Site: Mandalong Title: Subsidence Stature ID:1001025001

Version: 1 Lifecycle State:

Stature for Risk Management

Administration:

Risk Assessment Title: Subsidence

Version: 1
Region: North
Site: Mandalong

Department: ZZZZ Whole Site **Equipment / Process:** HSMS

Stature Risk Assessment No.: 1001025001

Study Lifecycle State: Risk Assessment Made Effective

Potential Hazard No.: 34369
PULSE Actions Required URL:

Site Risk Assessment Ref. No. (Optional):





Executive Summary of Top 10 Risks

Background	Potential Incident	RR
/lining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from	16 (S)
4450 5420 461.05	::: Less than adequate control measures to manage the risk of subsidence :::	(3)
	Caused by: not considering the characteristics of a relevant surface feature : Roads	
	Resulting in: Risk to health and safety.	
ining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	14 (S)
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines	
	Resulting in: Risk to health and safety.	
ining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	13 (S)
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines	
	Resulting in: Risk to health and safety.	
ining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from	8 (M)
	::: Less than adequate control measures to manage the risk of subsidence :::	()
	Caused by: not considering the characteristics of a relevant surface feature : fences	
	Resulting in: Risk to health and safety.	
fining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	8 (M)
ariado daboladrido	::: Less than adequate control measures to manage the risk of subsidence :::	(141)



Background	Potential Incident	RR
	Caused by: not considering the characteristics of a relevant surface feature : communication towers	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	8 (M)
	::: Less than adequate control measures to manage the risk of subsidence :::	(,
	Caused by: not considering the characteristics of all relevant geological conditions : faults	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	6 (L)
Surface substaction	::: Less than adequate control measures to manage the risk of subsidence :::	(2)
	Caused by: not considering the characteristics of a relevant surface feature : trees	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	6 (L)
	::: Less than adequate control measures to manage the risk of subsidence :::	(=)
	Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	6 (L)
	::: Less than adequate control measures to manage the risk of subsidence :::	(=)
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	6 (L)
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	Risk to health and safety.	

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Background	Potential Incident	RR
	Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes	
	Resulting in: Risk to health and safety.	

Lifecycle State:



Executive Summary of Top 10 Severities

Background	Potential Incident	MRO
fining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	4
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines	
	Resulting in: Risk to health and safety.	
lining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	3
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature : trees	
	Resulting in: Risk to health and safety.	
fining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	3
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant subsurface features:Underground communication lines	
	Resulting in: Risk to health and safety.	
ining methods which intentionally cause the extracted void to collapse resulting in infrace subsidence	There is a risk to Mandalong from	3
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts	
	Resulting in: Risk to health and safety.	
fining methods which intentionally cause the extracted void to collapse resulting in urface subsidence	There is a risk to Mandalong from	3
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by:	



Background	Potential Incident	MRC
	not considering the characteristics of all relevant geotechnical conditions: Identification of Geotechnical units	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	3
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature : Roads	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature: Bridges	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant surface feature : fences	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
04.1400 04201001.00	::: Less than adequate control measures to manage the risk of subsidence :::	

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Background	Potential Incident	MRC
	Caused by: not considering the characteristics of a relevant surface feature : communication towers	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of a relevant subsurface features:Trenching	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of all relevant geological conditions : faults	
	Resulting in: Risk to health and safety.	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	2
	::: Less than adequate control measures to manage the risk of subsidence :::	
	Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas	
	Resulting in: Risk to health and safety.	

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Lifecycle State:



Study Approval

Approver	Approved / Rejected	Date	Comments
Col Macdonald [cmacdonald]	Approved	February 12, 2016	

Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1 Lifecycle State:



1. Background

Mandalong is required by the Work Health Safety (Mines) Regulation 2014 to develop control measures to manage the risk to health and safety associated with subsidence

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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 health and safety associated with subsidence



3. Potential Hazards

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4a. Risk Assessment Boundary Definition

Mandalong Mine mining lease area



4b. Boundary Definition

Version: 1 Lifecycle State:



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):

Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1 Lifecycle State:



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

Document Name	Title	Version	Referenced Document Date
Work Health and Safety Act 2011			
Work Health and Safety Regulation 2011			
Work Health and Safety (Mines) Act 2013			
Work Health and Safety (Mines) Regulation 2014			



7. Information Required for Risk Assessment

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8. Venue and Time

Date	Description	Location	Start Time	End Time	Comment
1. 05-Mar-2015	Scoping	Compliance Office	10:00 AM	2:00 PM	
2. 03-Feb-2016	Assessment	Induction Training Room	10:30 AM	12:30 PM	
3.	Review				



9. Risk Assessment Team Selection

								Role	Attendanc		nce
Name	Title	Company	Industry Start Date		Mobile Phone #	E-Mail Address	Pulse User No.			2. 03- Feb- 2016	
Col MacDonald	Compliance manager	Centennial Mandalong	06-Dec-1977	39		col.macdonald@centennialc oal.com.au	80094	Risk Assessment Owner	Р	Α	
Phil Enright	Subsidence Management Coordinator	Centennial Mandalong	25-Aug-1983	33	0439 409 781	phil.enright@centennialcoal. com.au	60001		Р	Р	
Steve Mudford	HST Superintendent	Centennial Mandalong	09-Jan-1995	22	0457 603 043	steve.mudford@centennialc oal.com.au	80078		Α	Р	
Andrew Heald	Production Manager	Centennial Mandalong	05-Sep-1980	36	0439 260 877	andrew.heald@centennialco al.com.au	80059		Α	Α	
Jeffrey Dunwoodie	Environmental & Community Coordinator	Centennial Mandalong	02-Dec-2002	14	0448490023	jeffrey.dunwoodie@centenni alcoal.com.au	80084		Α	Р	
Mark Harrower	Project Surveyor	Centennial Mandalong	14-Jan-1985	32		mark.harrower@centennialcoal.com.au	80013		Α	Р	
Richard Lloyd	MSMW (Local Check inspector)	Centennial Mandalong	15-Jan-1979	38		richard.lloyd@centennialcoal .com.au	52061		Α	Р	
James Enright									Α	Р	

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10. Scope Confirmation

Approver	Scope Confirmation	Date	Comments
1. Col Macdonald	Yes	March 05, 2015	



WRAC Analysis Worksheet

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : Buildings	Subsidence Management Plan/Extraction Plan to manage subsidence impacts			1 1 PI) (L)		
		1.1.c. Individual property subsidence management plans					
	Resulting in: Risk to health and safety.	Flood modelling assessments to determine flood risk to dwellings and access	E (D)				
		Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines		1 (PI)			
		1.1.f. Pre Mining MSB inspections on dwellings and buildings					
		Pre mining structural inspection and assessment by qualified civil/structural engineer					
		Subsidence monitoring on dwellings conducted by Mandalong Survey					
		Subsidence design below safe, servicible and repairable criteria for buildings AS2870					
	There is a risk to Mandalong from ::: Less than adequate control measures	Flood modelling assessments to determine flood risk to dwellings and access					
	to manage the risk of subsidence :::	1.2.b. Narrow longwall mine design					
	Caused by: not considering the characteristics of a relevant surface feature : Roads	utilising massive conglomerate overburden to minimise surface subsidence	A (D)	2 (PI)	16 (S)		
	Resulting in:	Subsidence Management Plan/Extraction Plan to manage subsidence impacts					



