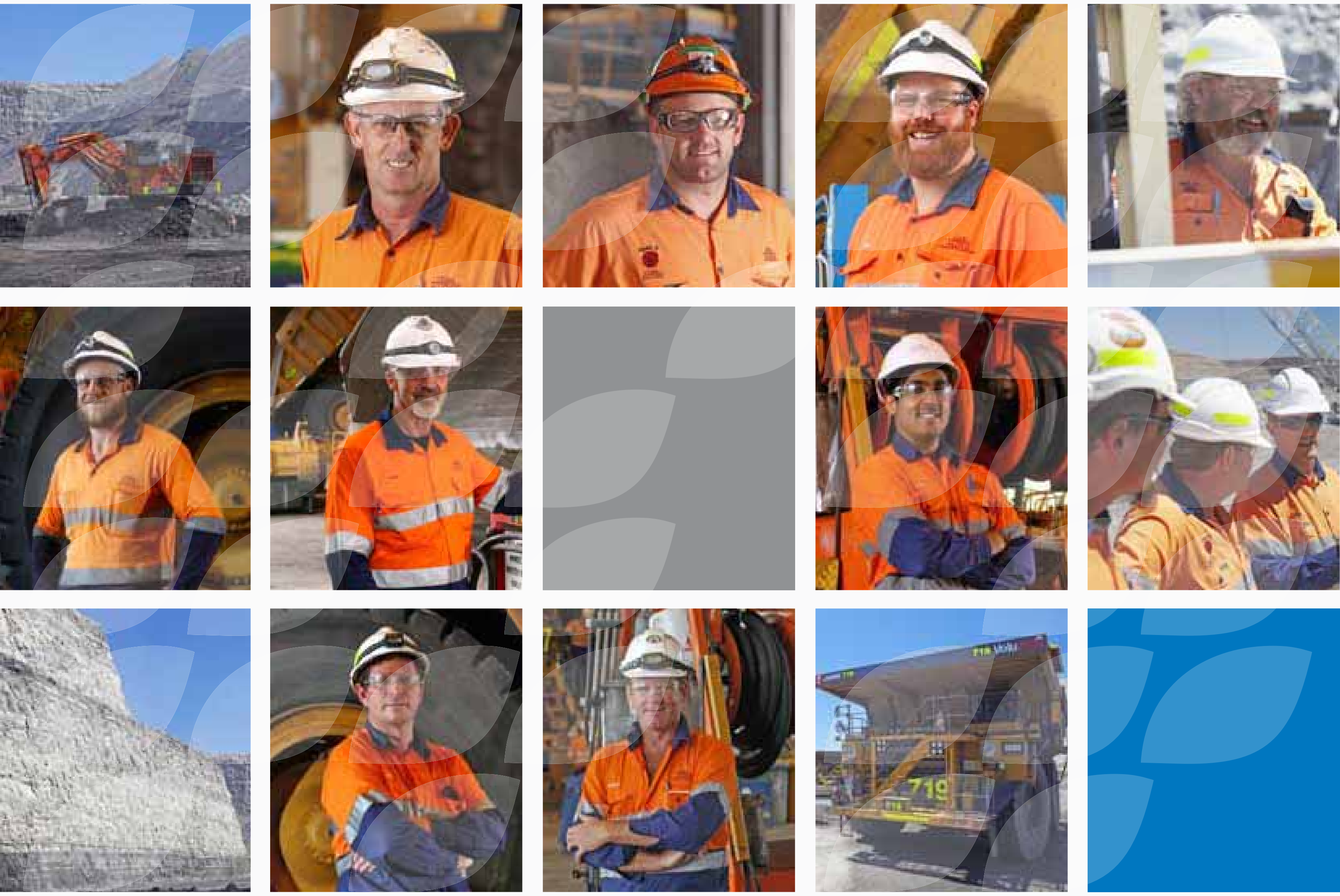
Warkworth Continuation 2014

2

Environmental Impact Statement

Prepared for Warkworth Mining Limited | June 2014

VOLUME 2 — Appendices A to G



COAL & ALLIED
Managed by Rio Tinto Coal Australia

EMM
EMGA Mitchell McLennan

VOLUME 1 — MAIN REPORT

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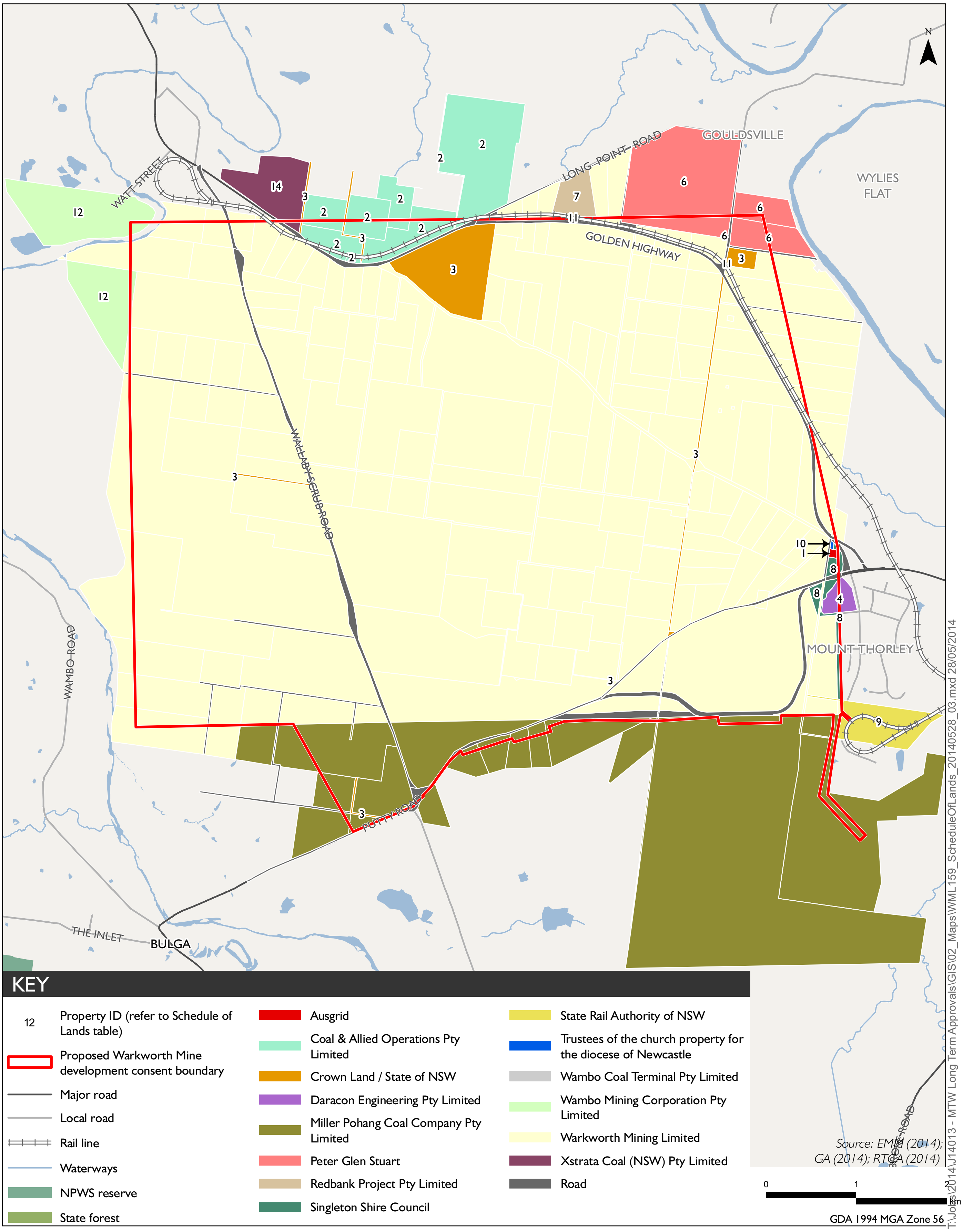
Appendix A

Schedule of land

Appendix A — Schedule of land

A



COAL & ALLIED

Managed by Rio Tinto Coal Australia

Schedule of Lands

Warkworth Continuation 2014
Environmental Impact Statement

Figure A.1

ID	LOT	DP	OWNER
	3	1026900	Road
	4	1026900	Road
	10	1121154	Road
1	40	587922	Ausgrid
2	146	970755	Coal & Allied Operations Pty Limited
2	143	755267	Coal & Allied Operations Pty Limited
2	135	755267	Coal & Allied Operations Pty Limited
2	2	129806	Coal & Allied Operations Pty Limited
2	4	113342	Coal & Allied Operations Pty Limited
2	142	755267	Coal & Allied Operations Pty Limited
2	1	129808	Coal & Allied Operations Pty Limited
2	1	129806	Coal & Allied Operations Pty Limited
3	1	1086834	Crown Land / State of NSW
3	2011	1137289	Crown Land / State of NSW
3	3	705493	Crown Land / State of NSW
3		0	Crown Land / State of NSW
3		0	Crown Land / State of NSW
3		0	Crown Land / State of NSW
3		0	Crown Land / State of NSW
4	372	1026537	Daracon Engineering Pty Limited
5	271	600747	Miller Pohang Coal Company Pty Limited
5	1	42614	Miller Pohang Coal Company Pty Limited
5	99	755270	Miller Pohang Coal Company Pty Limited
5	551	569597	Miller Pohang Coal Company Pty Limited
5	17	658927	Miller Pohang Coal Company Pty Limited
5	3	42614	Miller Pohang Coal Company Pty Limited
5	8	247340	Miller Pohang Coal Company Pty Limited
5	19	247339	Miller Pohang Coal Company Pty Limited
5	6	587986	Miller Pohang Coal Company Pty Limited
5	61	755270	Miller Pohang Coal Company Pty Limited
5	9	247340	Miller Pohang Coal Company Pty Limited
5	7	247340	Miller Pohang Coal Company Pty Limited
5	272	600747	Miller Pohang Coal Company Pty Limited
5	271	260663	Miller Pohang Coal Company Pty Limited
5	2	610376	Miller Pohang Coal Company Pty Limited
5	5	247340	Miller Pohang Coal Company Pty Limited
5	273	260663	Miller Pohang Coal Company Pty Limited
5	341	612684	Miller Pohang Coal Company Pty Limited
5	1	43422	Miller Pohang Coal Company Pty Limited
6	74	755267	Peter Glen Stuart
6	1	910550	Peter Glen Stuart

ID	LOT	DP	OWNER
6	75	755267	Peter Glen Stuart
6	126	665628	Peter Glen Stuart
7	450	1119428	Redbank Project Pty Limited
8	5	1026900	Singleton Shire Council
8	28	255730	Singleton Shire Council
8	371	1026537	Singleton Shire Council
8	29	255730	Singleton Shire Council
9	6	251238	State Rail Authority of NSW
10	2	602169	Trustees of church property for the diocese of Newcastle
11	2	1086834	Wambo Coal Terminal Pty Limited
11	451	1119428	Wambo Coal Terminal Pty Limited
12	23	3030	Wambo Mining Corporation Pty Limited
12	7	3030	Wambo Mining Corporation Pty Limited
13	360	1135647	Warkworth Mining Limited
13	220	1135537	Warkworth Mining Limited
13	99	755267	Warkworth Mining Limited
13	350	1135536	Warkworth Mining Limited
13	35	260056	Warkworth Mining Limited
13	19	113342	Warkworth Mining Limited
13	B	182301	Warkworth Mining Limited
13	162	755267	Warkworth Mining Limited
13	18	113342	Warkworth Mining Limited
13	105	755267	Warkworth Mining Limited
13	16	113342	Warkworth Mining Limited
13	17	113342	Warkworth Mining Limited
13	102	755267	Warkworth Mining Limited
13	154	755267	Warkworth Mining Limited
13	91	755267	Warkworth Mining Limited
13	A	182301	Warkworth Mining Limited
13	103	755267	Warkworth Mining Limited
13	7	248570	Warkworth Mining Limited
13	1	248570	Warkworth Mining Limited
13	1	705493	Warkworth Mining Limited
13	35	755270	Warkworth Mining Limited
13	24	755270	Warkworth Mining Limited
13	272	260663	Warkworth Mining Limited
13	140	248186	Warkworth Mining Limited
13	21	113342	Warkworth Mining Limited
13	129	755267	Warkworth Mining Limited
13	166	657481	Warkworth Mining Limited
13	16	755267	Warkworth Mining Limited

ID	LOT	DP	OWNER
13	6	113342	Warkworth Mining Limited
13	13	113342	Warkworth Mining Limited
13	179	755267	Warkworth Mining Limited
13	138	248186	Warkworth Mining Limited
13	1B	37572	Warkworth Mining Limited
13	22	113342	Warkworth Mining Limited
13	48	755267	Warkworth Mining Limited
13	189	755267	Warkworth Mining Limited
13	3	43383	Warkworth Mining Limited
13	203	704466	Warkworth Mining Limited
13	200	755267	Warkworth Mining Limited
13	1	227280	Warkworth Mining Limited
13	2	227280	Warkworth Mining Limited
13	3	227280	Warkworth Mining Limited
13	178	755267	Warkworth Mining Limited
13	132	755267	Warkworth Mining Limited
13	6	245850	Warkworth Mining Limited
13	8	245850	Warkworth Mining Limited
13	155	755267	Warkworth Mining Limited
13	1	326244	Warkworth Mining Limited
13	1	245850	Warkworth Mining Limited
13	3	245850	Warkworth Mining Limited
13	137	755267	Warkworth Mining Limited
13	1	129800	Warkworth Mining Limited
13	152	755267	Warkworth Mining Limited
13	21	625709	Warkworth Mining Limited
13	4	43383	Warkworth Mining Limited
13	2	827333	Warkworth Mining Limited
13	3	129811	Warkworth Mining Limited
13	8	246201	Warkworth Mining Limited
13	20	113342	Warkworth Mining Limited
13	36	260056	Warkworth Mining Limited
13	139	248186	Warkworth Mining Limited
13	136	755267	Warkworth Mining Limited
13	71	755270	Warkworth Mining Limited
13	170	755267	Warkworth Mining Limited
13	165	755267	Warkworth Mining Limited
13	144	755267	Warkworth Mining Limited
13	6	248570	Warkworth Mining Limited
13	137	248186	Warkworth Mining Limited
13	143	573290	Warkworth Mining Limited

