ▪ ponding.	1.1.a. Mine design providing low levels of subsidence 1.1.b. Surface and underground exploration programs to determine geotechnical conditions 1.1.c. DgS Report - Subsidence Prediction and Impact Assessment 1.1.d. Flood modelling and assessment 1.1.e. Potential remnant ponding locations identified in flood modelling and assessment 1.1.f. Water Management Plan 1.1.g. Potential changes to surface water is documented and managed in PSMPs 1.1.h. Floodpath inspections are conducted twice per year and after flood events 1.1.i. Subsidence monitoring along Morans Creek and tributary	**D** (D)	1 (E)	**2** **(L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
1. Surface Water	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting surface water ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ alter flow conveyance capacity ▪ changes to flood regime ▪ channel realignment ▪ localised channel instability ▪ ponding.	1.2.a. Mine design providing low levels of subsidence 1.2.b. Surface and underground exploration programs to determine geotechnical conditions 1.2.c. DgS Report - Subsidence Prediction and Impact Assessment 1.2.d. Flood modelling and assessment 1.2.e. Flood modelling based on maximum subsidence predictions at Upper 95% confidence limits 1.2.f. Potential remnant ponding locations identified in flood modelling and assessment 1.2.g. Water Management Plan 1.2.h. Potential changes to surface water is documented and managed in PSMPs 1.2.i. Floodpath inspections are conducted twice per year and after flood events 1.2.j. Subsidence monitoring along Morans Creek and tributary	**D** (D)	1 (E)	**2 (L)**	
2. Groundwater	There is a risk to Mandalong from ::: predicted subsidence affecting alluvial groundwater ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ change in alluvial groundwater quality (pH and EC) ▪ decline in alluvial groundwater level.	2.1.a. Mine design providing low levels of subsidence 2.1.b. Alluvial aquifer located above massive conglomerate and sandstone strata, with no connective cracking to mine workings. 2.1.c. DgS Report - Subsidence Prediction and Impact Assessment 2.1.d. Groundwater bore monitoring network and quarterly sampling for water level and quality 2.1.e. Groundwater bores adjacent Extraction Plan Area 2.1.f. Water Management Plan 2.1.g. Extraction outside the alluvial floodplain.	**D** (D)	1 (E)	**2 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
2. Groundwater	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting alluvial groundwater ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ change in alluvial groundwater quality (pH and EC) ▪ decline in alluvial groundwater level.	2.2.a. Extraction outside the alluvial floodplain. 2.2.b. Mine design providing low levels of subsidence 2.2.c. Alluvial aquifer located above massive conglomerate and sandstone strata, with no connective cracking to mine workings. 2.2.d. DgS Report - Subsidence Prediction and Impact Assessment 2.2.e. Groundwater bore monitoring network and quarterly sampling for water level and quality 2.2.f. Groundwater bores adjacent Extraction Plan Area 2.2.g. Water Management Plan	**D** (D)	1 (E)	**2 (L)**	
3. Land	There is a risk to Mandalong from ::: predicted subsidence increasing erosion potential ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ increased extent of tunnel erosion ▪ land damage by erosion.	3.5.a. Mine design providing low levels of subsidence 3.5.b. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.5.c. Flood modelling and assessment 3.5.d. Minimal remnant ponding locations identified in flood modelling and assessment 3.5.e. No BSAL within Extraction Plan Area 3.5.f. Land Management Plan 3.5.g. Property Subsidence Management Plans 3.5.h. Subsidence Monitoring Program	**D** (Op)	1 (E)	**2 (L)**	
3. Land	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits increasing erosion potential ::: Caused by: ▪ Geotechnical conditions worse than anticipated	3.6.a. Mine design providing low levels of subsidence 3.6.b. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.6.c. Minimal remnant ponding locations identified in flood modelling and assessment 3.6.d. Flood modelling and assessment 3.6.e. Land and Soil Capability - Class 5 and 7	**D** (D)	1 (E)	**2 (L)**	

Instructions:

WRAC Analysis Sorted by RR (hover for instructions):

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: ▪ increased extent of tunnel erosion ▪ land damage by erosion.	3.6.f. No BSAL within Extraction Plan Area 3.6.g. Land Management Plan 3.6.h. Property Subsidence Management Plans 3.6.i. Subsidence Monitoring Program				
3. Land	There is a risk to Mandalong from ::: predicted subsidence affecting agricultural land capability ::: Caused by: ▪ Expected geotechnical conditions Resulting in: ▪ impact on agricultural land use.	3.3.a. Mine design providing low levels of subsidence 3.3.b. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.3.c. Flood modelling and assessment 3.3.d. Potential remnant ponding locations identified in flood modelling and assessment 3.3.e. Land Management Plan 3.3.f. Property Subsidence Management Plans 3.3.g. Land and Soil Capability - Class 5 and 7 3.3.h. Minimal domestic agriculture 3.3.i. No BSAL within Extraction Plan Area	**E** (D)	1 (E)	**1 (L)**	
3. Land	There is a risk to Mandalong from ::: Subsidence at the worst- case, Upper 95% Confidence Limits affecting agricultural land capability ::: Caused by: ▪ Geotechnical conditions worse than anticipated Resulting in: ▪ impact on agricultural land use.	3.4.a. Minimal domestic agriculture 3.4.b. Land and Soil Capability - Class 5 and 7 3.4.c. Mine design providing low levels of subsidence 3.4.d. Land and Agricultural Resource Assessment for LW30-33 (SLR) 3.4.e. Flood modelling and assessment 3.4.f. Potential remnant ponding locations identified in flood modelling and assessment 3.4.g. No BSAL within Extraction Plan Area 3.4.h. Property Subsidence Management Plans	**E** (D)	1 (E)	**1 (L)**	