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Risk to health and safety.	Public roads management plan developed in consultation with Lake Macquarie City Council					
		Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining)					
		Weekly inspection conducted until subsidence finialised					
		Pre and post mining subsidence monitoring					
		Neekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard					
	There is a risk to Mandalong from	1.3.a. Not applicable					
	::: Less than adequate control measures to manage the risk of subsidence :::						
	Caused by: not considering the characteristics of a relevant surface feature : Railways		()	0	0		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.4.a. Flood modelling assessments to determine flood risk to					
	Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Bridges	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	D	2	5		
	Resulting in:	Pre and post mining subsidence monitoring	(D)	(PI)	(L)		
	Risk to health and safety.	Pre mining structural inspection and assessment by qualified civil/structural engineer					
		1.4.e. Public roads management					



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		plan developed in consultation with Lake Macquarie City Council					
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts					
		1.4.g. Weekly inspection conducted until subsidence finialised					
	There is a risk to Mandalong from	1.5.a. No public water supply tanks in mining area					
	Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks	1.5.b. Household water tanks assessed in property subsidence management plan	E (D)	1 (PI)	1 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	No commercial fuel or gas storage tanks within subsidence area					
	Caused by: not considering the characteristics of a relevant surface feature: Gas and Fuel tanks		E (D)	1 (PI)	1 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.7.a. Not applicable					
	::: Less than adequate control measures to manage the risk of subsidence :::						
	Caused by: not considering the characteristics of a relevant surface feature: Water Pipe lines		0	0	0		
	Resulting in: Risk to health and safety.						



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in: Risk to health and safety.	Pre and post mining subsidence monitoring Subsidence Management Plan/Extraction Plan to manage subsidence impacts Powerlines Line Management Plan developed in consultation with Ausgrid and DRE Project for relocation of Transmission Line TL24 underway as agreed by Transgrid	D (D)	4 (PI)	14 (S)	Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.	
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences Resulting in: Risk to health and safety.	Individual property subsidence management plans	C (D)	2 (PI)	8 (M)		
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : air strips Resulting in: Risk to health and safety.	1.10.a. Not applicable	0	0	0		
	::: Less than adequate control measures	under the Dam Safety Act	C (D)	1 (PI)	4 (L)		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	not considering the characteristics of a relevant surface feature : dams Resulting in: Risk to health and safety.	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
	rtion to ribuith and baloty.	1.11.d. Pre and post mining subsidence monitoring					
		1.11.e. Pre Mining MSB inspections on farm dams					
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts					
		Subsidence monitoring on farm dams conducted by Mandalong Survey					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
	Caused by: not considering the characteristics of a relevant surface feature : communication towers	Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface features including comms towers	C (D)	2 (PI)	8 (M)		
	Resulting in: Risk to health and safety.	1.12.c. None currently identified					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
	Caused by:	1.13.b. Pre and post mining subsidence monitoring	E (D)	3 (PI)	6 (L)		
	not considering the characteristics of a relevant surface feature: trees Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	. ,		.,		
	There is a risk to Mandalong from	1.14.a. Not applicable					
	::: Less than adequate control measures to manage the risk of subsidence :::		()	0	0		
	Caused by:						



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	not considering the characteristics of a relevant subsurface features: Road tunnels						
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.15.a. Not applicable					
	::: Less than adequate control measures to manage the risk of subsidence :::						
	Caused by: not considering the characteristics of a relevant subsurface features: Rail tunnels		()	0	0		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
	Caused by: not considering the characteristics of a relevant subsurface	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	C (D)	3 (PI)	13 (S)		
	features:Underground communication lines	1.16.c. Telstra Management Plan developed in consultation with Telstra					
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.17.a. Not applicable					
	::: Less than adequate control measures to manage the risk of subsidence :::						
	Caused by: not considering the characteristics of a relevant subsurface features:Underground gas lines		0	0	0		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.18.a. Not applicable	()	0	0		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Underground fuel tanks and lines Resulting in: Risk to health and safety. There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Underground water lines Resulting in: Risk to health and safety.	1.19.a. No commercial water supply in mining area	0	0	0		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines Resulting in: Risk to health and safety.	1.20.b. Individual property subsidence management plans	E (D)	1 (PI)	1 (L)		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a	1.21.a. Ground Water Management Plan identifies registered bores 1.21.b. Individual property subsidence management plans	D (D)	1 (PI)	2 (L)		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	relevant subsurface features:Fresh Water Bore holes						
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.22.a. None currently identified					
	::: Less than adequate control measures to manage the risk of subsidence :::	lucitifica ariy ola workings					
		1.22.c. Mine Planner on site					
	Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts	Pre drilling assessment procedure which identifies presence of existing workings	E (D)	3 (PI)	6 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.23.a. None currently identified					
	::: Less than adequate control measures to manage the risk of subsidence :::	Historical search has not identified any old workings					
		1.23.c. Mine Planner on site					
	Caused by: not considering the characteristics of a relevant subsurface features: Mine service bores	Pre drilling assessment procedure which identifies presence of existing workings	E (D)	1 (PI)	1 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures	1.24.a. Individual property subsidence management plans					
	to manage the risk of subsidence :::	1.24.b. Narrow longwall mine design					
	Caused by: not considering the characteristics of a relevant subsurface features:Trenching	utilising massive conglomerate overburden to minimise surface subsidence	E (D)	2 (PI)	3 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.25.a. Exploration drilling program.	С	2	8		
	::: Less than adequate control measures	1.25.b. Geologist employed at Mandalong Mine.	(D)	(PI)	(M)		