ID	LOT	DP	OWNER
13	1	949066	Warkworth Mining Limited
13	46	755267	Warkworth Mining Limited
13	15	113342	Warkworth Mining Limited
13	180	755267	Warkworth Mining Limited
13	131	248186	Warkworth Mining Limited
13	2	705493	Warkworth Mining Limited
13	134	755267	Warkworth Mining Limited
13	2	1097294	Warkworth Mining Limited
13	1	755267	Warkworth Mining Limited
13	168	755267	Warkworth Mining Limited
13	7	245850	Warkworth Mining Limited
13	156	755267	Warkworth Mining Limited
13	1	326245	Warkworth Mining Limited
13	197	657482	Warkworth Mining Limited
13	5	248570	Warkworth Mining Limited
13	11	246201	Warkworth Mining Limited
13	2	129822	Warkworth Mining Limited
13	131	755267	Warkworth Mining Limited
13	1	129819	Warkworth Mining Limited
13	2	129811	Warkworth Mining Limited
13	3	246201	Warkworth Mining Limited
13	6	247820	Warkworth Mining Limited
13	95	755267	Warkworth Mining Limited
13	93	755267	Warkworth Mining Limited
13	1	610376	Warkworth Mining Limited
13	104	755267	Warkworth Mining Limited
13	164	755267	Warkworth Mining Limited
13	2	804245	Warkworth Mining Limited
13	191	755267	Warkworth Mining Limited
13	97	755267	Warkworth Mining Limited
13	130	755267	Warkworth Mining Limited
13	5	113342	Warkworth Mining Limited
13	141	573290	Warkworth Mining Limited
13	184	755267	Warkworth Mining Limited
13	89	755267	Warkworth Mining Limited
13	132	248186	Warkworth Mining Limited
13	130	248186	Warkworth Mining Limited
13	27	755267	Warkworth Mining Limited
13	90	755267	Warkworth Mining Limited
13	10	113342	Warkworth Mining Limited
13	7	113342	Warkworth Mining Limited

ID	LOT	DP	OWNER
13	196	755267	Warkworth Mining Limited
13	150	755267	Warkworth Mining Limited
13	173	755267	Warkworth Mining Limited
13	2	245850	Warkworth Mining Limited
13	12	246201	Warkworth Mining Limited
13	5	246201	Warkworth Mining Limited
13	2	130264	Warkworth Mining Limited
13	1	129822	Warkworth Mining Limited
13	1	129812	Warkworth Mining Limited
13	1	129811	Warkworth Mining Limited
13	92	755267	Warkworth Mining Limited
13	25	755270	Warkworth Mining Limited
13	185	755267	Warkworth Mining Limited
13	161	755267	Warkworth Mining Limited
13	1	804245	Warkworth Mining Limited
13	182	755267	Warkworth Mining Limited
13	135	248186	Warkworth Mining Limited
13	142	573290	Warkworth Mining Limited
13	2	43383	Warkworth Mining Limited
13	12	113342	Warkworth Mining Limited
13	183	755267	Warkworth Mining Limited
13	144	573290	Warkworth Mining Limited
13	1	573286	Warkworth Mining Limited
13	47	1096589	Warkworth Mining Limited
13	1	176095	Warkworth Mining Limited
13	167	755267	Warkworth Mining Limited
13	111	755267	Warkworth Mining Limited
13	1	1097294	Warkworth Mining Limited
13	9	246201	Warkworth Mining Limited
13	5	245850	Warkworth Mining Limited
13	1	130264	Warkworth Mining Limited
13	151	755267	Warkworth Mining Limited
13	3	129819	Warkworth Mining Limited
13	2	129799	Warkworth Mining Limited
13	2	246201	Warkworth Mining Limited
13	11	113342	Warkworth Mining Limited
13	8	1026900	Warkworth Mining Limited
13	1	1041796	Warkworth Mining Limited
13	7	247820	Warkworth Mining Limited
13	96	755267	Warkworth Mining Limited
13	94	755267	Warkworth Mining Limited

ID	LOT	DP	OWNER
13	26	755270	Warkworth Mining Limited
13	87	755267	Warkworth Mining Limited
13	190	755267	Warkworth Mining Limited
13	841	531116	Warkworth Mining Limited
13	106	755267	Warkworth Mining Limited
13	110	755267	Warkworth Mining Limited
13	187	755267	Warkworth Mining Limited
13	1	130275	Warkworth Mining Limited
13	177	755267	Warkworth Mining Limited
13	157	755267	Warkworth Mining Limited
13	159	755267	Warkworth Mining Limited
13	10	246201	Warkworth Mining Limited
13	4	245850	Warkworth Mining Limited
13	120	1089243	Warkworth Mining Limited
13	2	129819	Warkworth Mining Limited
13	1	129799	Warkworth Mining Limited
13	1	246201	Warkworth Mining Limited
13	2	735566	Warkworth Mining Limited
13	12	1121154	Warkworth Mining Limited
13	22	625709	Warkworth Mining Limited
13	1	130276	Warkworth Mining Limited
13	14	113342	Warkworth Mining Limited
13	136	248186	Warkworth Mining Limited
13	5	43383	Warkworth Mining Limited
13	134	248186	Warkworth Mining Limited
13	172	755267	Warkworth Mining Limited
13	1	43383	Warkworth Mining Limited
13	133	248186	Warkworth Mining Limited
13	2	248570	Warkworth Mining Limited
13	4	658759	Warkworth Mining Limited
13	4	248570	Warkworth Mining Limited
13	11	1121154	Warkworth Mining Limited
13	63	755267	Warkworth Mining Limited
14	1	1043120	Xstrata Coal (NSW) Pty Limited

Appendix B

Study team

Appendix B — Study team

B

Table B.1 Study team

Role	Person	Organisation	Qualifications
Lead consultancy			
Project director	Luke Stewart	EMM	BAppSc (Hons)
Project manager	Duncan Peake	EMM	BSc (Hons)
Project coordinator	Andrew Wiltshire	EMM	BSc (Geography), PGDip (EnvMgt)
Contributing authors	Rachael Russell	EMM	BSc, MEnvP
	Rebecca Newell	EMM	BA (Hons Class 1)
	Cassandra Thompson	EMM	BSc, MAppSc (EnvSc)
	Kate Cox	EMM	BSc (Marine Science)
	Robert Janssen	EMM	BSc, DipBus
Graphics	Antony Edenhofner	EMM	BSc (Applied Economic Geography)
	Robyn Sharpe	Sharper Graphics	DipA(Graphic Design and Advertising)
Administrative support	Jamie Wharemate	EMM	-
Technical specialists			
Aboriginal cultural heritage	David Cameron	Rio Tinto Coal Australia	BA, BA(Hons), PhD (Economic History)
	Luke Goodwin	Central Queensland Cultural Heritage Management	BA(Hons), PhD
	Joel Deacon	Rio Tinto Coal Australia	BA (Hons)
Air quality	Aleks Todoroski	Todoroski Air Sciences	BE(Mech)
	Philip Henschke	Todoroski Air Sciences	BSc
Ecology	David Robertson	Cumberland Ecology	BSc (Hons) PhD (Ecology)
Economics	Brian Fisher	BAEconomics	BScAgr (Hons I)
	Sabine Schnittger	BAEconomics	DipEc, MMatEcon
Groundwater	James Tomlin	AGE Consultants	BSc (Env Studies), MSc (Hydrogeology), CertSc (Geology)
	Doug McAlister	AGE Consultants	MAppSc, Hydrogeology
Historic Heritage	Tina King	RTCA	BA (Archaeology and Anthropology), BA (Hons), MA (Cultural Heritage)
	Holly Maclean	RTCA	BA (Archaeology and Anthropology), BSocSc (Hons, MA (Cultural Heritage)
Noise and vibration	Najah Ishac	EMM	MEngSc, BE (Mech)
	Daniel Weston	EMM	BEngTech (Audio), MDesSc (Acoustics)
	David Sallak	EMM	BE (Mech), Dip (Mech Eng)
Social and consultation	Brett McLennan	EMM	BTP (Hons), BSc (Hons)
	Michael Askew	EMM	Bbus (Management, Environmental & Urban), MEnvSt, PhD (Environmental Studies)
	Louise Askew	EMM	PhD (Geography), BSc (Hons)
Surface water	David Newton	WRM Water and Environment	BE (Hons), MEngSt, PhD (CPEng)
	Tallulah Kaegi	WRM Water and Environment	BE (Hons)
Traffic	Tim Brooker	EMM	PhD, BScEng
Visual	Esther Dickens	IDS	BA Design (Hons) (Landscape Architecture)

Appendix C

Surrounding residences and assessment locations

Appendix C — Surrounding residences and assessment locations

C

Assessment location ID	Property owner
1	Judith Leslie
2	Shayne Aaron Currie
3	Charleroi Pty Limited
4	Graeme O'Brien & Susann Florence O'Brien
5	Daniel Bruce Jones
6	Russell James Doidge, Trinette Louise Reid
7	Darral Keith Margery & Annette Gaye Margery
8	Laurence Fletcher, Margaret Ann Fletcher
9	Donald Bruce Roser
10	Andrew Mark Robey, Kim Luanne Robey
11	Wambo Mining Corporation Pty. Limited
12	Ronald Alexander Corino, Pauline Rayner
13	Ilario Francisco Circosta, Maria Angela Circosta*
14	Karin Margaret Hunt
15	William Lindsay Gordon Slaney, Peta Slaney
16	Leona Ann Williams
17	George David Lianos, Honor Claire Lianos
18	Barry John Anderson, Melissa Gai Anderson
19	Denis Cyril Maizey, Elaine Margaret Maizey
20	Gregory William Banks, Marion Elizabeth Banks
21	Gregory William Banks, Marion Elizabeth Banks
22	Elizabeth Mackenzie
23	Peter Jason Kolatchew, Heidi Kolatchew
24	Ronald Garry Bailey, Fiona Susan Bailey
25	William George Joseph Lambkin, Dawn Lambkin*
26	Barbara Gae Harrison, Trevor Eric Harrison
27	Warkworth Mining Limited
28	Hubert George Upward
29	Ilario Francisco Circosta, Maria Angela Circosta*
30	Damien Michael Hanson, Danielle Louise Hanson
31	Gregory Malcolm Caban
32	Paul Mark Dunn, Susan Joy Urwin
33	Ian Norris Bartholomew, Annette Maria Bartholomew
34	Allan Clyde Lepisto, Nerida Lepisto
35	Lawrence Malcolm Caban, Rhonda Beryl Caban
36	Raymond Carl Powell
37	Gregory Paul Crowe
38	Benjamin John Street, Jami Ann Street
39	Gregory John Mcnaught
40	Margaret Player, John Maclachlan Player
41	Hubert George Upward
42	Mark Anthony Lancaster, Debbie Marie Lancaster
43	Geoffrey Allen Burgess, Betty Joy Burgess
44	Barry Fogwell
45	Adam Charles Cameron
46	Jason Phillip Horn
47	Philip Adamthwaite

Assessment location ID	Property owner
48	Brett James Gallagher, Rebecca Louise Gallagher
49	John Thompson, Delwyn Kay Jackson
50	Bradley Richard Sales, Sharon Ann Bellamy
51	Warkworth Mining Limited
52	Stewart James Mitchell, Marie Clare Mitchell
53	Robert Mclaughlin
54	Christopher Stanley Neville & Elizabeth Ann Neville
55	Robert John Evans
56	Leonard Walter Mclachlan, Noelene Rita Mclachlan
57	Paul William Harris, Tracey Anne Swindail
58	David Andrew Gregory
59	Warkworth Mining Limited
60	Vaughan Thomas Cagney, Candice Rose Albert
61	Darrell Stanley Kaizer
62	Dwi Octaviani
63	Margueriette Ann Henneberry, Paul Andrew Burgess
64	Dusko Dragicevic, Milan Dragicevic
65	Gordon Keith Grainger, Selma Rosalind Grainger
66	Michael Vivian Bendall, Sue-Ellen Bendall
67	Michael Shane Dawson & Suzana Dawson
68	Warkworth Mining Limited
69	Warkworth Mining Limited
70	Peter Francis Ritchie And Fiona Jennifer Ritchie
71	Robert Ian Hedley, Jan Maree Louis
72	Frank Henry Turnbull
73	Phillip Joseph Reid, Carol Reid
74	Ronald Guy Godyn, Anne-Marie Godyn
75	Lindsay Robert Smith, Jillian Maree Smith
76	The State Of New South Wales
77	William Joseph Kelly, Marie Joyce Kelly, Lawrence Kelly
78	Warkworth Mining Limited
79	Wambo Mining Corporation Pty. Limited
80	Dimitrious Vikas & Joy Mary Vikas
81	Agl Energy Limited
82	Stephen Glenn Williamson, Nicole Leanne Highett
83	Xstrata Coal Pty Limited
84	Mary Veronica Thompson
86	The State Of New South Wales
87	Andre Marc Renaud, Noela Mary Renaud*
89	Bryan Dudley Medhurst
90	Coal & Allied Operations Pty Limited
91	Wambo Coal Pty Limited
92	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
93	Coal & Allied Operations Pty Limited
94	Wambo Coal Pty Limited
95	Miller Pohang Coal Company Pty Limited
96	Wambo Mining Corporation Pty. Limited