Recommended Controls

Recommended Controls	Place(s) Used	Risk Ranking			Allocated To	Required By Date	Control Importance	Pulse User No.	PULSE Ref. No.
		L	C	RR					
1. Subsidence warning signs to be placed prior to mining.	Events: 3.1	**D**	4	14 (S)	Phil Enright	16-Jun-2021	1	60001	
2. Geotech to attend pre-mining phase 1 monitoring.	Events: 5.1	**C**	3	13 (S)	Jeffrey Dunwoodie	12-Mar-2021	1	80084	

CEY Risk Matrix Page 1

CENTENNIAL RISK MATRIX							Likelihood					
							A Certain	B Probable	C Possible	D Remote	E Improbable	Description (D)
Rating	Consequence Note: Consequence may result from a single event or may represent a cumulative impact over a period of 12 months. Use the worst case reasonable consequence if there is more than one.						Common	Has Happened within Centennial	Could Happen & has happened in non-CEY operations	Not Likely	Practically impossible	Probability (Pb)
	Financial Impact to Annual Business Plan (F)	Personal Injury (PI)	Business Interruption (BI)	Legal (L)	Reputation (R)	Environment (E)	Frequent incidents	Regular incidents	Infrequent incidents	Unlikely to occur. Very few recorded or known incidents	May occur in exceptional circumstances. Almost no recorded incidents.	Incident Frequency (IF)
							Operations – within 3 months	Operations – within 2 years	Operations – within 5 years	Operations – within 10 years	Operations – within 30 years	Operations (Op)
							Project – Every project	Project – Every 2 projects	Project – Every 5 projects	Project – Every 10 projects	Project – Every 30 projects	Project (Pr)
5. Catastrophic	>$50m	Multiple Fatalities	> 1month	Prolonged litigation, heavy fines, potential jail term	Prolonged International media attention	Long term impairment habitats/ ecosystem	25 (E)	24 (E)	21 (H)	19 (H)	15 (S)	
4. Major	$10m - $50m	Single Fatality	1 week to 1 month	Major breach/ major litigation	International media attention	Long term effects of ecosystem	23 (E)	22 (E)	18 (H)	14 (S)	10 (M)	
3. Moderate	$1m - $10m	Serious/ Disabling Injury	1 day to 1 week	Serious breach of regulation. prosecution/ fine	National media attention	Serious medium term environmental effects	20 (H)	17 (H)	13 (S)	9 (M)	6 (L)	
2. Minor	$100k - $1m	Lost Time Injury	12 hrs to 1 day	Non-compliance, breaches in regulation	Adverse local public attention	Minor effects to physical environment	16 (S)	12 (S)	8 (M)	5 (L)	3 (L)	
1. Insignificant	<$100k	First Aid Treatment Only	< 12 hrs	Low level compliance issue	Local complaints	Limited physical damage	11 (S)	7 (M)	4 (L)	2 (L)	1 (L)	

CEY Risk Matrix Page 2

Risk Rating	Risk Category		Generic Management Actions
22 to 25	E	Extreme	Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by Centennial Coal Chief Executive
17 to 21	H	High	Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the relevant Centennial Coal Executive General Manager
11 to 16	S	Significant	Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the Manager of the Centennial Coal Operation
7 to 10	M	Moderate	Action is required to eliminate or reduce the risk. If the risk is considered to be ALARP then the decision to accept the risk is to be made by the Manager of the Centennial Coal Operation
1 to 6	L	Low	Actions to eliminate or further reduce the risk should be considered. If risk is considered to be ALARP then the decision to accept the risk is to be made by the risk assessment owner (no recommended control is required to be created for this)

CEY Risk Matrix Page 3

BOW TIE ANALYSIS - Control Effectiveness Matrix

TYPE OF CONTROL	Examples	Description	Rank	Control Category	CONTROL – Impact / Status / Quality				
					A >= 80%	B 50 – 80%	C 50 / 50%	D 50 – 20%	E <= 20%
	Replace electric hand tools with compressed air alternatives in wet conditions	Eliminates a hazard by removal	1.	Elimination of hazard	100	45.0	40.0	14.0	10.0
	Replace large diameter, heavy cables with smaller ones that are easier to handle manually	Replace element with less risky alternative	2.	Substitution	85.0	40.0	35.0	13.0	8.5
	Automatic fire fighting sprinkler systems, Earth Leakage protection devices	An automatic device that operates without intervention by personnel	3.	Engineered without people	70.0	30.0	25.0	12.0	7.0
	Fire alarm that sounds & the operator then has to initiate an evacuation	A device that requires personnel to respond to a stimulus	4.	Engineered with people	50.0	20.0	14.0	10.0	5.0
	Inspection, maintenance and repair of machinery	A process carried out by personnel	5.	Procedural	20.0	15.0	10.0	6.5	2.0
	Employee made aware of dangers of large moving equipment where the operators have limited vision	Induction training programs	6.	Awareness	5.0	3.0	2.5	1.5	1.0