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Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	to manage the risk of subsidence :::	1.25.c. Geological mapping of underground workings.					
	Caused by: not considering the characteristics of all relevant geological conditions: faults	Ground magnetometer surveys to identify large geological structures.					
	Resulting in: Risk to health and safety.	Broad based aero magnetometer surveys to identify geological structures.					
		Mine planning to consider impact of geological structures on mine design.					
	There is a risk to Mandalong from	1.26.a. Exploration drilling program.					
	::: Less than adequate control measures to manage the risk of subsidence :::	Geologist employed at Mandalong Mine.					
	commanage the risk of subsidence ::: Caused by: not considering the characteristics of al relevant geological conditions : Dykes	1.26.c. Geological mapping of underground workings.					
		Ground magnetometer surveys to identify large geological structures.	E (D)	1 (PI)	1 (L)		
	Resulting in: Risk to health and safety.	Broad based aero magnetometer surveys to identify geological structures.					
		Mine planning to consider impact of geological structures on mine design.					
	There is a risk to Mandalong from	1.27.a. Exploration drilling program.					
	::: Less than adequate control measures to manage the risk of subsidence :::	Geologist employed at Mandalong Mine.					
	Caused by:	1.27.c. Geological mapping of underground workings.					
	not considering the characteristics of all relevant geological conditions: Sills Resulting in: Risk to health and safety.	Ground magnetometer surveys to identify large geological structures.	E (D)	1 (PI)	1 (L)		
		Broad based aero magnetometer surveys to identify geological structures.					
		Mine planning to consider impact of geological structures on mine design.					
	There is a risk to Mandalong from	1.28.a. Exploration drilling program	С	1	4		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	::: Less than adequate control measures to manage the risk of subsidence :::	to identify defects in the Munmorah conglomerate beam used to minimise subsidence.	(D)	(PI)	(L)		
	Caused by: not considering the characteristics of all relevant geological conditions:	Geologist employed at Mandalong Mine.					
	Variations in lithology	1.28.c. Geological mapping of underground workings.					
	Resulting in: Risk to health and safety.	Mine planning to consider impact of geological structures on mine design.					
	There is a risk to Mandalong from	1.29.a. Geological mapping of underground workings.					
	::: Less than adequate control measures to manage the risk of subsidence :::	1.29.b. No steep seam >30 degrees.					
	Caused by: not considering the characteristics of all relevant geological conditions : Seam dip		C (D)	1 (PI)	4 (L)		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	Identified from in-seam drilling.					
	::: Less than adequate control measures to manage the risk of subsidence :::	1.30.b. Geologist / geotechnical engineer employed at Mandalong Mine.			_		
	Caused by: not considering the characteristics of all relevant geological conditions : Seam	1.30.c. Geological mapping of underground workings.	C (D)	1 (PI)	4 (L)		
	roll Resulting in: Risk to health and safety.	1.30.d. Incorporate impacts of seam roll on subsidence predictions.					
	There is a risk to Mandalong from	1.31.a. Depth of cover is determined by exploration drilling.					
	::: Less than adequate control measures to manage the risk of subsidence :::	1.31.b. No depth of cover is less than 160 metres.	E	1	1 (L)		
	Caused by: not considering the characteristics of all relevant geological conditions : Depth of	1.31.c. No shallow workings.	(D)	(PI)	(L)		

Lifecvcle State:



Bow Tie Step **Potential Incident Current Controls Recommended Control** L MRC **RR Extension** cover Resulting in: Risk to health and safety. 1.32.a. Exploration drilling program There is a risk to Mandalong from to identify seam thickness in ::: Less than adequate control measures mining areas. to manage the risk of subsidence ::: 1.32.b. In-seam drilling. 1.32.c. Mining equipment limits Ε Caused by: 1 extraction thickness 3.6 -(PI) not considering the characteristics of all (D) (L) 4.8m. relevant geological conditions : Seam thickness 1.32.d. Variations in seam thickness has minimal impacts on mine Resulting in: subsidence levels at Risk to health and safety. Mandalong Mine. There is a risk to Mandalong from 1.33.a. Groundwater impact assessment completed for SMP / Extraction Plan. ::: Less than adequate control measures to manage the risk of subsidence ::: 1.33.b. No contiguous aquifiers in the Mandalong mining area. Caused by: not considering the characteristics of all |1.33.c. Ground Water Management Plan identifies registered D 2 1 relevant hydrogeological (PI) (L) (D) conditions:Aquifers and ground water resources 1.33.d. Extensive groundwater monitoring network - 50 Resulting in: bores. Risk to health and safety. 1.33.e. No connection between fractured zone and alluvial aguifers to date. There is a risk to Mandalong from 1.34.a. Narrow longwall mine design utilising massive conglomerate overburden to ::: Less than adequate control measures to manage the risk of subsidence ::: minimise surface subsidence 1.34.b. No impacts on flow within Caused by: Morans and Stockton Creek Ε 1 not considering the characteristics of all to date. (D) (PI) (L) relevant hydrological conditions: 1.34.c. Bi-annual floodpath Catchment areas monitoring. Resulting in: 1.34.d. Subsidence monitoring along Risk to health and safety. creek lines to assess change in grades.



Version: 1 Lifecycle State:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events.					
	Caused by:	1.35.b. Flood modelling assesses impact on infrastructure and private property.	D (D)	2 (PI)	5 (L)		
	relevant hydrological conditions: flood areas Resulting in: Risk to health and safety.	1.35.c. Include flooding assessment in PSMPs and Infrastructure Management Plans.					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence					
	Caused by: not considering the characteristics of all relevant hydrological conditions: creeks	No impacts on flow within Morans and Stockton Creek to date.	C (D)	1 (PI)	4 (L)		
	Resulting in:	1.36.c. Bi-annual floodpath monitoring.					
	Risk to health and safety.	1.36.d. Subsidence monitoring along creek lines to assess change in grades.					
	There is a risk to Mandalong from ::: Less than adequate control measures	1.37.a. No prescribed public dams under the Dam Safety Act 1973					
	to manage the risk of subsidence ::: Caused by:	1.37.b. Individual property subsidence management plans					
	not considering the characteristics of all relevant hydrological conditions: dams Resulting in:	Narrow longwall mine design utilising massive conglomerate overburden to	E (D)	1 (PI)	1 (L)		
	Risk to health and safety.	minimise surface subsidence 1.37.d. Pre and post mining subsidence monitoring	(D)	(F1)	(L)		
		1.37.e. Pre Mining MSB inspections on farm dams					
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts					



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		1.37.g. Subsidence monitoring on farm dams conducted by Mandalong Survey					
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.38.a. No lakes within the mining area.					
	Caused by: not considering the characteristics of all relevant hydrological conditions: lakes Resulting in:		()	0	0		
	Risk to health and safety. There is a risk to Mandalong from	1.39.a. N/A					
	::: Less than adequate control measures to manage the risk of subsidence :::						
	Caused by: not considering the characteristics of all relevant hydrological conditions: Rivers		()	0	0		
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence.					
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata	Exploration drilling program to identify seam thickness in mining areas.	E	1	1		
	Resulting in: Risk to health and safety.	1.40.c. Exploration drilling program.1.40.d. Testing of the immediate roof and floor horizon (for strength).	(D)	(PI)	(L)		
		Geotechnical subsidence consultant to review geological date from drilling program.					
	There is a risk to Mandalong from	1.41.a. Depth of cover is determined	E	1	1		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
		by exploration drilling.	(D)	(PI)	(L)		
	::: Less than adequate control measures to manage the risk of subsidence :::	1.41.b. No depth of cover is less than 160 metres.					
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden	1.41.c. No shallow workings.					
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures	 1.42.a. Exploration drilling program to identify seam thickness in mining areas. 					
	to manage the risk of subsidence :::	1.42.b. Exploration drilling program.					
	Caused by: not considering the characteristics of all	 Testing of the immediate floor horizon (for strength). 	E (D)	1 (PI)	1 (L)		
	relevant geotechnical conditions: Floor Resulting in: Risk to health and safety.	1.42.d. Geotechnical subsidence consultant to review geological date from drilling program.					
	There is a risk to Mandalong from ::: Less than adequate control measures	Exploration drilling program to identify seam thickness in mining areas.					
	to manage the riels of subsidence	1.43.b. Exploration drilling program.					
	Caused by: not considering the characteristics of all	1.43.c. Testing of the immediate floor horizon (for strength).					
	relevant geotechnical conditions: Identification of Geotechnical units Resulting in:	1.43.d. Geotechnical subsidence consultant to review geological date from drilling program.	E (D)	3 (PI)	6 (L)		
	Risk to health and safety.	1.43.e. No windblast potential.					
		1.43.f. No immediate massive strata in immediate mining horizon.					
		 Geologist / geotechnical engineer employed at Mandalong Mine. 					
	There is a risk to Mandalong from	1.44.a. N/A					
	::: Less than adequate control measures to manage the risk of subsidence :::		()	0	0		