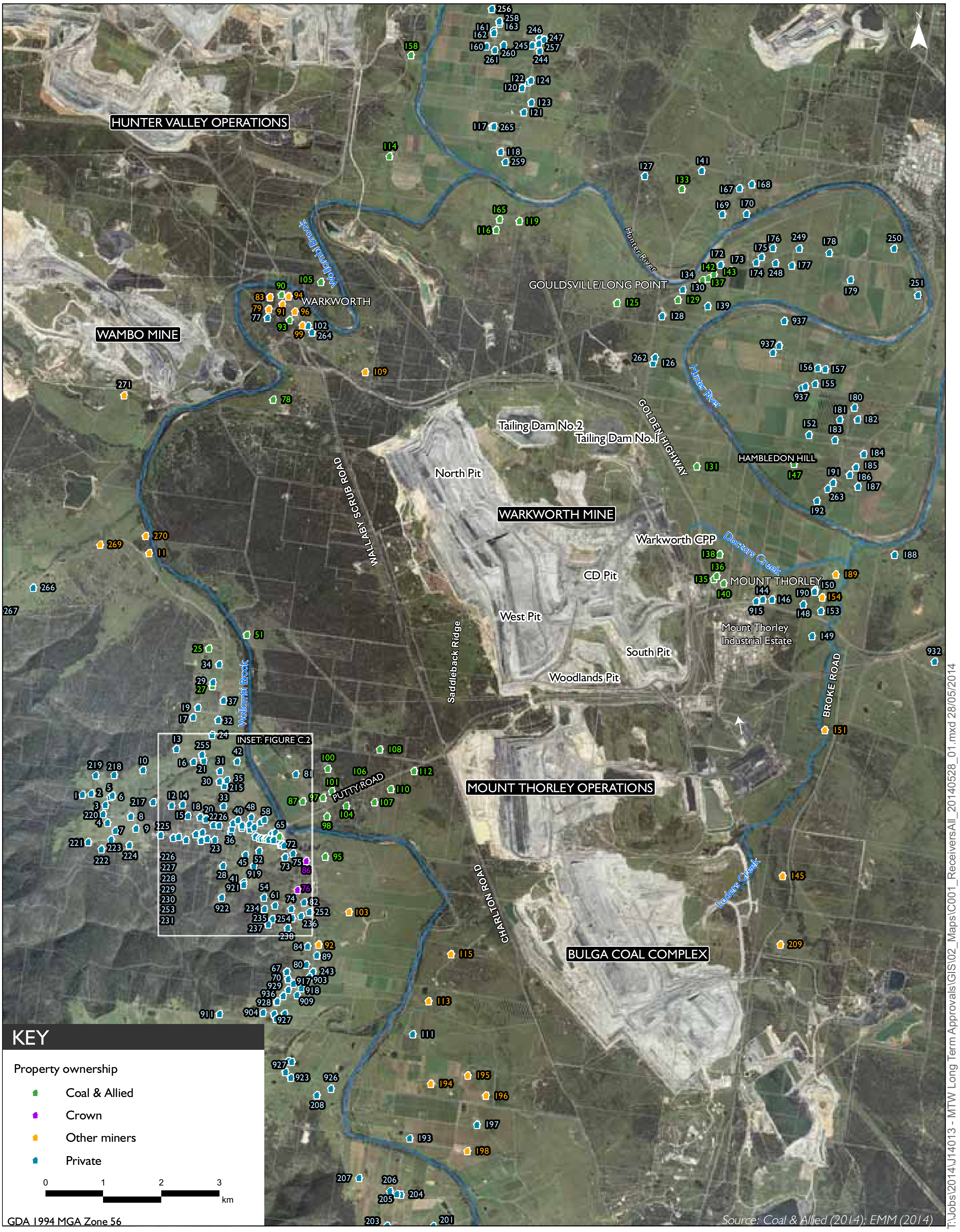
Assessment location ID	Property owner
97	Warkworth Mining Limited
98	Miller Pohang Coal Company Pty Limited
99	Wambo Coal Pty Limited
100	Miller Pohang Coal Company Pty Limited
101	Miller Pohang Coal Company Pty Limited
102	Brian Edward Kennedy, John Griffiths
103	Saxonvale Coal Pty. Limited, Nippon Steel Australia Pty. Limited
104	Miller Pohang Coal Company Pty Limited
105	Coal & Allied Operations Pty Limited
106	Miller Pohang Coal Company Pty Limited
107	Miller Pohang Coal Company Pty Limited
108	Miller Pohang Coal Company Pty Limited
109	Xstrata Coal (Nsw) Pty Limited
110	Miller Pohang Coal Company Pty Limited
111	Ian Wallace Russell
112	Miller Pohang Coal Company Pty Limited
113	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
114	Coal & Allied Operations Pty Limited
115	Saxonvale Coal Pty. Limited, Nippon Steel Australia Pty. Limited
116	Coal & Allied Operations Pty Limited
117	Phillip John Algie, Colleen Ann Maree Algie
118	Robert John Algie
119	Coal & Allied Operations Pty Limited
120	Russell John Wenham, Janelle Susan Wenham
121	Julie Gai Ernst, Gregory John Ernst
122	Stephen Douglas Edwards, Terri-Anne Howard, Joselyn Vida Clifton
123	Neil Robert Nelson, Glenda Joy Nelson
124	Stephen Douglas Edwards, Terri-Anne Howard, Joselyn Vida Clifton
125	Coal & Allied Operations Pty Limited
126	Peter Glen Stuart
127	Noel Francis Riley, Elaine Roslyn Riley
128	Warren John Welsh, Adam John Young
129	Coal & Allied Operations Pty Limited
130	Francescantonio Ventra, Joanne Ventra
131	Warkworth Mining Limited
133	Coal & Allied Operations Pty Limited
134	Andrew Arthur Barrett, Nicole Maree Kenny
135	Warkworth Mining Limited
136	Warkworth Mining Limited
137	Coal & Allied Operations Pty Limited
138	Warkworth Mining Limited
139	Kevin Denis Hartcher, Linda Anne Hartcher
140	Warkworth Mining Limited
141	Warren Thomas Barry, Lesley Una Barry
142	Coal & Allied Operations Pty Limited
143	Coal & Allied Operations Pty Limited
144	Jason Cyril Rumbel, Rebecca Ruth Rumbel

Assessment location ID	Property owner
145	Saxonvale Coal Pty. Limited, Nippon Steel Australia Pty. Limited
146	Paul Henry Russell
147	Warkworth Mining Limited
148	Dorothy Clare Russell
149	Timothy Peter Hedley
150	Keith David Isaac, Sharon Ann Isaac
151	Bulga Coal Management Pty Limited
152	Graham Edwin Berry, Elizabeth Anne Berry
153	Thomas William Kermode, Kathleen May Kermode
154	Bulga Coal Management Pty Limited
155	Trevor Keith Berry, Graham Edwin Berry
156	Jean Mary O'Hara
157	Jean Mary O'Hara
158	Coal & Allied Operations Pty Limited
160	Elizabeth Stuart Bowman
161	Wyoming Holsteins Pty Limited
162	Wyoming Holsteins Pty Limited
163	Wyoming Holsteins Pty Limited
165	Coal & Allied Operations Pty Limited
167	Nathan James Laing
168	Stuart Francis Nichol Wright, Pamela Lynn Wright
169	Harold Douglas Hobden
170	John Marcheff
172	John Stuart Gough, Lynette Jean Gough
173	Michael John Wellard, Faye Denise Wellard
174	Margaret Anne Neal
175	Bradley John Halter
176	Michael Raymond Mapp, Shirley Maree Mapp
177	Greig Andrew Delaney
178	Craig Ian Flissinger, Catherine Anne Flissinger
179	Tickalara Pty. Limited
180	Bruce Graham Moore
181	David Charles Vassallo, Sheree Ann Vassallo
182	Robert Francis Holstein And Andrea Terry Holstein
183	Paul Anthony Cavanough, Jacinta Jade Dawkins
184	Campbell Stuart Ball And Gail Agnes Ball
185	Leonard Dale Franks
186	Leonard Dale Franks
187	Keith Heuston Pty. Limited
188	Comserve (No.932) Pty Ltd
189	Bulga Coal Management Pty Limited
190	Keith David Isaac, Sharon Ann Isaac
191	Robert John Vidler, Coral May Vidler
192	Jean Mary O'Hara
193	Robert Kennedy
194	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
195	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited

Assessment location ID	Property owner
196	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
197	Robert Kennedy
198	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
199	Adrian Garton, Susan Jean Garton
200	Karren Anne Mccraw, Kenneth Ian Mccraw
201	Richard James Owens
202	Richard James Owens
203	Grapemen Holdings Pty Limited
204	Brenda Joan Tanner
205	Victoria Ann Foster
206	Theo Poulos, Maria Poulos
207	John Stephen Tulloch
208	Cybele Genevieve Orton
209	Saxonvale Coal Pty Limited, Nippon Steel Australia Pty Limited
210	Meria Violet Ford
211	Mike Dean Silk, Antoinette Silk
215	Allan Wayne Louis, Cheryl Anne Louis
217	Packtron Packaging Pty Limited
218	Phillip John Haerse, Elizabeth Rae Haerse
219	Philip Geoffrey Carroll
220	George Jiri Tlaskal
221	Christina Mary Metlikovec
222	John Vincent Putland
223	Andrew Glenn Upward
224	Rex Wayne Davis, Heather Anne Davis
225	Anthony and Trudie Seibel – Barnes
226	Neale Mccallum, Julie Marie Mcnaughton
227	Ian Wyn Jones, Karen Michelle Jones
228	Jason Peter Passlow, Belinda Louise Lee
229	Maurice Francis Chapman, Nellie Vera Chapman
230	Paul Dermot Byrne O'Toole, Melissa Jane O'Toole
231	Mark Mcalpin Roser, Nicole Roser
234	Robert John Bridge, Kylie Terese Bridge
235	Garrett James Walters & Clare Joanne Gowans
236	Scott Francis Ryan
237	Leslie Carol Krey
238	Raymond George Caban, Kathryn Louise Caban
243	John Patrick Cant, Cherie Margaret Cant
244	Todd Anthony Mills, Sharron Ann Mills
245	Chriss Ivan Maskey
246	Paul Raymond Burley, Catherine Maree Burley
247	Tony Zanardi, Sandra Maree Zanardi
248	Keith Joseph Horne
249	Thomas William Watson, Betty Watson
250	John Michael Woods
251	Frederick John & Carole Maria Flinn
252	Jaques Family Investments Pty Limited

Assessment location ID	Property owner
253	Stuart Edward Reakes
254	Peter William Shore & Melanie Louise Shore
255	Ilario Francisco Circosta, Maria Angela Circosta*
256	Bruce Eric Moxey, Thea Anne Moxey
257	Robert John Algie
258	Wyoming Holsteins Pty Limited
259	Robert John Algie
260	Wyoming Holstiens Pty. Limited
261	Wyoming Holstiens Pty. Limited
262	Peter Glen Stuart
263	John Klasen, Ruth Anne Klasen
264	George Robert Miller
265	Phillip John Algie, Colleen Ann Maree Algie
266	Ronald Wayne Fenwick
267	Kenneth Max Brosi
268	Kenneth Max Brosi, Julie Anne Brosi & Pauline June Mcloughlin
269	Wambo Mining Corporation Pty Limited
270	Wambo Mining Corporation Pty Limited
271	Wambo Mining Corporation Pty Limited
903	Adam John Baker
904	Allan Mark Brasington, Judith Anne Brasington
905	Cameron Michael Turner, Melissa Jayne Harris
909	Emanuel Victor Vassallo
911	Gary Dale Harris
915	Jason Cyril Rumbel, Rebecca Ruth Rumbel
917	John Robert Lamb
918	Joseph Vassallo, Doris Vassallo
919	Kenneth Neil Cameron
920	Lindsay Gordon Harris, Jillian May Ferguson
921	Melanie Caban, Keiran Lionel Caban
922	Melanie Evelyn Upward
923	Michelle Maria Brennan
926	Paul William Mackay, Suzanne Elizabeth Mackay
927	Phillip John Gunter, Leona Mary Gunter
928	Sarah Elizabeth Purser, Stirling Owen Keayes
929	Simon James Beavis
932	Stephen Dennis Tipping
936	Thomas Charles Jackson, Susan Gai Jackson
937	Trevor Keith Berry, Graham Edwin Berry

** at date of document publication private residence status still being determined on land transfer and have been treated as mine owned properties in the EIS.*

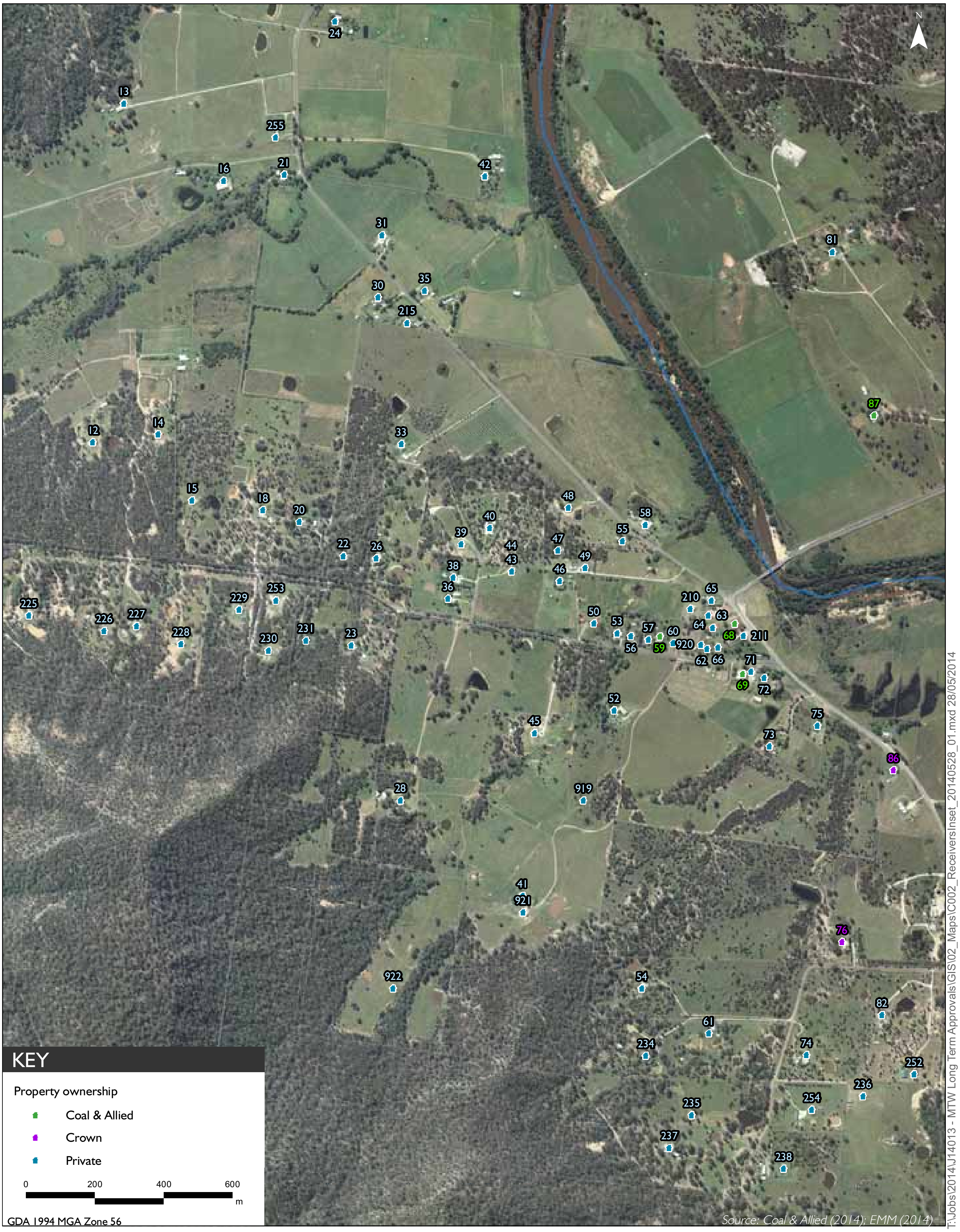


Assessment locations

Warkworth Continuation 2014

Environmental Impact Statement

Figure C.1



COAL & ALLIED
Managed by Rio Tinto Coal Australia

Assessment locations - Bulga area
Warkworth Continuation 2014
Environmental Impact Statement
Figure C.2

Appendix D

Secretary's requirements

Appendix D — Secretary's requirements

D

Development Assessment Systems & Approvals
Mining Projects
Contact: Elle Donnelley
Phone: (02) 9228 6340
Fax: (02) 9228 6466
Email: elle.donnelley@planning.nsw.gov.au

Mr Mark Nolan
Principal Advisor Project Approvals NSW
Health, Safety, Environment and Communities
Rio Tinto
PO Box 315
SINGLETON NSW 2330

Dear Mr Nolan

State Significant Development - Secretary's Requirements
Warkworth Continuation Project (SSD 6464)

I have attached the Secretary's requirements for the preparation of an Environmental Impact Statement (EIS) for the Warkworth Continuation Project.