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep slopes Resulting in:	Plan/Extraction Plan to manage subsidence impacts,	E (D)	3 (PI)	6 (L)		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Plateaus Resulting in: Risk to health and safety.		0	0	0		
	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Gorges, revines and canyons		()	0	0		

Lifecycle State:



Bow Tie Potential Incident Current Controls MRC Recommended Control Step L **RR Extension** Resulting in: Risk to health and safety. There is a risk to Mandalong from 1.48.a. Flood modelling assessments to determine ::: Less than adequate control measures flood risk to dwellings and to manage the risk of subsidence ::: access. 1.48.b. No depth of cover is less Ε 1 Caused by: than 160 metres. (L) (D) (PI) not considering the characteristics of all 1.48.c. No direct connection between relevant climatic conditions: rainfall surface and underground. Resulting in: Risk to health and safety. There is a risk to Mandalong from 1.49.a. No depth of cover is less than 160 metres. ::: Less than adequate control measures 1.49.b. Subsidence Management to manage the risk of subsidence ::: Plan/Extraction Plan to manage subsidence impacts Caused by: 1 1 1.49.c. Narrow longwall mine design "not considering any conditions that (PI) (D) (L) utilising massive may cause elevated or abnormal conglomerate overburden to subsidence or the formation of minimise surface subsidence sinkholes" Resulting in: Risk to health and safety. There is a risk to Mandalong from 1.50.a. Historical search has not identified any old workings ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of Ε 1 (PI) any previously excavated or abandoned (D) (L) workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety. There is a risk to Mandalong from 1.51.a. N/A () 0 0 ::: Less than adequate control measures



Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control	Bow Tie Extension
	to manage the risk of subsidence :::						
	Caused by: not considering the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings						
	Resulting in: Risk to health and safety.						
	There is a risk to Mandalong from	1.52.a. Systematic longwall design.					
	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations		E (D)	1 (PI)	1 (L)		
	Resulting in: Risk to health and safety.						

Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1

Lifecycle State:

Centennial Coal

WRAC Analysis Sorted by RR

Instructions:

	RR (hover for instructions):			MDC		B 110 / 1
Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from 1.2.a. Flood modelling assessments to determine flood risk to dwellings and access					
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : Roads	ot considering the characteristics of a conclomerate overburden to				
	Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Public roads management plan developed in consultation with Lake Macquarie City Council	A (D)	2 (PI)	16 (S)	
		1.2.e. Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining)				
		1.2.f. Weekly inspection conducted until subsidence finialised				
		Pre and post mining subsidence monitoring				
		Weekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard				
Mining methods which intentionally cause the	There is a risk to Mandalong from	Pre and post mining subsidence monitoring				Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	D (D)	4 (PI)	14 (S)	
	not considering the characteristics of a relevant surface feature : Electricity transmission lines	Powerlines Line Management Plan developed in consultation with Ausgrid and DRE	(-)	(/	ζ-γ	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.	Project for relocation of Transmission Line TL24 underway as agreed by Transgrid				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence Subsidence Management		3	13	
	not considering the characteristics of a relevant subsurface features:Underground communication lines	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	C (D)	(PI)	(S)	
	Resulting in: Risk to health and safety.	1.16.c. Telstra Management Plan developed in consultation with Telstra				
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences	Individual property subsidence management plans	subsidence management plans 9.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 9.c. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 9.d. Elecrtic fence tester for Surveyors and Environmental Contractors provided when conducting			
collapse resulting in surface subsidence		conglomerate overburden to		2	8	
	Resulting in: Risk to health and safety.			(PI)	(M)	
	RISK to nearth and salety.	Environmental Contractors				
. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	С	2	8	
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface	(D)	(PI)		

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.	features including comms towers				
		1.12.c. None currently identified				
intentionally cause the	There is a risk to Mandalong from	1.25.a. Exploration drilling program.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	1.25.b. Geologist employed at Mandalong Mine.				
	Caused by: not considering the characteristics of all	1.25.c. Geological mapping of underground workings.				
	relevant geological conditions : faults Resulting in:	Ground magnetometer surveys to identify large geological structures.	C (D)	2 (PI)	8 (M)	
	Risk to health and safety.	Broad based aero magnetometer surveys to identify geological structures.				
		Mine planning to consider impact of geological structures on mine design.				
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	Caused by: not considering the characteristics of a	1.13.b. Pre and post mining subsidence monitoring	E (D)	3 (PI)	6 (L)	
	relevant surface feature : trees Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
	There is a risk to Mandalong from	1.22.a. None currently identified				
intentionally cause the extracted void to collapse resulting in	::: Less than adequate control measures to manage the risk of subsidence :::	Historical search has not identified any old workings				
surface subsidence	manage the flak of ausaldence	1.22.c. Mine Planner on site	Е	3	6	
0	Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts	Pre drilling assessment procedure which identifies presence of existing workings	(D)	(PI)	PI) (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	Exploration drilling program to identify seam thickness in mining areas.				
collapse resulting in surface subsidence	manage the risk of subsidence :::	1.43.b. Exploration drilling program.	E (D)			
	Caused by: not considering the characteristics of all relevant geotechnical conditions:	1.43.c. Testing of the immediate floor horizon (for strength).		3 (PI)		
	Identification of Geotechnical units Resulting in: Risk to health and safety.	Geotechnical subsidence consultant to review geological date from drilling program.			6 (L)	
		1.43.e. No windblast potential.				
		No immediate massive strata in immediate mining horizon.				
		Geologist / geotechnical engineer employed at Mandalong Mine.				
Mining methods which intentionally cause the	There is a risk to Mandalong from	1.45.a. Steep Slopes Management Plan.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.45.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts,				
	not considering the characteristics of all relevant topographic conditions: Steep slopes	1.45.c. Steep slopes monitoring and inspection program.	E (D)	3 (PI)	6	
	Resulting in: Risk to health and safety.	1.45.d. Broad based mapping of steep slopes has been completed.	(D)	(F1)	(L)	
		Airborne Laser Scanning of mining lease areas has been conducted to provide detail mapping				
Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Rood modelling assessments to determine flood risk to dwellings and access	D (D)	2 (PI)	5 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : Bridges	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	Resulting in: Risk to health and safety.	Pre and post mining subsidence monitoring				
	Nisk to health and salety.	1.4.d. Pre mining structural inspection and assessment by qualified civil/structural engineer				
		Public roads management plan developed in consultation with Lake Macquarie City Council				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Weekly inspection conducted until subsidence finialised				
. Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events.				
surface subsidence	Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas	Flood modelling assesses impact on infrastructure and private property.	D (D)	2 (PI)	5 (L)	
	Resulting in: Risk to health and safety.	Include flooding assessment in PSMPs and Infrastructure Management Plans.				
. Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	1.11.a. No prescribed public dams under the Dam Safety Act 1973				
collapse resulting in surface subsidence		Individual property subsidence management plans	C (D)	1 (PI)	4 (L)	
		Narrow longwall mine design utilising massive conglomerate overburden to minimise surface				