These requirements are based on the information you have provided to date, and have been prepared in consultation with the relevant government agencies. The agencies' comments are attached for your information (see Attachment 2).

Please note that the Department may alter these requirements at any time, and that you must consult further with the Department if you do not lodge a development application and EIS for the project within the next two years.

Please contact the Department at least two weeks before you plan to submit the development application and EIS for the project. This will enable the Department to:

- confirm the applicable fee (see Division 1AA, Part 15 of the *Environmental Planning and Assessment Regulation 2000*); and
- determine the number of copies (hard-copy and CD-ROM) of the EIS required.

It is important for you to recognise that the Department will review the EIS for the project before putting it on public exhibition, and make you submit an amended EIS if it fails to adequately address these requirements.

Yours sincerely

DKitto 22/5/14

David Kitto
Director
Mining Projects
As delegate of the Secretary

Secretary's Environmental Assessment Requirements

State Significant Development

Section 78A(8A) of the *Environmental Planning and Assessment Act 1979*

<table>
<tr><td>Application Number</td><td>SSD 6464</td></tr>
<tr><td>Proposal</td><td>The Warkworth Continuation Project, which includes:
the continuation of existing and approved development on site;
extending approved open cut mining operations further west;
developing a range of associated infrastructure to support this extension;
maintaining maximum coal extraction rates at 18 million tonnes of run of mine coal a year;
exporting coal, tailings and overburden to the Mt Thorley mine;
water sharing with other mines;
exporting sand and gravel from the site; and
progressively rehabilitating the site.</td></tr>
<tr><td>Location</td><td>Approximately 15 km southwest of Singleton</td></tr>
<tr><td>Applicant</td><td>Warkworth Mining Limited</td></tr>
<tr><td>Date of Issue</td><td>22 May 2014</td></tr>
<tr><td>General Requirements</td><td>The Environmental Impact Statement (EIS) for the development must comply with the requirements in Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000.

In particular, the EIS must include:
a full description of the development, including:
the resource to be extracted, demonstrating efficient resource recovery within environmental constraints;
the mine layout and scheduling;
minerals processing;
a waste (overburden, tailings, etc.) management strategy, dealing with the EPA's requirements (see Attachment 2);
a water management strategy, dealing with the EPA's and NSW Trade and Investment's requirements (see Attachment 2);
a rehabilitation strategy, dealing with NSW Trade and Investment's requirements (see Attachment 2); and
the likely interactions between the development and any other existing, approved or proposed mining development in the vicinity of the site;
a list of any approvals that must be obtained before the development may commence;
an assessment of the likely impacts of the development on the environment, focussing on the specific issues identified below, including:
a description of the existing environment likely to be affected by the development, <u>using sufficient baseline data</u>;
an assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice;
a description of the measures that would be implemented to mitigate and/or offset the likely impacts of the development, and an assessment of:
whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented;
the likely effectiveness of these measures; and</td></tr>
</table>

	o whether contingency plans would be necessary to manage any residual risks; – a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved; • a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS; • consideration of the development against all relevant environmental planning instruments (including Part 3 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007);* and • the reasons why the development should be approved having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development. While not exhaustive, Attachment 1 contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development. In addition to the matters set out in Schedule 1 of the *Environmental Planning and Assessment Regulation 2000*, the development application must be accompanied by a signed report from a suitably qualified expert that includes an accurate estimate of the: • capital investment value (as defined in Clause 3 of the *Environmental Planning and Assessment Regulation 2000*) of the development, including details of all the assumptions and components from which the capital investment value calculation is derived; and • jobs that would be created during each stage of the development.
Specific Issues	The EIS must address the following specific issues: • **Noise & Blasting** – including: - an assessment of the likely operational noise impacts of the development (including construction noise) under the *NSW Industrial Noise Policy*, paying particular attention to establishing accurate background noise levels in the surrounding area, the effect of removing Saddleback Ridge and the obligations in chapters 8 and 9 of the policy; - if a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely construction noise impacts of these activities under the *Interim Construction Noise Guideline*; - an assessment of the likely road noise impacts of the development under the *NSW Road Noise Policy*; and - an assessment of the likely blasting impacts of the development on people, animals, buildings and infrastructure, and significant natural features, having regard to the relevant ANZEC guidelines; • **Air** – including: - an assessment of the likely air quality impacts of the development in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* and the EPA's additional requirements (see Attachment 2); and - an assessment of the likely greenhouse gas impacts of the development, dealing with the EPA's requirements (see Attachment 2); • **Biodiversity** – including: - an assessment of the likely biodiversity impacts of the new development, having regard to the principles and strategies in the draft *NSW Biodiversity Offsets Policy for Major Projects* and the *Upper Hunter Strategic Assessment – Interim Policy*, using the Biodiversity Certification Assessment Methodology as amended by the Upper Hunter Strategic Assessment for credit calculation, and the Biobanking Assessment Methodology as amended by the Upper Hunter Strategic Assessment for calculating the credits of any

	offsets; - specific assessment of the likely impacts of the new development on the Warkworth Sands Woodland endangered ecological community; and - the provision of alternate offsets for the disturbance area approved under the 2003 development consent, using the Biodiversity Certification Assessment Methodology as amended by the Upper Hunter Strategic Assessment for credit calculation and the Biobanking Assessment Methodology as amended by the Upper Hunter Strategic Assessment for calculating the credits of any offsets; • **Water** – including: - an assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPA's and NSW Trade and Investment's requirements (see Attachment 2); - an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users; and - an assessment of the likely flooding impacts of the development; • **Land** – including: - an assessment of the likely impacts of the development on the soils, land capability, and landforms (topography) of the site; and - an assessment of the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clause 12 of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*; • **Heritage** – including an assessment of the likely Aboriginal and historic heritage (cultural and archaeological) impacts of the development having regard to OEH's requirements (see Attachment 2), and paying particular attention to the likely impacts on the Bulga Bora Ground, Great North Road, and former air strip on the site; • **Traffic** – including: - an assessment of the likely impacts of the closure of Wallaby Scrub Road, particularly on the provision of emergency services; and - an assessment of the likely traffic impacts of the development on the capacity, condition, safety and efficiency of the local and State road network, including the impacts associated with the potential tunnel under Putty Road and the haulage of sand and gravel from the site; • **Visual** – including an assessment of the likely visual impacts of the development on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to the removal of Saddleback Ridge, the creation of new landforms (overburden dumps, bunds, etc.), and minimising the lighting impacts of the development; • **Public Safety** – including an assessment of the likely risks to public safety off-site, paying particular attention to bushfire risks and the handling and use of any dangerous goods; • **Social & Economic** – including: - an assessment of the likely social impacts of the development (including perceived impacts), paying particular attention to any impacts on Bulga village; and - an assessment of the likely economic impacts of the development, paying particular attention to: o the significance of the resource; o economic benefits of the project for the State and region; and o the demand for the provision of local infrastructure and services.

Consultation	During the preparation of the EIS, you must consult with relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. The EIS must describe the consultation that was carried out, identify the issues raised during this consultation, and explain how these issues have been addressed in the EIS.

ATTACHMENT 1

Environmental Planning Instruments, Policies, Guidelines & Plans

Noise & Blasting	
	NSW Industrial Noise Policy (EPA)
	NSW Road Noise Policy (EPA)
	Interim Construction Noise Guideline (EPA)
	Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC)
Air	
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (EPA)
	Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline (EPA)
	Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA)
	National Greenhouse Accounts Factors (Commonwealth)
Biodiversity	
	Draft NSW Biodiversity Offset Policy for Major Projects (OEH)
	BioBanking Assessment Methodology (OEH)
	Biodiversity Certification Assessment Methodology (OEH)
	Upper Hunter Strategic Assessment – Interim Policy (DP&E)
	NSW State Groundwater Dependent Ecosystem Policy (NOW)
	Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW)
	State Environmental Planning Policy No. 44 – Koala Habitat Protection
Water	
Water Sharing Plans	Hunter Unregulated and Alluvial Water Sources 2009
	Hunter Regulated River Water Source 2003
Groundwater	NSW State Groundwater Policy Framework Document (NOW)
	NSW State Groundwater Quality Protection Policy (NOW)
	NSW State Groundwater Quantity Management Policy (NOW)
	NSW Aquifer Interference Policy 2012 (NOW)
	Australian Groundwater Modelling Guidelines 2012 (Commonwealth)
	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
	Guidelines for the Assessment & Management of Groundwater Contamination (EPA)
Surface Water	NSW Government Water Quality and River Flow Objectives (EPA)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (EPA)
	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC)
	Hunter River Salinity Trading Scheme (EPA)
	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA)

	Managing Urban Stormwater: Soils & Construction (Landcom) and associated Volume 2E: Mines and Quarries (DECC)
	Managing Urban Stormwater: Treatment Techniques (EPA)
	Managing Urban Stormwater: Source Control (EPA)
	Technical Guidelines: Bunding & Spill Management (EPA)
	Environmental Guidelines: Use of Effluent by Irrigation (EPA)
	A Rehabilitation Manual for Australian Streams (LWRRDC and CRCCH)
	NSW Guidelines for Controlled Activities (NOW)
Flooding	Floodplain Development Manual (OEH)
	Floodplain Risk Management Guideline (OEH)
Land	
	Agfact AC25: Agricultural Land Classification (NSW Agriculture)
	State Environmental Planning Policy No. 55 – Remediation of Land
	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC)
Heritage	
	The Burra Charter (The Australia ICOMOS charter for places of cultural significance)
	Draft Guidelines for Aboriginal Cultural Heritage Assessment and Community Consultation (DP&E)
	Aboriginal Cultural Heritage Consultation Requirements for Proponents (OEH)
	Code of Practice for the Archaeological Investigation of Aboriginal Objects in NSW (OEH)
	NSW Heritage Manual (OEH)
	Statements of Heritage Impact (OEH)
	Hunter Regional Environmental Plan 1989 (Heritage)
Traffic	
	Guide to Traffic Generating Development (RTA)
	Road Design Guide (RTA) & relevant Austroads Standards
Public Safety	
	State Environmental Planning Policy No. 33 – Hazardous and Offensive Development
	Hazardous and Offensive Development Application Guidelines – Applying SEPP 33
	Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis
Resource	
	Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves 2012 (JORC)
Waste	
	Waste Classification Guidelines (DECC)
Rehabilitation	
	Mine Rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth)
	Mine Closure and Completion – Leading Practice Sustainable Development Program for the Mining Industry (Commonwealth)
	Strategic Framework for Mine Closure (ANZMEC-MCA)
Environmental Planning Instruments - General	
	State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007
	State Environmental Planning Policy (State and Regional Development) 2011
	State Environmental Planning Policy (Infrastructure) 2007
	Singleton LEP 2013

For *Attachment 2 Agency Correspondence* please refer to the Department of Planning and Environment's website at http://www.planning.nsw.gov.au/

Appendix E

Economic study

Appendix E — Economic study

E

Economic Impact Assessment for Warkworth Continuation 2014 and Mount Thorley Operations 2014

Prepared for Rio Tinto Coal Australia

Client name: RTCA
Date: June 2014

35 Endeavour Street
Red Hill, ACT 2603
Phone: +61 2 62951306
Fax: +61 2 6239 5864
www.baeconomics.com.au

Table of contents

Abbreviations

ABS	Australian Bureau of Statistics
ASNA	Australian System of National Accounts
BBAM	Biobanking Assessment Methodology
BCAM	Biodiversity certification assessment methodology
BMP	Biodiversity Management Plan
CBA	Cost benefit analysis
CHPP	Coal handling and preparation plant
CMP	Conservation management plan
EEC	Endangered ecological community
EIS	Environmental impact statement
FTE	Full-time equivalent
GDP	Gross domestic product
GOS	Gross operating surplus
GMI	Gross mixed income
GSP	Gross state product
ha	Hectare
HMP	Heritage management plan
HVRF	Hunter Valley Research Foundation
INP	Industrial Noise Policy
IPCC	Intergovernmental Panel on Climate Change
LGA	Local government area
MAGICC	'Model for the Assessment of Greenhouse Gas Induced Climate Change'
MTCL	Mount Thorley Coal Loader
MTO	Mount Thorley Operations
Mtpa	Million tonnes per annum
MTW	Mount Thorley Warkworth
NBA	Northern Biodiversity Area
REIA	Regional economic impact analysis
ROM	Run of mine

RUCs	Road user costs
SBA	Southern Biodiversity Area
SCC	Social cost of carbon
UHSA	Upper Hunter Strategic Assessment
VOCs	Vehicle operating costs
WBACHCA	Wollombi Brook Aboriginal Cultural Heritage Conservation Area
WMS	Water management system
WTA	Willingness-to-accept
WSW	Warkworth Sands Woodland
WTP	Willingness-to-pay
ZOA	Zone of acquisition

Summary

This report describes the direct and flow-on economic benefits of the proposed continuation of operations at Mount Thorley Warkworth (MTW) for the Mid and Upper Hunter region and for NSW.

The proposal is for the continuation of existing operations of an integrated mining complex – consisting of the Warkworth Mine and the Mount Thorley Operations (MTO) – beyond the timeframe permitted under the mines' existing consents until 2035. Two separate applications (proposals) will be lodged to continue operations at MTW; one for Warkworth Mine and one for MTO.

MTW has the necessary infrastructure in place to extend the life of the mine, and currently employs around 1,300 employees and contractors.

The analysis described in this report has been prepared in accordance with relevant NSW Government guidelines, including the 'Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals' (NSW Government 2012), the 'Guideline for economic effects and evaluation in EIA' (Planning NSW 2002), and the 'NSW Government Guidelines for Economic Appraisal' (NSW Treasury 2007).

Direct economic benefits

The extent to which a project contributes directly to the economic welfare of a state or region is measured with reference to value added. Value added is the additional value of goods and services that are newly created in an economy, and that are available for domestic consumption or for export. Value added is a central concept in the Australian System of National Accounts (ASNA). Subject to some adjustments, the sum of gross value added across all industries in a State equals gross state product (GSP). Whether the proposed continuation of operations at MTW benefits NSW has therefore been determined by examining its (net) impact on the GSP of NSW.

The economic effects described in this report refer to 'incremental' or 'net' impacts relative to the reference case (the counterfactual) whereby the proposals are not approved. The reference case assumes that mining at MTW continues until the Warkworth Mine development consent expires in May 2021, and the MTO development consent in June 2017. However, mining at Warkworth Mine's West Pit is expected to reach the existing consent limit in 2015, at which point production may no longer be economically viable. The estimated net benefits presented in this report are therefore conservative.

In net present value (NPV) terms, the continuation of operations at MTW would deliver direct net benefits to NSW of almost A$1.5 billion. These net benefits take the form of:

- the additional disposable income received by MTW employees and long-term contractors who live in NSW, around A$612 million in NPV terms;
- the additional coal royalties paid to the NSW government of around A$617 million in

NPV terms; and

- additional payroll taxes, council rates and other payments that accrue to State and local government, and which amount to around A$259 million in NPV terms.

Almost three quarters of MTW employees and long-term contractors live in the Mid and Upper Hunter region. Around A$464 million in NPV terms in additional disposable income would flow to that region.

The assumptions underpinning the derivation of wages and salary benefits described above are conservative. It has been assumed that, in the event that the proposals are not approved and MTW closes by 2021, most MTW employees and contractors would find alternative employment in the Mid and Upper Hunter region. It is noted, however, that unemployment in the Mid and Upper Hunter region has trended upward noticeably in recent years.

State-wide flow-on effects

In addition to the direct effects described above, the continuation of operations at MTW is expected to have positive flow-on effects on the NSW economy. These (indirect) flow-on effects are a reflection of the significant projected expenditures on wages and salaries, and on other mining inputs by MTW. The additional demand for labour, goods and services sets the economy in motion as businesses buy and sell goods and services from one another and households earn and spend additional income. These linkages between businesses and households cause the total effects on the regional and state economy to exceed the initial change in demand by MTW.

The initial flow-on effects of the proposals (taking account only of the *immediate* impacts on other industries who produce the additional inputs required by MTW) are estimated at:

- A$385 million in additional income (in NPV terms) for NSW (A$33 million annually);
- additional annual employment of around 206 full-time equivalent workers in NSW; and
- an increase in the GSP of NSW of around A$450 million in NPV terms (A$39 million annually).

Regional flow-on effects

Significant positive flow-on effects are also expected for the Mid and Upper Hunter region. The initial flow-on effects are estimated at:

- around A$227 million in additional income (in NPV terms) would flow to the Mid and Upper Hunter region; and
- additional annual employment of around 214 full-time equivalent workers.

The employment flow-on effects for the Mid and Upper Hunter region are not directly comparable with those for NSW (and are higher than for NSW). This effect arises because the movement of labour and substitution effects have been accounted for: MTW would continue to offer a significant number of jobs in the Mid and Upper Hunter region if the proposals are approved (continued employment of around 1,300 positions on average over the life of the proposals), but a share of these employees or contractors can be expected to come from outside the region (from other positions in NSW). Therefore the aggregate (net) employment benefits tend to become smaller, as the geographical scope of the analysis expands.

Effects on the Singleton local government area

Thirty five per cent of MTW's employees and long-term contractors live in Singleton. The estimated flow-on effects for the Singleton local government area (LGA) are:

- around A$84 million in additional income (in NPV terms); and
- additional annual employment of around 61 full-time equivalent workers.

Relative contribution of Warkworth Mine to NSW benefits

While Warkworth Mine and MTO would continue to operate as an integrated mining complex if the applications are approved, the relative contributions of the two mines to the benefits that would accrue to NSW have also been examined. The analysis indicates that the direct (net) economic benefit that can be attributed to Warkworth Mine is around $1,339 million in NPV terms, or 90 per cent of the contribution of the MTW Continuation Project to NSW GSP.

Where the economic flow-on effects of the proposals are concerned, the benefits attributable to Warkworth Mine amount to:

- for NSW, around $346 million in additional income (in NPV terms), additional annual employment of 191 full-time equivalent workers, and a contribution to NSW GSP of around $406 million;
- for the Mid and Upper Hunter region, around $204 million in additional income in NPV terms, and additional annual employment of 198 full-time equivalent workers; and
- for the Singleton LGA, around $75 million in additional income in NPV terms, and additional annual employment of 57 full-time equivalent workers.

Relative contribution of MTO to NSW benefits

The analysis indicates that the direct (net) economic benefit that can be attributed to MTO is around $149 million in NPV terms, or 10 per cent of the contribution of the MTW Continuation Project to NSW GSP.

Where the economic flow-on effects of the proposals are concerned, the benefits attributable to MTO amount to:

- for NSW, around $39 million in additional income (in NPV terms), additional annual employment of 15 full-time equivalent workers, and a contribution to NSW GSP of around $45 million;
- for the Mid and Upper Hunter region, around $23 million in additional income in NPV terms, and additional annual employment of 16 full-time equivalent workers; and

- for the Singleton LGA, around $9 million in additional income in NPV terms, and additional annual employment of 4 full-time equivalent workers.

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

Section 12AA of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) requires that the consent authority must consider the significance of the resource that is the subject of the application, having regard to benefits, both to the State and the region in which the development is proposed, including (sub-section (2)):

a) employment generation;

b) expenditures, including capital investment; and

c) the payment of royalties to the State.

A summary of the incremental benefits associated with the proposal for these key measures is provided in Table 1-1 below. Approvals of the proposals would result in:

- additional employment generation of 1,307 full-time equivalent (FTE) jobs on average per year for MTW as a whole;
- total additional (operating and capital) capital expenditures of A$6 billion in NPV terms; and
- total additional royalty payments of A$617 million in NPV terms.

Table 1-1. Summary of incremental benefits of the MTW Continuation Project

	Employment generation (annual average FTEs)		Incremental Expenditure (A$ m NPV)	Incremental royalties (A$ m NPV)
	Without approvals (reference case)	With approvals		
MTW	987 over 7 years	1,307 over 21 years	$6,020	$617
Warkworth Mine	835 over 7 years	1,187 over 21 years	$5,723	$567
MTO	152 over 7 years	121 over 21 years	$297	$50

Notes: Totals may not sum due to rounding. NPVs calculated using a discount rate of 7 per cent.

1 Introduction

BAEconomics was commissioned by Rio Tinto Coal Australia to prepare an economic impact assessment of the proposed Warkworth Continuation 2014 and Mount Thorley Operations (MTO) 2014.

The operations at MTO and Warkworth Mine are integrated, and the economic impact assessment has been based on the combined projects (the proposals). This assessment forms part of the environmental impact statement (EIS) for each project. Additionally, a separate economic impact assessment has been prepared for MTO to assess the relative contributions of Warkworth Mine and MTO, respectively, to the direct and flow-on benefits that have been identified.

1.1 Purpose of the economic impact assessment

The proposals would permit MTW operations to continue until 2035 and maintain the current workforce comprising approximately 1,300 people. This economic impact assessment forms part of the EIS that accompanies applications by Coal & Allied for the proposals, in accordance with Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The report is intended to assist Planning and Infrastructure (P&I) in their assessment of the merit of the proposal and inform the Minister for Planning and Infrastructure in determining as to whether or not to grant approval.

The economic assessment has two components, a cost benefit analysis (CBA) and a regional economic impact analysis (REIA). The ‘Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals’ (NSW Government 2012) recommends that applicants for a mining proposal submit a CBA with their development application. The purpose of the CBA is to examine the welfare implications of the application. The ‘Guideline for economic effects and evaluation in EIA’ (Planning NSW 2002) furthermore recommends that, if a proposal is predicted to have significant economic impacts at a regional or state scale, these regional or state-wide effects should be formally assessed. This report has been prepared in accordance with Director-General’s requirements as known at the time of writing.

1.2 Structure of this report

This report is structured as follows:

- Section 2 describes the proposals and regional economic context.
- Section 3 describes the CBA approach and the approach to valuing external effects, the results of the CBA in terms of the welfare implications of the proposals for NSW, and the relative contribution of MTO to these benefits.
- Section 4 describes the predicted regional impacts of the proposals on the Singleton LGA, Mid and Upper Hunter region and on NSW, as well as the relative contribution of MTO.

Supporting documentation is presented in five appendices:

- Appendix A provides additional detail on the methodology and assumptions used to derive the CBA;
- Appendix B describes the external effects identified for the MTW Continuation Project;
- Appendix C describes the external effects attributed separately to MTO;
- Appendix D describes the derivation of the input-output multipliers; and
- Appendix E describes the CBA and the REIA undertaken separately for MTO.

2 The proposals in context

This section describes the current operations of the Warkworth Mine and MTO, the proposals, and sets out the regional context.

2.1 Operational context

Warkworth Mine is an existing open cut coal mine with an approved production rate of 18 million tonnes per annum (Mtpa) of run of mine (ROM) coal, which is equivalent to approximately 12.5 Mtpa of product coal until May 2021. Warkworth Mine is located approximately 15 km southwest of Singleton in the Hunter Valley, and within the Singleton local government area (LGA). Warkworth Mine operates three open cut pits: North, South and West pits. Coal extraction at South Pit is coming to a close with future production at Warkworth Mine to come from West and North pits.

Mining in West Pit at Warkworth Mine is expected to reach consent limits in 2015, which would result in mining at a reduced strike. This would in turn reduce mining below economically viable production rates. The proposal is seeking to extend the spatial limit approved under the current development consent to enable mining in West Pit along the full strike length, and subsequently, to enable the two main pits, North and West Pit, to advance to the west.

MTO is an existing open cut mine that adjoins Warkworth Mine. MTO's current development consent enables the extraction of 10 Mtpa of ROM coal, equivalent to approximately 8 Mtpa of product coal, until June 2017.

Warkworth Mine and MTO were originally developed separately. In 2004, Warkworth Mining Limited (WML) and the owners of MTO entered into an agreement to integrate their respective mining operations. The integrated operation encompassing Warkworth Mine and MTO is known as Mount Thorley Warkworth (MTW). MTW is managed and operated by Coal & Allied, a company owned by Rio Tinto Company, on behalf of the joint venture (JV) partner owners of MTW.

MTW operates under a single management team, and utilises a single workforce and equipment fleet. The agreement also provides for sharing of infrastructure and resources. Hence, MTW operates an integrated mine water management system, and shares management infrastructure, coal handling and preparation plant (CHPP) infrastructure, and other facilities. ROM coal from Warkworth Mine is transported to either the Warkworth CHPP or the Mount Thorley CHPP for processing. Product coal from the Warkworth CHPP is transported via conveyor to either the Mount Thorley Coal Loader (MTCL) or to Redbank Power Station. Coal loaded onto trains at the MTCL is transported to the Port of Newcastle for export.

2.2 Scope of the economic assessment

This economic assessment relates to two applications for MTW; for Warkworth Mine and for MTO, respectively. Approval of the two applications would enable the continued joint operation of the mines while using the existing facilities. The justification for the combined assessment of the proposals is provided in Section 3.1.

2.2.1 Warkworth Mine development application

Warkworth Mine has approval to operate until 19 May 2021 under its development consent. The application seeks a new development consent to enable the ongoing operation of Warkworth Mine for around 21 years from the date of approval, at the existing maximum production rate of 18Mtpa of ROM coal. If approval is granted in late 2014, operations at Warkworth Mine would continue to 2035, a 14-year extension of the current approval. The application seeks the following changes to the existing layout and operation of Warkworth Mine:

- an extension of the mining footprint of 698 hectares (ha) to the west of current operations (referred to in this document as 'the proposed 2014 extension area');
- the closure of Wallaby Scrub Road;
- the ability to transfer overburden to MTO to complete MTO's final landform;
- an option to develop an underpass between Putty Road for the third bridge crossing yet to be constructed (while retaining the current approval for an overpass);
- minor changes to the design of the Northern out-of-pit (NOOP) dam; and
- the continued use of secondary access gates to the mine site and offsets for activities such as drilling, offset management, equipment shutdown, amongst other things.

All other aspects of the operations of Warkworth Mine, including coal production and processing rates, as well as the integrated operations of Warkworth Mine and MTO would remain unchanged.

2.2.2 MTO development application

MTW is furthermore seeking a new development consent to enable the ongoing operation of MTO for 18 years at the current production rate of 10Mtpa of ROM coal. MTO has approval to mine until 22 June 2017 under its development consent. If approval is granted in 2015, operations at MTO are forecast to continue to the end of 2035.

The proposal seeks a continuation of all aspects of MTO as it presently operates and extends or alters them, including:

- mining in Loders Pit and AGN Pit;
- the ability to transfer of overburden between MTO and Warkworth Mine to assist in rehabilitation and development of the final landform;
- the maintenance and upgrade of the integrated MTW water management system (WMS);
- the maintenance and upgrade of the integrated MTW tailings management system;

- the upgrade of the MTO CHPP to facilitate an increase in maximum throughput to 18Mtpa with the ability to receive this coal from Warkworth Mine;
- the continuation of coal transfer between Warkworth Mine and MTO and transportation of coal via the MTCL to the Port of Newcastle.

All activities, including coal extraction will be within disturbance areas approved under the existing development consent.

2.3 Reference case and proposals scenario

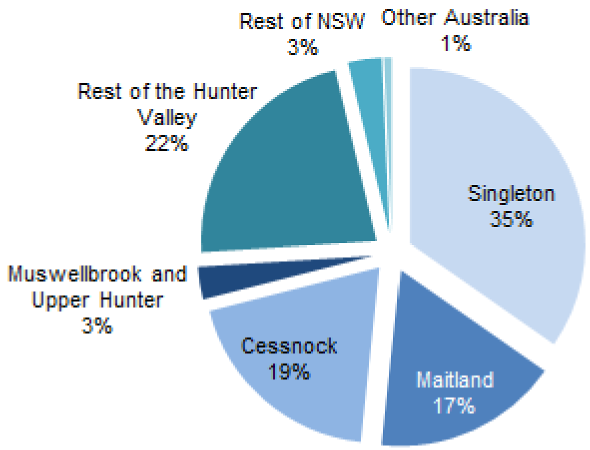
The CBA and REIA described in Sections 3 and 4 of this report, respectively, consider the incremental (net) benefits, and regional and state impacts of the 'proposals' scenario in which the development applications for Warkworth Mine and MTO are approved, relative to a 'reference case' scenario in which the development applications are assumed not to be approved (the counterfactual). The reference case and the proposals scenario differ in terms of their production and employment (and associated costs) profiles:

- In the reference case, coal production at MTW would begin to decline from 2016 onwards and would end in 2021. However, as noted, the reference case is considered 'optimistic', since mining in West Pit at Warkworth Mine is expected to reach the consent limit in 2015, which would result in mining at a reduced strike, and potentially below economically viable production rates. In the proposals scenario, in contrast, production would continue at a level of around 18 Mtpa ROM coal until 2030 and decline toward the end of the open cut life. Production would be completed by the end of 2035.
- In the reference case, employment at MTW would begin to decline from 2016 onwards and all employment at MTW would cease in 2021. In the proposals scenario, the number of full-time employees (FTEs) would be maintained until operations ramp down for expected closure in 2035.