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Risk to health and safety.	subsidence				
		1.11.d. Pre and post mining subsidence monitoring				
		1.11.e. Pre Mining MSB inspections on farm dams				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Subsidence monitoring on farm dams conducted by Mandalong Survey				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence.				
	Caused by: not considering the characteristics of all relevant geological conditions: Variations in	1.28.b. Geologist employed at Mandalong Mine.	C (D)	1 (PI)	4 (L)	
	lithology	1.28.c. Geological mapping of underground workings.				
	Resulting in: Risk to health and safety.	Mine planning to consider impact of geological structures on mine design.				
Mining methods which intentionally cause the	There is a risk to Mandalong from	1.29.a. Geological mapping of underground workings.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam dip Resulting in:	1.29.b. No steep seam >30 degrees.	C (D)	1 (PI)	4 (L)	
	Risk to health and safety.					
Mining methods which intentionally cause the	There is a risk to Mandalong from	Identified from in-seam drilling.	С	1	4	
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	Geologist / geotechnical engineer employed at Mandalong Mine.	(D)	(PI)	(L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: not considering the characteristics of all relevant geological conditions : Seam roll Resulting in: Risk to health and safety.	Geological mapping of underground workings. Incorporate impacts of seam roll on subsidence predictions.				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	Caused by: not considering the characteristics of all relevant hydrological conditions: creeks	No impacts on flow within Morans and Stockton Creek to date.	C (D)	1 (PI)	4 (L)	
	Resulting in: Risk to health and safety.	1.36.c. Bi-annual floodpath monitoring.				
	torio rodani drio caroly.	Subsidence monitoring along creek lines to assess change in grades.				
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	Individual property subsidence management plans				
collapse resulting in surface subsidence	manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Trenching	1.24.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence		2 (PI)	3 (L)	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Fresh Water Bore holes	Ground Water Management Plan identifies registered bores	-			
collapse resulting in surface subsidence		Individual property subsidence management plans	D (D)	1 (PI)	2 (L)	
	Resulting in: Risk to health and safety.					

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
I. Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	entionally cause the cracted void to ::: Less than adequate control measures to manage the risk of subsidence :::	 1.33.a. Groundwater impact assessment completed for SMP / Extraction Plan. 1.33.b. No contiguous aquifiers in the Mandalong mining area. 1.33.c. Ground Water Management Plan identifies registered bores. 	D (D)	1 (PI)	2 (L)	
		1.33.d. Extensive groundwater monitoring network - 50 bores. 1.33.e. No connection between fractured zone and alluvial aquifers to date.				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Buildings Resulting in: Risk to health and safety.	1.1.a. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence 1.1.b. Subsidence Management Plan/Extraction Plan to manage subsidence impacts 1.1.c. Individual property subsidence management plans 1.1.d. Flood modelling assessments to determine flood risk to dwellings and access 1.1.e. Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines 1.1.f. Pre Mining MSB inspections on dwellings and buildings 1.1.g. Pre mining structural inspection and assessment by qualified civil/structural engineer	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		dwellings conducted by Mandalong Survey				
		Subsidence design below safe, servicible and repairable criteria for buildings AS2870				
Mining methods which intentionally cause the	There is a risk to Mandalong from	1.5.a. No public water supply tanks in mining area				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks	1.5.b. Household water tanks assessed in property subsidence management plan	E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	No commercial fuel or gas storage tanks within subsidence area				
	Caused by: not considering the characteristics of a relevant surface feature : Gas and Fuel tanks		E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	No commercial Ausgrid owned underground assets in mining area				
collapse resulting in surface subsidence	manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines Resulting in: Risk to health and safety.	1.20.b. Individual property subsidence management plans	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the	There is a risk to Mandalong from	None currently identified Search has not	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine service bores Resulting in: Risk to health and safety.	identified any old workings 1.23.c. Mine Planner on site 1.23.d. Pre drilling assessment procedure which identifies presence of existing workings				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Dykes Resulting in: Risk to health and safety.	Exploration drilling program. 1.26.b. Geologist employed at Mandalong Mine. 1.26.c. Geological mapping of underground workings. 1.26.d. Ground magnetometer surveys to identify large geological structures. 1.26.e. Broad based aero magnetometer surveys to identify geological structures of identify geological structures. 1.26.f. Mine planning to consider impact of geological structures on mine design.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Sills Resulting in: Risk to health and safety.	Exploration drilling program. Seologist employed at Mandalong Mine. Seological mapping of underground workings. Seological structures. Broad based aero magnetometer surveys to identify large geological structures. Seological structures.	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		impact of geological structures on mine design.				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Depth of cover Resulting in: Risk to health and safety.	Depth of cover is determined by exploration drilling. No depth of cover is less than 160 metres. No shallow workings.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geological conditions : Seam thickness Resulting in: Risk to health and safety.	Exploration drilling program to identify seam thickness in mining areas. I.32.b. In-seam drilling. Seam drilling. Assume thickness 3.6 - 4.8m. Variations in seam thickness has minimal impacts on mine subsidence levels at Mandalong Mine.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: Catchment areas Resulting in: Risk to health and safety.	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence No impacts on flow within Morans and Stockton Creek to date. Si-annual floodpath monitoring. Subsidence monitoring along creek lines to assess change in grades.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the	There is a risk to Mandalong from	No prescribed public dams under the Dam Safety Act	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
extracted void to collapse resulting in surface subsidence	collapse resulting in manage the risk of subsidence ::: Caused by: not considering the characteristics of all	1973 1.37.b. Individual property subsidence management plans				
		Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
		1.37.d. Pre and post mining subsidence monitoring				
		1.37.e. Pre Mining MSB inspections on farm dams				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Subsidence monitoring on farm dams conducted by Mandalong Survey				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence.				
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata	Exploration drilling program to identify seam thickness in mining areas.	_		_	
	Resulting in:	1.40.c. Exploration drilling program.	E (D)	1 (PI)	1 (L)	
	Risk to health and safety.	Testing of the immediate roof and floor horizon (for strength).				
		Geotechnical subsidence consultant to review geological date from drilling program.				
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to	Depth of cover is determined by exploration drilling.	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden Resulting in: Risk to health and safety.	No depth of cover is less than 160 metres. 1.41.c. No shallow workings.				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant geotechnical conditions: Floor Resulting in: Risk to health and safety.	 1.42.a. Exploration drilling program to identify seam thickness in mining areas. 1.42.b. Exploration drilling program. 1.42.c. Testing of the immediate floor horizon (for strength). 1.42.d. Geotechnical subsidence consultant to review geological date from drilling program. 	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant climatic conditions: rainfall Resulting in: Risk to health and safety.	1.48.a. Flood modelling assessments to determine flood risk to dwellings and access. 1.48.b. No depth of cover is less than 160 metres. 1.48.c. No direct connection between surface and underground.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: "not considering any conditions that may cause elevated or abnormal subsidence or the formation of sinkholes" Resulting in:	No depth of cover is less than 160 metres. Subsidence Management Plan/Extraction Plan to manage subsidence impacts Narrow longwall mine design utilising massive conglomerate overburden to minimise surface	E (D)	1 (PI)	1 (L)	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	ш	MRC	RR	Recommended Control
_	Risk to health and safety.	subsidence				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings	1.50.a. Historical search has not identified any old workings	E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations Resulting in: Risk to health and safety.	1.52.a. Systematic longwall design.	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Railways Resulting in: Risk to health and safety.	1.3.a. Not applicable	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.7.a. Not applicable	0	0	0	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	not considering the characteristics of a relevant surface feature: Water Pipe lines Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : air strips Resulting in: Risk to health and safety.	1.10.a. Not applicable	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Road tunnels Resulting in: Risk to health and safety.	1.14.a. Not applicable	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Rail tunnels Resulting in: Risk to health and safety.	1.15.a. Not applicable	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.17.a. Not applicable	0	0	0	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Caused by: not considering the characteristics of a relevant subsurface features:Underground gas lines					
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the	There is a risk to Mandalong from	1.18.a. Not applicable				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::					
	Caused by: not considering the characteristics of a relevant subsurface features:Underground fuel tanks and lines		()	0	0	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.19.a. No commercial water supply in mining area				
	Caused by: not considering the characteristics of a relevant subsurface features:Underground water lines		()	0	0	
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.38.a. No lakes within the mining area.				
Surrace Subsiderice	Caused by: not considering the characteristics of all relevant hydrological conditions: lakes		()	0	0	
	Resulting in: Risk to health and safety.					
1. Mining methods which	There is a risk to Mandalong from	1.39.a. N/A	()	0	0	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all					
	relevant hydrological conditions: Rivers Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in:	1.44.a. N/A	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	Risk to health and safety. There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Plateaus Resulting in: Risk to health and safety.	1.46.a. N/A	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Gorges, revines and canyons	1.47.a. N/A	0	0	0	