2.4 Local and regional context

The CBA and REIA presented in this report consider the economic impacts of the proposals on NSW. The REIA additionally considers two smaller regions of interest, namely the Singleton LGA and the Mid and Upper Hunter region, which comprises the Singleton, Upper Hunter, Muswellbrook, Cessnock and Maitland LGAs. Around 74 per cent of MTW employees live in the Mid and Upper Hunter region, and 22 per cent live in other LGAs in the Hunter Valley Region (Figure 2-1). Overall, 99 per cent of MTW employees live in NSW.

Figure 2-1. Residences of Mount Thorley Warkworth employees



Notes: Rest of the Hunter Valley refers to Great Lakes, Dungog, Port Stephens, Newcastle, and Lake Macquarie LGAs.
Source: RTCA.

2.4.1 Historical employment and income trends

Table 2-1 provides an overview of the characteristics of the labour force in the Mid and Upper Hunter region based on the Australian Bureau of Statistics (ABS) 2011 Census of Population and Housing:

- In the Mid and Upper Hunter region, Singleton and Muswellbrook stand out as having by far the highest share of persons employed in the mining industry, the lowest rates of unemployment, as well as significantly higher than average incomes.
- The share of persons employed in the mining industry is far higher in the Mid and Upper Hunter region than in the Hunter Valley region overall. Average incomes are correspondingly higher in the Mid and Upper Hunter region.

Table 2-1. Overview of labour force statistics (2011)

	Labour force	Unemployment rate (per cent)	Average wage & salary income [a]	Employed in mining (per cent)
Singleton	11,789	3.4	$62,313	24.6
Maitland	32,829	5.0	$50,647	6.4
Cessnock	22,335	6.5	$48,051	10.2
Upper Hunter	6,771	3.6	$48,075	10.9
Muswellbrook	7,779	4.8	$57,054	21.3
Port Stephens	28,377	6.2	$44,875	1.8
Newcastle	74,540	5.8	$49,187	1.6
Lake Macquarie	88,251	5.3	$47,734	2.6
Great Lakes	12,066	8.3	$38,290	1.5

	Labour force	Unemployment rate (per cent)	Average wage & salary income [a]	Employed in mining (per cent)
Dungog	3,896	4.5	$46,155	3.8
Mid and Upper Hunter region (average)	81,503	5.0	$52,021	14.7
Hunter Valley Region (average)	288,633	5.6	$48,623	8.5

Notes: [a] Wage & salary data are for 2010.

Source: ABS 1379.0.55.001 National Regional Profile, 2007-2011, by LGA.

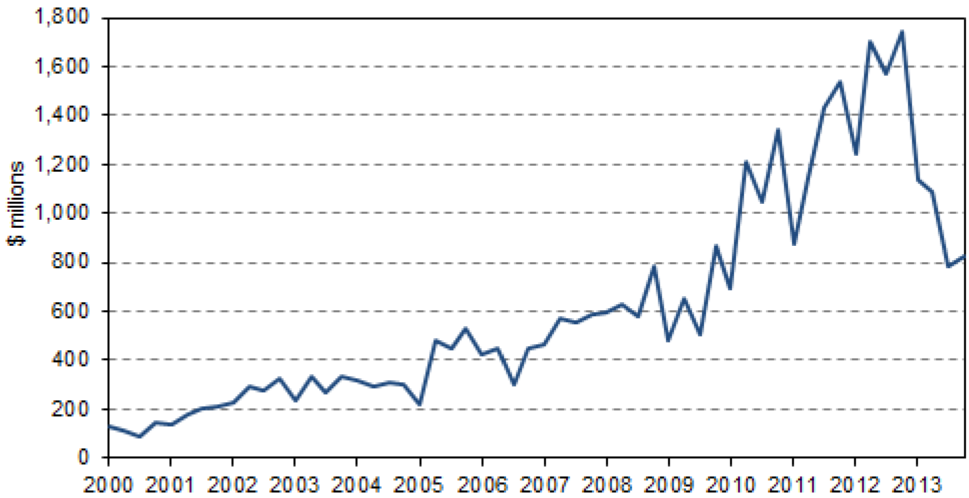
A socio-economic assessment of the Mid and Upper Hunter region undertaken by the Hunter Valley Research Foundation (HVRF 2013) highlights the positive impact of the mining sector on the local economy to date. Across the five LGAs, all income indicators (average wage and salary incomes, median weekly personal, family and household incomes) rose between 2006 and 2011, and at a faster rate than for NSW as a whole. Singleton and Muswellbrook LGAs had the highest levels of average total personal income, and of median personal, family and household income within the Mid and Upper Hunter region. Employment in the mining sector increased by 63 per cent over that timeframe, but other sectors also experienced substantial growth, including construction and other services. In addition, between 2001 and 2011:

- labour force participation increased consistently in all LGAs;
- unemployment fell significantly, and more rapidly than in NSW as a whole;
- the labour force expanded, substantially more so than in NSW as a whole, largely as a result of new migrants and existing residents moving into employment in the mining sector; and
- youth unemployment fell significantly.

2.4.2 Medium-term perspective

A number of indicators suggest that while mining activity was historically very high, significant declines in Australian thermal coal prices, amongst other factors, over the past two years have had a negative impact on activity. Figure 2-2 shows quarterly mining investment in NSW from March 2000 to December 2013. Investment in new tangible assets has fallen by more than half between December 2012 and December 2013. These trends are consistent with the expectation by the HVRF (HVRF 2013a, b) that few additional mining investment proposals will progress in the medium term, excepting moderate expansions of existing mines. Investment intentions on the part of small- and medium sized businesses have similarly declined markedly (HVRF 2014).

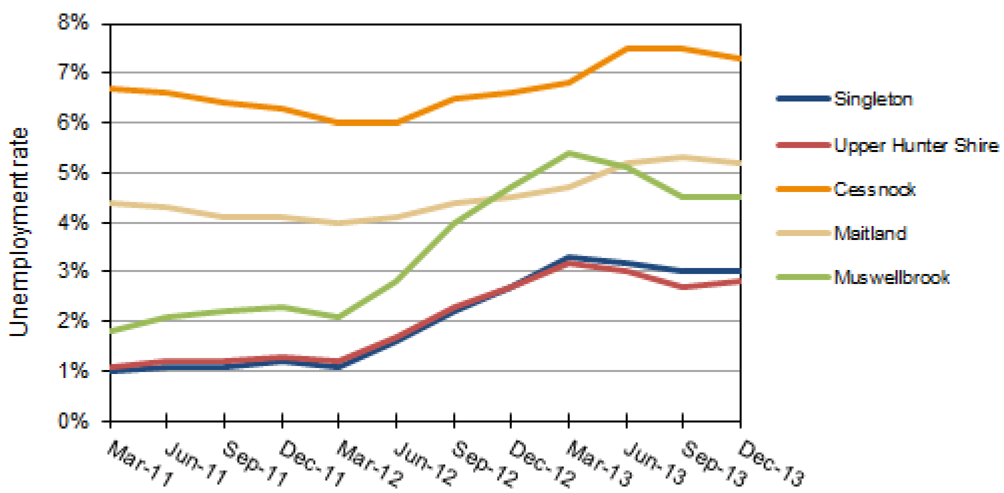
Figure 2-2. New capital expenditure in the NSW mining industry (current prices)



Source: ABS 5625.0 Private New Capital Expenditure and Expected Expenditure, Australia, 27-02-2014.

The effects of the mining slowdown are also being observed in the labour market. In a reversal of past trends, there is now an excess of qualified mining engineers in NSW (Australian Journal of Mining, 2014), as well as a shortage of positions for mining apprentices and trainees in the Hunter Valley (Australian Mining 2013). HVRF (2013a) note that the unemployment rate in the Hunter Valley region has increased notably since 2011. These estimates are consistent with noticeable increases in local unemployment rates (Figure 2-3), and reports of recent job losses in Australia's coal sector (Table 2-2). Recent reports following the closure of the Integra coal operations in the Hunter Valley indicate that around 12,000 jobs have been lost in the Australian coal sector to date, and that a quarter of coal operations in Queensland and NSW are operating at a loss (Saunders 2014).

Figure 2-3. Mid and Upper Hunter region – Local trends in unemployment



Source: Department of Employment, Small Area Labour Markets December Quarter 2013.

Table 2-2. Reported job losses in coal mining (NSW and Queensland)

Mine	Location	Job losses
Ravensworth	Hunter Valley, NSW	46
Stratford and Duralie	Gloucester, NSW	60
Mt Owen	Upper Hunter Valley, NSW	74
Illawarra (BHP)	Illawarra, NSW	36
Illawarra (Gujurat NRE)	Illawarra, NSW	100
Newlands	Bowen Basin, Queensland	300
Gregory	Bowen Basin, Queensland	250
Saraji	Dysart, Queensland	230
Norwich Park	Dysart, Queensland	950
Dawson	Moura, Queensland	200
Oaky Creek	Bowen Basin, Queensland	150
Wilkie Creek	Dalby, Queensland	190
Total		2586

Source: Tasker, S (2014, April 12-13). Coal downturn rocks mining towns. The Australian, p.24,

HVRF's measure of employment intentions suggests that further weakness in the Hunter region labour market can be anticipated. Employment intentions have declined since December 2011; HVRF's most recent measures are lower than during the Global Financial Crisis. Similar trends are also evident in the HVRF's Household Survey, which suggests that consumer confidence and purchasing intentions in the Hunter Valley region remains negative. Overall, HVRF conclude that the economic outlook for the Hunter region reflects the end of the previous expansion phase combined with a drive to achieve efficiencies, the effects of which are now being felt by local suppliers, contractors and operational employees.

2.5 Regional and local effects of the proposals

Against this backdrop, it should be noted that the MTW Continuation Project, if approved, would provide, on average, 1,307 full-time equivalent positions between 2015 and 2035.[1] If current trends continue, almost three quarters of employees (74 per cent) would reside in the Mid and Upper Hunter region, and more than a third (35 per cent) would reside in Singleton.

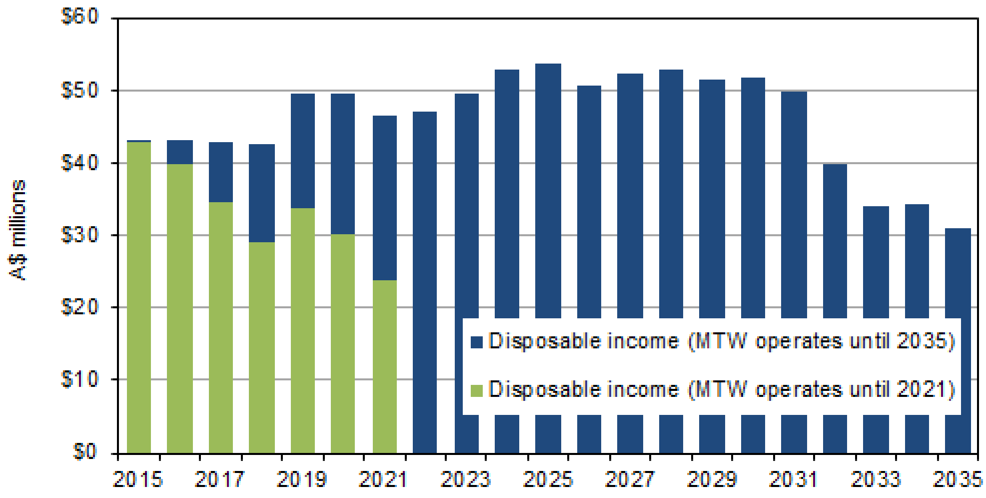
As set out in Section 4 in this report, and using conservative assumptions, the additional regional and local (disposable) income generated is estimated at A$227 million in NPV terms for the Mid and Upper Hunter region and at A$84 million in NPV terms for Singleton LGA. The

[1] Actual levels fluctuate on a year-to-year basis depending on amount of earth that must be removed, market conditions, weather and other factors.

proposals would furthermore generate an additional 214 and 61 FTE indirect jobs in the Mid and Upper Hunter region and in Singleton LGA, respectively.

These figures translate into ongoing and tangible benefits for Singleton. Disposable income paid to Singleton residents (net of taxes, superannuation and Medicare payments) would average almost A$49 million per year from 2015 to 2030 after which production would begin to decline (Figure 2-4). Much of this income would be expected to benefit the local economy.

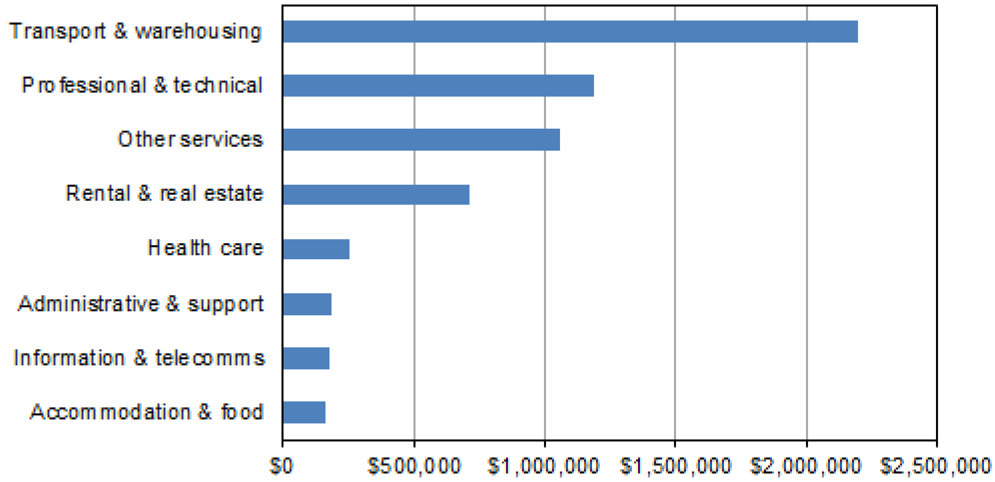
Figure 2-4. Projected disposable income – Singleton residents



Notes: Wages and salaries paid to Singleton employees and contractors, net of income taxes, superannuation contributions and Medicare payments.

Similarly, many of MTW's day-to-day expenditures benefit local suppliers. An analysis of local spend by supplier postcode in 2013, for instance, shows that MTW purchases at Singleton postcodes amount to around A$77.5 million. The majority of these expenditures went to local contractors and labour hire firms (around 30 per cent), and to purchase construction services (17 per cent), mining services and equipment (42 per cent), and steel and electrical equipment (18 per cent). Most of these materials and services are likely to be 'imported' to Singleton, so that businesses based in Singleton would only earn a margin on these sales. However, MTW also purchased almost A$6 million on a variety of services that would likely have been provided by local businesses directly (Figure 2-5). These trends would be expected to continue in the future.

Figure 2-5. MTW spend on services in Singleton (2013)



Source: RTCA.

Finally, if the applications are approved, MTW would continue to pay significant shire rates to Singleton Council, estimated at around A$0.7 million per year until 2035 (around A$8 million in NPV terms). On current trends, these payments would account for around 3.5 per cent of Singleton Council's revenues from rates and annual charges (A$20.2 million in 2012-13, Singleton Council 2013). Some of the additional payments flowing to NSW Government in the form of additional royalty payments and payroll taxes, as well as, indirectly, from additional income tax receipts, can be expected to benefit Singleton in the form of grants and contributions for capital and operating purposes made by the NSW Local Government Grants Commission.

3 Cost benefit analysis of the proposals

This section describes the CBA of the proposals. The main focus in this report is on the costs and benefits of the proposals as they relate to NSW. The methodology and assumptions underpinning the CBA, as well as the results of a CBA of the proposals for Australia, are provided in Appendix A. A separate CBA was undertaken for MTO (described in Appendix E); the results were used to derive the respective contributions of Warkworth Mine and MTO, respectively, to the net benefits of the MTW Continuation Project.

3.1 Economic framework

The CBA considers the direct costs and benefits accruing in NSW from the proposals, for instance, from additional value added in the form of wages and salaries paid to employees and contractors. Flow-on effects of the proposals, such as the effects on regional income, employment or value added, are assessed in the REIA, which is described in Section 4.

3.1.1 Economic impacts of the proposals on NSW

The 'Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals' (NSW Government 2012) sets out that the main objective of the CBA is to estimate the impacts of the project on NSW.

From an economic perspective, the extent to which a project contributes to the welfare of a country or state differs from a private benefit calculation, which focuses on profits. The *public* benefit of a project is measured with reference to value added. Value added is the additional value of goods and services that are newly created in an economy, and that are available for domestic consumption or for export.

Value added is a central concept in the Australian System of National Accounts (ASNA), where it is referred to as 'gross value added' to emphasise that this measure is gross of the consumption of fixed capital (that is, depreciation). Gross value added is the difference between output and intermediate inputs (the value created by production), and equals the contribution of labour and capital to the production process (ABS 2013). Subject to adjustments that need to be made to ensure that valuations are internally consistent by accounting for various taxes and subsidies, the sum of gross value added across all industries in a country or state equals gross domestic product (GDP) or gross state product (GSP), respectively. The economic impact of the proposals has therefore been evaluated with reference to its contribution to NSW GSP.

Formally, GSP at market prices derived using the income approach (GSP(I)) measures the sum of income flows accruing to the factors of production, plus taxes less subsidies on production and imports (ABS 2013):

$$GSP(I) = Compensation\ of\ employees$$

$$+\ Gross\ operating\ surplus$$

$$+\ Gross\ mixed\ income$$

$$+(-)Taxes\ (Subsidies)\ on\ production\ and\ imports$$

In the ASNA accounting framework:

- ‘compensation of employees’ refers to the remuneration of labour in the form of wages, salaries, and employers’ social contributions;
- gross operating surplus (GOS) refers to the share of income from production that can be attributed to capital inputs for incorporated businesses;[2]
- gross mixed income (GMI) is a similar concept as GOS, and refers to the share of income from production that can be attributed to unincorporated businesses (for instance, self-employed people) and therefore also includes a labour component; and
- taxes (subsidies) on production include taxes on products, such as GST and import duties, and other taxes (subsidies) on production, such as payroll taxes or subsidies, land taxes, stamp duties and taxes on pollution.

The change in GSP as a result of the proposals being approved therefore captures the incremental benefits accruing to NSW from:

- the additional salaries and wages paid to NSW employees and long-term contractors of MTW;
- the share of MTW’s GOS that can be attributed to NSW, including significant coal royalty payments to NSW; and
- the additional payroll taxes and land taxes/shire rates paid to the NSW State and local Government.

[2] Hence the contribution of capital to value added in NSW depends on the extent to which capital is owned by the residents of NSW.

3.1.2 Combined assessment of the integrated MTW

As set out in Section 2, Warkworth Mine and MTO function as an integrated operation and share the use of a number of resources and infrastructure. These include a joint workforce and management team, water, CHPPs and reject management infrastructure, as well as other facilities. The proposals would also involve some production of coal located within the mining lease of MTO that can only be economically accessed from Warkworth Mine. From an economic perspective, therefore, the value added generated by the two mines is created jointly.

Preparing the CBA separately for Warkworth Mine and MTO does not reflect the current operations of the mines, since ROM coal and waste may be processed either at Warkworth Mine or at MTO, depending on circumstances and what is more efficient, and since product coal produced at Warkworth Mine and destined for export is loaded onto trains at MTO. Preparing a separate CBA for Warkworth Mine and MTO, respectively, therefore requires additional assumptions about how the two mines will operate and interact in future, and assumptions about how shared costs should be allocated to each mining operation.

For the above reasons, the CBA has been prepared for the integrated MTW. However, in order to provide an indication of the respective contributions of the two mines to the economic benefits of the proposals, the direct benefits to NSW and the state, regional and local flow-on effects that can be attributed to MTO and Warkworth Mine have also been separately identified. As described in Appendix E, and for the purposes of attributing the overall benefits of the proposals to Warkworth Mine and MTO, respectively, a (notional) tolling and service arrangement has been introduced whereby MTO is deemed provide coal handling services to and accept overburden services to Warkworth Mine.

3.1.3 Distributional effects

A classical cost-benefit assessment does not consider the distribution of impacts across different segments of society. From this perspective, a CBA is solely concerned with economic efficiency, which implies that all mutually beneficial trades have been made (allocative efficiency), and that all goods and services are produced at least cost (productive efficiency). Allocative and productive efficiency maximise the economic 'pie' in the sense that the best use is made of existing resources, and total welfare is maximised.

Irrespective of broader efficiency objectives, information about the distributional impacts of proposed projects – the gains and losses for affected individuals and groups – is of interest to policy makers (Commonwealth 2006). Identifying distributional impacts is sometimes difficult because of data limitations; for instance, increased corporate profits may be distributed to individual shareholders and to superannuation funds (on behalf of other individuals), so that the eventual beneficiaries are a diffuse group of individuals. In other cases, for instance, in the case of local employment effects, beneficiaries can be identified more easily. In the economic impact assessment of the proposals described in this report, we have therefore addressed distributional effects as follows:

- in the context of the CBA, we comment, where possible, on whether the identified impacts may occur at a local or state-wide level; and
- in the context of the REIA, we set out estimated flow-on effects at the State-wide, regional (Mid and Upper Hunter region) and local (Singleton LGA) levels.

3.1.4 Cumulative impacts of the proposals

If the proposals are approved, mining operations would continue at MTW until 2035. The economic impacts of the proposals would therefore not occur on a 'blank slate', but within a broader context where coal mining is already an important aspect of the local economy (as described in Section 2.4). Indeed, the MTW Continuation Project is contingent on the ability of Warkworth Mine and MTO to economically extract existing coal resources because of the considerable capital expended into the operations since 1981, and availability of the required infrastructure, such as rail.

The question then arises whether some of the impacts of the proposals may have broader regional implications that are not adequately captured using a conventional, incremental CBA approach. For instance, this could be an issue in relation to environmental impacts if some critical threshold is exceeded that may lead to wider adverse consequences, or if there are environmental interactions.

It is considered unlikely that cumulative impacts of this type are of concern in the context of the present proposals. Warkworth Mine and MTO have both been in operation since 1981, and have operated jointly as MTW since 2004. The impacts of the mining operations on the environment, in terms of ground and surface water, air quality, noise and vibration, and others (as described in Section 3.2 below) are therefore well understood, and have been assessed taking account of other established mining operations in the area. The expert reports that have been prepared to assess these and other effects reflect this understanding, and have been prepared to identify the incremental and cumulative impacts that may arise from the continued operations of the mines.

3.2 Valuation of external effects

A CBA requires a full accounting calculation whereby the costs and benefits of a project are compared in monetary terms, and therefore requires that costs and benefits should, as far as possible, be valued. As a general matter, CBA relies on the 'opportunity cost' principle to value goods or services (NSW Treasury 2007; Commonwealth 2006). In practice, the opportunity cost concept is made operational with reference to the 'willingness-to-pay' (WTP) criterion. For 'conventional', market-based transactions, such as the sale of coal outputs or the purchase of labour and other inputs, the relevant valuation approach is therefore the market price.

3.2.1 Overview

The NSW Treasury Guidelines (2007) require that 'external effects' (also referred to as 'externalities') are accounted for as part of economic benefits and costs. External effects are spillovers (positive or negative) from the production of a good or service, for example, in the form of air pollution or noise (negative spillovers).

The EIS's prepared for the MTW Continuation Project identify the potential environmental impacts from the proposals across a range of categories, as well as the risks of these impacts occurring, and their potential consequences. The descriptions and valuations of the external effects described in this section and in Appendix B and Appendix C rely on the experts' findings set out in the EIS's.

As set out in Table 3-1, the proposals are predicted to give rise to a range of external effects, although the majority of these impacts is relatively limited. The approach to valuing effects is set out in the following; additional detail is provided in Appendix B.

Table 3-1. External effects associated with MTW

Category	External effect	Overall nature of impact
1. Noise & vibration	Noise exceedance criteria of 5dB exceeded for 4 privately owned receptors; 3 receptors are located at residential properties, 1 receptor is located at a community hall): - 2 residential properties are located within Wambo Mine's ZOA - 1 residential property is within Warkworth Mine's ZOA	Local
2. Air quality	Criteria for 24-hour and annual average particulate (PM10) emissions are exceeded for 2 privately owned receptors located at residential properties: - 2 residential properties are located within Wambo Mine's ZOA	Local
3. Visual amenity	Visual impacts generally moderate to low. Moderate to high visual impacts on residences to the south and west.	Local
4. Aboriginal heritage	Loss of 110 sites	Aboriginal people of the Upper Hunter Valley
5. Ecology *	Clearing of 459 ha of forest and woodland and 151.5 ha of grassland communities, including removal of endangered ecological communities (EECs) and habitats of threatened species	NSW
6. Traffic	Closure of Wallaby Scrub Road Minimal traffic impacts on the local road network	Local
7. Groundwater	Negligible and manageable impacts on groundwater systems	Local
8. Surface water	No significant impacts on surface water quality of adjacent water features	Local

Category	External effect	Overall nature of impact
9. GHG emissions	Net GHG emissions of appr. 15.9Mt CO_2-e	Global
10. Historical heritage	Low potential heritage impacts	Local/NSW

Notes: * The 611 ha estimate excludes the area already approved to be cleared by MTO, but included within Warkworth's disturbance area. Ecological impacts are deemed to refer to NSW, given that Commonwealth approval has been obtained in the course of the 2010 extension application.

Additional detail is provided in Appendix B.

External effects give rise to non-market impacts that are difficult to value. A variety of techniques have been developed to quantify these effects, including surrogate market (revealed preference) valuation techniques and hypothetical market (stated preference) techniques. These techniques aim to elicit estimates of either the WTP for, or the 'willingness-to-accept' (WTA) a particular outcome. They differ in a number of ways, including in terms of the amount and detail of data that are required (which may or may not be available) and how reliable the results are (the extent to which they are subject to biases).

Market-based valuations (direct revealed preference methods) infer an implicit price that is revealed by examining consumer behaviour and/or prices in a similar or related market (Department of Treasury and Finance 2013). Market-based valuation techniques include the use of:

- defensive expenditures: the costs incurred by individuals to mitigate the impact of changes and/or to recreate a situation that existed before a change, for instance by investing in noise insulation;
- replacement costs: the cost of replacing or repairing a damage, for instance, to restore the environment to its previous condition; and
- the productivity method: this method is used where an impact leads to a change in production levels, costs or prices.

Indirect revealed preference methods derive values of environmental goods and services from market prices. They include hedonic pricing whereby WTP for specific environmental or other characteristics is inferred from market prices, and travel cost analysis, where the opportunity cost of time and travel costs is interpreted as a proxy of the value of ecosystem sites, such as parks.

Stated preference methods, finally, rely on specifically constructed questionnaires and interviews that are put to survey participants in order to discover the WTP for a particular outcome, or the WTA a particular outcome. Stated preference techniques include:

- contingent valuation methods: these ask individuals the amount they would be willing to pay to get a particular benefit or to avoid a negative impact, for instance, to maintain an ecosystem, a common good, or a heritage building; and
- choice modelling methods: individuals reveal the value of a non-market impact indirectly by choosing between goods with different characteristics and various monetary contributions.

Stated preference methods suffer from biases that often limit their validity and reliability

(Pearce et al. 2006, Commonwealth 2006).[3] In contrast, and while such approaches cannot be applied in all circumstances and may not precisely capture the effect in question, the strength of revealed preference methods is that they are based on actual decisions made by individuals/households or other decision-makers. This report has therefore relied on market-based and revealed preference techniques for valuing the external effects associated with the proposals. The unifying characteristic of both techniques is that they aim to value non-market impacts by observing actual behaviour, and are therefore considered to be a more reliable indicator of people's preferences.

3.2.2 External effects that can be internalised by MTW

External effects that can be internalised by MTW are non-market costs that can be accounted for through either financial instruments, or the creation of direct offsets.

Financial instruments (market-based valuation)

Financial instruments generally involve the compensation of affected individuals or payments for measures designed to mitigate or remove the impact of the external effect. This is a 'defensive expenditure' valuation method, which relies on the observed behaviour of households or individuals of incurring financial outlays to insulate themselves against a non-market 'bad', for instance, by moving house or by installing double-glazing in noise-affected homes (Pearce et al. 2006).