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Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1

Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the existence, distribution, geometry and stability of significant voids, standing pillars or remnants within any old pillar workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.51.a. N/A	0	0	0	

Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1

Lifecycle State:



WRAC Analysis Sorted by Consequence

Instructions:

Step	y Consequence (hover for instructions): Potential Incident	Current Controls	L	MRC	RR	Recommended Control
Mining methods which intentionally cause the		Pre and post mining subsidence monitoring				Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements.
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Electricity transmission lines Resulting in:	Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Powerlines Line Management Plan developed in consultation with Ausgrid and DRE	D (D)	4 (PI)	14 (S)	
	Risk to health and safety.	Project for relocation of Transmission Line TL24 underway as agreed by Transgrid				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	to ::: Less than adequate control measures to manage the risk of subsidence ::: conglomerate overburden to minimise surface subsidence Caused by:					
			(D)	3 (PI)	6 (L)	
	Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
C r r f	not considering the characteristics of a relevant subsurface features: Underground communication	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	C (D)	3 (PI)		
	lines Resulting in: Risk to health and safety.	Telstra Management Plan developed in consultation with Telstra				

Version: 1 Lifecycle State:





	y Consequence (hover for instructions):					
Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Mine shafts and drifts Resulting in: Risk to health and safety.	None currently identified 1.22.b. Historical search has not identified any old workings 1.22.c. Mine Planner on site 1.22.d. Pre drilling assessment procedure which identifies presence of existing workings	E (D)	3 (PI)	6 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	 1.43.a. Exploration drilling program to identify seam thickness in mining areas. 1.43.b. Exploration drilling program. 1.43.c. Testing of the immediate floor horizon (for strength). 1.43.d. Geotechnical subsidence consultant to review geological date from drilling program. 1.43.e. No windblast potential. 1.43.f. No immediate massive strata in immediate mining horizon. 1.43.g. Geologist / geotechnical engineer employed at Mandalong Mine. 	E (D)	3 (PI)	6 (L)	
intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant topographic conditions: Steep	Steep Slopes Management Plan. Subsidence Management Plan/Extraction Plan to manage subsidence impacts, Steep slopes monitoring and inspection program.	E (D)	3 (PI)	6 (L)	

Version: 1 Lifecycle State:

Instructions:



WRAC Analysis Sorted by	by Consequence (hover for instructions):					
Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	slopes Resulting in: Risk to health and safety.	Broad based mapping of steep slopes has been completed. Airborne Laser Scanning				
		of mining lease areas has been conducted to provide detail mapping				
intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Flood modelling assessments to determine flood risk to dwellings and access				
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : Roads Resulting in:	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	A (D)	2 (PI)		
	Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Public roads management plan developed in consultation with Lake Macquarie City Council			16 (S)	
	1.2.e. Daily inspections when road is within active subsidence zone (100m pre mining 500m post mining)					
		Neekly inspection conducted until subsidence finialised				
		1.2.g. Pre and post mining subsidence monitoring				
		Neekly steep slope inspection in active mining area in immediate vicinity of road where boulders could be a hazard				
1. Mining methods which	There is a risk to Mandalong from	1.4.a. Flood modelling	D	2	5	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	::: Less than adequate control measures to manage the risk of subsidence :::	assessments to determine flood risk to dwellings and access	(D)	(PI)	(L)	
surface subsidence	Caused by: not considering the characteristics of a relevant surface feature : Bridges Resulting in:	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	Risk to health and safety.	Pre and post mining subsidence monitoring				
		Pre mining structural inspection and assessment by qualified civil/structural engineer				
		Public roads management plan developed in consultation with Lake Macquarie City Council				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		Weekly inspection conducted until subsidence finialised				
intentionally cause the extracted void to	::: Less than adequate control measures	Individual property subsidence management plans				
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : fences	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	С	2	8	
	Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	(D)	(PI)	(M)	
		Elecrtic fence tester for Surveyors and Environmental Contractors provided when conducting				

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		field work				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : communication towers Resulting in: Risk to health and safety.	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence Subsidence Management Plan/Extraction Plan to manage subsidence impacts includes identification of surface features including comms towers None currently identified	c (D)	2 (PI)	8 (M)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Trenching Resulting in: Risk to health and safety.	1.24.a. Individual property subsidence management plans 1.24.b. Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	E (D)	2 (PI)	3 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	Exploration drilling program. Seologist employed at Mandalong Mine. Geological mapping of underground workings. Ground magnetometer surveys to identify large geological structures. Broad based aero magnetometer surveys to identify geological structures. Seological structures. Seological structures. Seological structures.	C (D)	2 (PI)	8 (M)	

Version: 1 Lifecycle State:

Centennial Coal

Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to	::: Less than adequate control measures to manage the risk of subsidence :::	1.35.a. Flood modelling assessments to determine flood risk at 1 year and 100 year ARI events.				
	Caused by: not considering the characteristics of all relevant hydrological conditions: flood areas	Flood modelling assesses impact on infrastructure and private property.	D (D)	2 (PI)	5 (L)	
	Resulting in: Risk to health and safety.	1.35.c. Include flooding assessment in PSMPs and Infrastructure Management Plans.				
intentionally cause the extracted void to	::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	not considering the characteristics of a relevant surface feature : Buildings Resulting in: Risk to health and safety.	Subsidence Management Plan/Extraction Plan to manage subsidence impacts	E (D)	1 (PI)		
		1.1.c. Individual property subsidence management plans				
		Flood modelling assessments to determine flood risk to dwellings and access			1 (L)	
		Dwellings constructed post 1997 to Mine Subsidence Board (MSB) Guidelines				
		1.1.f. Pre Mining MSB inspections on dwellings and buildings				
		Pre mining structural inspection and assessment by qualified civil/structural engineer				

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		dwellings conducted by Mandalong Survey				
		Subsidence design below safe, servicible and repairable criteria for buildings AS2870				
Mining methods which intentionally cause the		1.5.a. No public water supply tanks in mining area				
surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water tanks Resulting in: Risk to health and safety.	Household water tanks assessed in property subsidence management plan	E (D)	1 (PI)	1 (L)	
intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Gas and Fuel tanks Resulting in: Risk to health and safety.	No commercial fuel or gas storage tanks within subsidence area	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	No prescribed public dams under the Dam Safety Act 1973 Individual property subsidence management plans Individual property subsidence management plans Individual property subsidence management plans Individual property subsidence management plans	C (D)	1 (PI)	4 (L)	

Version: 1 Lifecycle State:

Centennial Coal

Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		1.11.e. Pre Mining MSB inspections on farm dams				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.11.g. Subsidence monitoring on farm dams conducted by Mandalong Survey				
intentionally cause the extracted void to	::: Less than adequate control measures	1.20.a. No commercial Ausgrid owned underground assets in mining area				
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features:Underground electricity transmission lines	1.20.b. Individual property subsidence management plans	E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.					
intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.21.a. Ground Water Management Plan identifies registered bores				
surface subsidence	Caused by: not considering the characteristics of a relevant subsurface features:Fresh Water Bore holes	1.21.b. Individual property subsidence management plans	D (D)	1 (PI)	2 (L)	
	Resulting in: Risk to health and safety.					
	There is a risk to Mandalong from	1.23.a. None currently identified				
intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	Historical search has not identified any old workings	E (D)	1 (PI)	1	
Surrace Substitience	Caused by:	1.23.c. Mine Planner on site			(PI) (L)	
	not considering the characteristics of a relevant subsurface features. Mine	1.23.d. Pre drilling assessment procedure which				

Site: Mandalong Title: Subsidence Stature ID:1001025001 Version: 1

Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	service bores Resulting in:	identifies presence of existing workings				
	Risk to health and safety.					
intentionally cause the		Exploration drilling program.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	Geologist employed at Mandalong Mine.		1 (PI)		
surface subsiderice	Caused by: not considering the characteristics of all	1.26.c. Geological mapping of underground workings.				
	relevant geological conditions : Dykes Resulting in:	Ground magnetometer surveys to identify large geological structures.	E (D)			
	Risk to health and safety.	Broad based aero magnetometer surveys to identify geological structures.	_			
		Mine planning to consider impact of geological structures on mine design.				
intentionally cause the		1.27.a. Exploration drilling program.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	1.27.b. Geologist employed at Mandalong Mine.				
surface subsiderice	Caused by: not considering the characteristics of all	1.27.c. Geological mapping of underground workings.				
	relevant geological conditions : Sills Resulting in:	Ground magnetometer surveys to identify large geological structures.	E (D)	1 (PI)	1 (L)	
	Risk to health and safety.	Broad based aero magnetometer surveys to identify geological structures.	_			
		Mine planning to consider impact of geological structures on mine design.				
Mining methods which intentionally cause the extracted void to	n There is a risk to Mandalong from e ::: Less than adequate control measures	Exploration drilling program to identify defects in the Munmorah	C (D)	1 (PI)	4 (L)	

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Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	to manage the risk of subsidence :::	conglomerate beam used to minimise subsidence.				
	Caused by: not considering the characteristics of all relevant geological conditions: Variations	1.28.b. Geologist employed at Mandalong Mine.				
	in lithology	1.28.c. Geological mapping of underground workings.				
	Resulting in: Risk to health and safety.	Mine planning to consider impact of geological structures on mine design.				
Mining methods which intentionally cause the		1.29.a. Geological mapping of underground workings.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	1.29.b. No steep seam >30 degrees.				
	Caused by: not considering the characteristics of all relevant geological conditions : Seam dip		C (D)	(PI)	•	
	Resulting in: Risk to health and safety.					
intentionally cause the	There is a risk to Mandalong from	1.30.a. Identified from in-seam drilling.				
extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence ::: Caused by:	1.30.b. Geologist / geotechnical engineer employed at Mandalong Mine.	С	1	4	
	not considering the characteristics of all relevant geological conditions: Seam roll	1.30.c. Geological mapping of underground workings.	(D)	(PI)	(L)	
	Resulting in: Risk to health and safety.	1.30.d. Incorporate impacts of seam roll on subsidence predictions.				
intentionally cause the extracted void to	::: Less than adequate control measures	Depth of cover is determined by exploration drilling.				
collapse resulting in surface subsidence	to manage the risk of subsidence :::	1.31.b. No depth of cover is less than 160 metres.	E		1	
	Caused by: not considering the characteristics of all relevant geological conditions : Depth of cover	1.31.c. No shallow workings.	(D)		(L)	

Version: 1 Lifecycle State:

Centennial Coal

Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					
intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify seam thickness in mining areas.				
surface subsidence	Caused by:	1.32.b. In-seam drilling.				
	not considering the characteristics of all relevant geological conditions : Seam thickness	1.32.c. Mining equipment limits extraction thickness 3.6 - 4.8m.	E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.	1.32.d. Variations in seam thickness has minimal impacts on mine subsidence levels at Mandalong Mine.				
intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Groundwater impact assessment completed for SMP / Extraction Plan.				
surface subsidence	Caused by: not considering the characteristics of all	 No contiguous aquifiers in the Mandalong mining area. 				
	relevant hydrogeological conditions:Aquifers and ground water resources	1.33.c. Ground Water Management Plan identifies registered bores.	D (D)	1 (PI)	2 (L)	
	Resulting in: Risk to health and safety.	1.33.d. Extensive groundwater monitoring network - 50 bores.				
		No connection between fractured zone and alluvial aquifers to date.				
intentionally cause the extracted void to	::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	E (D)	1 (PI)		
	Caused by: not considering the characteristics of all relevant hydrological conditions:	No impacts on flow within Morans and Stockton Creek to date.				

Version: 1 Lifecycle State:





WRAC Analysis Sorted b	by Consequence (hover for instructions):					
Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Catchment areas Resulting in:	1.34.c. Bi-annual floodpath monitoring.				
	Risk to health and safety.	Subsidence monitoring along creek lines to assess change in grades.				
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence				
	Caused by: not considering the characteristics of all relevant hydrological conditions: creeks	No impacts on flow within Morans and Stockton Creek to date.	C (D)	1 (PI)	4 (L)	
	Resulting in: Risk to health and safety.	1.36.c. Bi-annual floodpath monitoring.				
	ŕ	1.36.d. Subsidence monitoring along creek lines to assess change in grades.				
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures	1.37.a. No prescribed public dams under the Dam Safety Act 1973	_			
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by:	Individual property subsidence management plans				
	not considering the characteristics of all relevant hydrological conditions: dams	1.37.c. Narrow longwall mine design utilising massive				
	Resulting in: Risk to health and safety.	conglomerate overburden to minimise surface subsidence	E	1 (PI)	1	
		1.37.d. Pre and post mining subsidence monitoring	(D)	(PI)	(L)	
		1.37.e. Pre Mining MSB inspections on farm dams				
		Subsidence Management Plan/Extraction Plan to manage subsidence impacts				
		1.37.g. Subsidence monitoring on farm dams conducted				

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Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		by Mandalong Survey				
intentionally cause the extracted void to	::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify defects in the Munmorah conglomerate beam used to minimise subsidence.				
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Strength and properties of Strata	Exploration drilling program to identify seam thickness in mining areas.	E	1	1	
	Resulting in: Risk to health and safety.	1.40.c. Exploration drilling program.	(D)	(PI)	(L)	
		1.40.d. Testing of the immediate roof and floor horizon (for strength).				
		Geotechnical subsidence consultant to review geological date from drilling program.				
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures	Depth of cover is determined by exploration drilling.				
collapse resulting in surface subsidence	to manage the risk of subsidence :::	1.41.b. No depth of cover is less than 160 metres.	_	4		
	Caused by: not considering the characteristics of all relevant geotechnical conditions: Overburden	1.41.c. No shallow workings.	E (D)	1 (PI)	1 (L)	
	Resulting in: Risk to health and safety.					
intentionally cause the extracted void to collapse resulting in	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	Exploration drilling program to identify seam thickness in mining areas.				
surface subsidence	Caused by:	1.42.b. Exploration drilling program.	E (D)	1 (PI)	1 (L)	
	not considering the characteristics of all relevant geotechnical conditions: Floor Resulting in:	1.42.c. Testing of the immediate floor horizon (for strength).			• • •	
	Risk to health and safety.	1.42.d. Geotechnical subsidence				

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
		consultant to review geological date from drilling program.				
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant climatic conditions: rainfall Resulting in: Risk to health and safety.	Flood modelling assessments to determine flood risk to dwellings and access. No depth of cover is less than 160 metres. No direct connection between surface and underground.	E (D)	1 (PI)	1 (L)	
intentionally cause the extracted void to	There is a risk to Mandalong from	No depth of cover is less than 160 metres. Subsidence Management Plan/Extraction Plan to manage subsidence impacts Narrow longwall mine design utilising massive conglomerate overburden to minimise surface subsidence	E (D)	1 (PI)	1 (L)	
intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of any previously excavated or abandoned workings that may interact with any proposed or existing mine workings Resulting in: Risk to health and safety.	1.50.a. Historical search has not identified any old workings	E (D)	1 (PI)	1 (L)	
Mining methods which intentionally cause the extracted void to	There is a risk to Mandalong from	1.52.a. Systematic longwall design.	E (D)	1 (PI)	1 (L)	

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Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
collapse resulting in surface subsidence	to manage the risk of subsidence ::: Caused by: not considering the rate, method, layout, schedule and sequence of mining operations Resulting in: Risk to health and safety.					
intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Railways Resulting in: Risk to health and safety.	1.3.a. Not applicable	0	0	0	
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant surface feature : Water Pipe lines Resulting in: Risk to health and safety.	1.7.a. Not applicable	0	0	0	
intentionally cause the extracted void to	There is a risk to Mandalong from	1.10.a. Not applicable	0	0	0	

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Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface features: Road tunnels Resulting in: Risk to health and safety.	1.14.a. Not applicable	0	0	0	
intentionally cause the extracted void to	There is a risk to Mandalong from	1.15.a. Not applicable	0	0	0	
intentionally cause the extracted void to	There is a risk to Mandalong from	1.17.a. Not applicable	0	0	0	
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of a relevant subsurface	1.18.a. Not applicable	()	0	0	

Version: 1 Lifecycle State:



Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	features:Underground fuel tanks and lines					
	Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	::: Less than adequate control measures to manage the risk of subsidence :::	No commercial water supply in mining area				
	Caused by: not considering the characteristics of a relevant subsurface features:Underground water lines Resulting in:		()	0	0	
	Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence ::: Caused by: not considering the characteristics of all relevant hydrological conditions: lakes Resulting in: Risk to health and safety.	1.38.a. No lakes within the mining area.	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	1.39.a. N/A	()	0	0	
	relevant hydrological conditions: Rivers Resulting in: Risk to health and safety.					
intentionally cause the extracted void to	There is a risk to Mandalong from ::: Less than adequate control measures to manage the risk of subsidence :::	1.44.a. N/A	0	0	0	

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Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
surface subsidence	Caused by: not considering the characteristics of all relevant topographic conditions: Escarpments Resulting in: Risk to health and safety.					
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from There is a risk	1.46.a. N/A	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	1.47.a. N/A	0	0	0	
Mining methods which intentionally cause the extracted void to collapse resulting in surface subsidence	There is a risk to Mandalong from	1.51.a. N/A	0	0	0	

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Instructions:

Step	Potential Incident	Current Controls	L	MRC	RR	Recommended Control
	Resulting in: Risk to health and safety.					

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Lifecycle State:



Recommended Controls

Recommended Controls Do NOT enter additional Recommended Controls on this sheet.	Place(s) Used	Allocated To (Only one SITE person for each Recommended Control)	Required By Date	Pulse User No.	PULSE Ref. No.
 Develop aTransmission Line Management Plan in consultation with Transgrid and DRE. Consider inclusion of montioring arrangements. 	Events: 1.8	Phil Enright	15-Aug-2016	60001	34369.88447

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CEY Risk Matrix Page 1

									Likelihood			
		С	ENTENNIAL	RISK MATRIX	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.							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)	

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CEY Risk Matrix Page 2

Risk Rating Risk Category			Generic Management Actions				
22 to 25 E Extreme		Extreme	Immediate intervention required from senior management to eliminate or reduce this risk				
17 to 21	Н	High	Imperative to eliminate or reduce risk to a lower level by the introduction of control measures. Management planning required at senior levels				
11 to 16	S	Significant	Corrective action required, senior management attention needed to eliminate or reduce risk				
7 to 10	M	Moderate	Corrective action to be determined, management responsibility must be specified				
1 to 6	L	Low	Monitor and manage by corrective action where practicable				

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CEY Risk Matrix Page 3

	1		SOW TIE	ANALYSIS - Control Effective			Impost / Ct	otuo / Ouslit	hv
	Examples	Description	Rank	Control Category	A >= 80%	B 50 – 80%	C 50 / 50%	atus / Qualit D 50 – 20%	E <= 20%
TYPE OF CONTROL	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 large diameter, 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