External effects that have been valued in this manner (that is, on the basis of expenditures that would be incurred by Rio Tinto if the applications are successful) are :

- Noise (1) and air quality (2) impacts: Significant noise and air impacts arise in three residential locations owned by third parties, as well as at Warkworth Community Hall. Two of these residential locations are within the zone of acquisition (ZOA) of a neighbouring mine (Wambo Mine); if the applications are successful, the owner(s) of the third property will have acquisition rights upon request under the development consent. Rio Tinto will additionally invest in noise attenuation equipment for that part of its heavy vehicle fleet, which has not yet had corresponding equipment fitted (drills, dozers, excavators, and trucks).

[3] These limitations include the presence of hypothetical bias, since the situations described to respondents is not a real-world decision (and therefore difficult to assess for respondents); strategic behaviour, whereby the respondent may, for one reason or another, give an exaggerated response; scope problems, whereby responses are insensitive to the size or coverage of the good being valued; anchoring bias, if the valuation given depends on prior options being presented; and information bias, whereby how the question is framed unduly influences the answer. Overcoming these types of difficulties requires a rigorous survey design and testing the survey responses for their robustness, including by testing whether responses can be reproduced and are stable over time. In practice, this is rarely done.

- Visual amenity (3) impacts: While the visual impacts of the MTW Continuation Project are generally expected to be moderate to low, a small number of properties, particularly to the south and west of Warkworth Mine/MTO are predicted to have moderate to high visual impacts.[4] If the applications are approved, Rio Tinto would undertake site specific visual assessments (SSVAs) on request for properties in Bulga village in the primary visual catchment and, where the impact is assessed as high, put in place vegetation screening or other measures agreed with the affected landowners where requied. In addition, MTW is undertaking a variety of onsite mitigation measures, including minimising lighting impacts and the construction of bunds, vegetated and built screens along the site boundary.
- Aboriginal heritage impacts (4): Rio Tinto has reached agreement with the local Aboriginal community and relevant NSW authorities on a suite of management strategies, including:
  - the establishment of the Wollombi Brook Aboriginal Cultural Heritage Conservation Area (WBACHCA) and the Loders Creek Aboriginal Cultural Heritage Conservation Area (LCACHCA) to protect areas of high Aboriginal community and scientific significance;
  - an integrated heritage management plan (HMP) and detailed initiatives to manage the impacts of the proposed 2014 disturbance area; as well as
  - various other commitments to limit the disturbance of Aboriginal places to a minimum and manage other potential issues in consultation with the Aboriginal community.
- Historical heritage impacts (10): While small portions of the Former RAAF Base Bulga Complex and Great North Road Complex would be affected by the proposal, there are no state significant heritage features within the disturbance area. One locally significant feature (the Brick Farm House) would not be directly affected by the proposal, and the overall heritage impacts are likely to be minor. Rio Tinto proposes to undertake various measures to manage any impacts, including Conservation management plans (CMPs) for a portion of the Great North Road Complex, the former RAAF Base Bulga Complex and the Brick Farm House, as well as the establishment of a community trust for the conservation, maintenance, interpretation and/or promotion of important historic heritage values in the surrounding area.

Defensive expenditures may represent an under- or an overestimate of the value of the non-market impact on wellbeing. For instance, households predicted to be significantly affected

[4] It is understood that the number of properties affected is difficult to quantify accurately, given the lack of access to properties. Factors such as existing vegetation, orientation of the house, window locations etc. play a role in the visual impacts of the proposal.

(that is, above government-prescribed criteria) by air and noise outcomes will be offered acquisition of their properties, generally at prices that are above market values. In these cases it could be argued that the valuation of the corresponding external effects on that basis overestimates the impacts, although the affected landowners may have a (subjective) perspective of these impacts that may be lower or higher.

More generally, there will inevitably be instances of more or less arbitrary cut-off points, for instance, because noise or dust criteria are exceeded at one location, but not at a different but nearby location. These types of boundary issues are difficult to address in practice, but are essentially a function of rigid environmental criteria that may deem one level of disturbance to be acceptable, but no longer tolerate a slightly higher level of disturbance. Irrespective of the criteria that may be set down in statutes or regulations, peoples' personal preferences may also vary, so that what may be an acceptable disturbance to some, may be considered distressing by others. While these variations in perceived impacts should be acknowledged, there is no way in which they could be measured or assessed in a reliable manner, and we have not attempted to do so here.

Offsets (market-based valuation)

Direct offsets refer to initiatives that deliver an outcome that is equivalent or preferable to the case in which the proposals do not proceed. The cost of establishing direct offsets and related initiatives is pertinent to the valuation of ecological impacts (5).

The primary impact from the proposals will be the progressive clearing of vegetation, including endangered ecological communities (EECs), within the disturbance boundary. If the proposals are approved, 459 ha of forest and woodland and 151.5 ha of grassland communities would be progressively cleared. In this regard, the clearing of a distinctive type of vegetation – Warkworth Sands Woodland (WSW), an EEC – is of particular concern. In addition, the disturbance area also contains a diverse range of native vegetation other than WSW ('non-WSW' vegetation). WSW and non-WSW vegetation provide habitat for numerous species, as well as threatened fauna and flora.

The impacts of the loss of native vegetation, EECs and habitats resulting from the proposals will be mitigated by establishing a number of offsets that would be approved under the NSW Biodiversity Certification Assessment Methodology (BCAM). The biodiversity certification scheme was established under the Threatened Species Conservation Act 1995. The Minister may confer biodiversity certification on land if the Minister is satisfied that biodiversity certification will improve or maintain biodiversity values (Department of Environment, Climate Change and Water NSW, 2011).

The required offset package for the proposals have correspondingly been estimated using the BCAM and in accordance with the Upper Hunter Strategic Assessment (UHSA):

- Impacts on WSW resulting from the proposals will be offset by the protection of areas of WSW in the Northern Biodiversity Area (NBA) and Southern Biodiversity Area (SBA), as well as the re-establishment of large areas of this community in designated offset areas. Additional offsets for WSW include provisions for the preparation of an Integrated Restoration Implementation Plan and contributions to research.

- Offset requirements for non-WSW vegetation have been determined using BCAM and appropriate offsets will be sought under the UHSA to ensure that a 'maintain and improve' outcome is achieved.

It is understood that commitments made by Rio Tinto will ensure that the offsets for both WSW and non-WSW vegetation will result in a 'maintain or improve' outcome for the respective communities. In the future, the SBA and mined land rehabilitation will combine to create a large area of treed vegetation in the landscape subject to long term conservation and exceeding 1,900 ha in size. The NBA will also be regenerated to form a large patch of woodland and forest of over 340 ha. Such vegetation is intended to provide and maintain substantial habitats for native flora and fauna in the long term. Overall, it is understood that:

- the offsets described above meet the offset requirements of the Office of Environment and Heritage's (OEH's) 'Principles for the Provision of Offsets for Major Projects';
- the credit estimates for the offset requirements identified for the proposals will be verified and certified by OEH for the UHSA; and
- the management and monitoring of the NBA and SBA according to the Warkworth Biodiversity Management Plan (BMP)BMP will ensure that a net positive ecological outcome is achieved.

Given therefore, that the identified ecological impacts (5) will be offset to achieve an outcome that is deemed to be as good or better than the status quo by the relevant NSW authorities and under legislation, the ecological impacts associated with the proposals have been valued at the cost of implementing the offsets and associated initiatives described above.

3.2.3 External costs/benefits that cannot be internalised, but that are measureable

Some external effects cannot be addressed through direct compensation or offsets, but can be given an appropriate public value.

Valuation of traffic impacts

In Australia, the costs and benefits of changed traffic conditions such as those implied by the closure of Wallaby Scrub Road (6) are typically evaluated on the basis of traffic studies overlaid with estimates of road user costs (RUCs, Austroads 2012). RUCs include the opportunity cost of drivers' travel time, which is estimated on the basis of labour costs (revealed preferences) and/or stated preference survey techniques; vehicle operating costs (VOCs), which are typically computed for various representative vehicles; and accident costs, which refer to costs associated with pain and suffering, other economic costs, and various measures of property damage. This approach that has been adopted here to value the impacts of closing Wallaby

Scrub Road.[5]

Publicly determined values

Revealed preference studies consider the public expenditure or taxes that are used to achieve, for example, an environmental outcome. From this perspective, the consequences or outcomes of government decisions reflect implicit choices and value judgements. The price of water licenses, as determined by government allocations and revealed through trades gives an indication of the value attached to the use of scarce water resources. The incremental effects on groundwater (7) and surface water (8) can therefore be valued using the cost of licences that MTW would need to acquire in order to compensate for any external effects:

- Where future groundwater requirements are concerned, it is understood that if the applications are approved, no additional Permian licenses would need to be acquired in future. No additional licensing costs have therefore been incorporated.
- Where future surface water requirements are concerned, it is understood that additional water access licences may potentially be required in future, but that such an outcome would be highly uncertain and dependent on future rainfall patterns. Given these climate-related uncertainties no additional licensing costs have been included in the CBA. We note that average prices for water access licence trades for the Hunter between 2008–09 and 2012–13 were around $2,600/ML (National Water Commission 2014), so that the potential costs of acquiring additional licenses would range from $2.3 million (average) to $8.9 million (maximum) in years in which MTW's existing entitlements were exceeded. These expenditures are unlikely to be material in changing the outcome of the CBA.

Damages associated with greenhouse gas emissions

If the applications are approved, the mining and associated processes will give rise to an increase in greenhouse gas (GHG) emissions (9). GHG emissions are projected to increase global mean temperatures, which are in turn expected to give rise to a range of negative effects, including on specific sectors like agriculture, but also on water availability, on the health of populations, and others.

The additional GHG emissions associated with the MTW Continuation Project have been valued using a 'social cost of carbon' (SCC), as determined by the US Interagency Working Group on Social Cost of Carbon (2013). The SCC is an estimate of the monetised damages associated with an incremental increase in carbon emissions in a given year. It includes changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. The NSW share of damages

[5] Additional greenhouse gas emissions associated with the closure of Wallaby Scrub Road have been valued jointly with incremental emissions associated with the proposals.

associated with additional GHG emissions has been estimated with reference to the NSW GSP as a percentage of world GDP.

3.2.4 Threshold values

Threshold values are costs and benefits that cannot be addressed through direct compensation or mitigation and that cannot be given an appropriate public value. Threshold values provide an indication of the value that the non-market benefits of protecting a resource or asset would need to reach, in order to be in the community's best interest to forego the benefits. No external effects that may be considered to fall under this heading have been identified for the proposals.

3.3 Results of the CBA

This section summarises the results of the CBA. As set out above, the proposals have been evaluated with reference to its impact on NSW GSP.

3.3.1 Gross operating surplus accruing to MTW

As set out in Section 3.1 above, one of the components of NSW GSP is the share of MTW's GOS that can be attributed to NSW. Deriving the incremental benefits to NSW if the proposals are approved therefore requires that the net GOS associated with the proposals is identified (Table 3-2). In the national accounts GOS is the portion of the income derived from production that is earned by the capital factor. GOS is therefore calculated as output valued at producer prices, net of intermediate consumption (operating expenditure), net of employee compensation, and net of taxes on production (ABS 2013).

Calculating the GOS requires that certain ASNA conventions are followed (see Appendix A). Expenditures on assets that are not 'used up' in the course of the production process and which yield benefits beyond the period in which they are purchased (i.e. capital expenditure) are not included in the calculation to derive GOS. GOS is also measured *prior to* deducting any explicit or implicit interest charges, rent or other property incomes payable on the financial assets, land or other natural resources required to carry on production (ABS 2013). The GOS calculation in Table 3-2 therefore excludes the opportunity cost of the land used by MTW to undertake mining activities. Coal royalty payments, which represent payments made by mining companies to the government in return for the right to extract minerals, are treated as property income, and are also not included as intermediate consumption. In summary, GOS resembles (but is not the same as) a corporation's earnings before interest payments, taxes and depreciation, and hence includes a number of components that are not explicitly listed in Table 3-2. These components include royalty payments, corporate income taxes, depreciation, interest payments and certain other expenses.

Table 3-2 indicates that the incremental GOS of the proposals is around A$2.156 billion in net present value (NPV) terms. The relevance of this calculation is that a number of items that are 'costs' to MTW represent 'benefits' to NSW, as described in the subsection below.

Table 3-2. Gross operating surplus of the proposals

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Operating expenditure	$3,812	Value of mining output	$7,527
Wages & salaries	$1,494		
Other taxes less subsidies on production	$65		
Total	$5,372		$7,527
Gross operating surplus	**$2,156**		

Notes: NPVs have been derived using a discount rate of 7 per cent.
Totals may not sum precisely due to rounding.
GOS includes royalty payments of $617m and company tax payments of $355m.

3.3.2 Net impacts of the proposals on NSW GSP

The net economic benefit of the proposals for NSW is estimated at A$1.488 billion in NPV terms (Table 3-3).

The key components of the benefits described in Table 3-3 are the additional wages and salaries paid by MTW to NSW employees (A$612 million), royalties (A$617 million), as well as various taxes paid by MTW (which directly or indirectly benefit NSW). Given that 74 per cent of MTW employees currently live in the Mid and Upper Hunter region (Figure 2-1), around A$464 million in NPV terms of the additional disposable income generated by the proposals would benefit the regional economy, as would the additional land taxes/shire rates paid by MTW (around A$10 million in NPV terms). For completeness, we have also derived the net economic benefits of the proposals for the Australian economy (see Appendix A, A.3).

Table 3-3. Incremental (economic) benefits of the proposals for NSW

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Production related		**Production related**	
		Compensation of employees/ contractors (disposable income)	$612
		NSW share of personal income taxes	$78
		NSW share of Medicare payments	$2
		Share of MTW GOS accruing to NSW:	
		Royalties	$617
		Shareholder income	$12
		Company taxes	$116
		Taxes on production and imports:	
		Payroll taxes	$61
		Land taxes/shire rates	$5
Total production related	**$0**	**Total production related**	**$1,501**
Externalities (costs)		**Externalities (offsets)**	
Noise & vibration	$15	Zone of mitigation work, noise attenuation	$15
Visual amenity	$2	Visual amenity upgrades	$2
Noise & air general	$3	Acquisition of properties	$3
Aboriginal heritage	$1	Cultural Heritage Facility	$1
Ecology	$10	Acquisition of offsets	$10
Traffic impacts	$13	Traffic impacts	$0
Groundwater	$0	N/a	$0
Surface water	$0	N/a	$0
European heritage	$0.5	Heritage trust, Great North Road	$0.5
GHG emissions	$0.5	GHG emissions	$0
Total externalities	**$45**	**Total externalities**	**$31**
Grand total	**$45**		**$1,533**
Net economic benefits	**$1,488**		

Notes: NPVs have been derived using a discount rate of 7 per cent.

The damages cost of GHG emissions to NSW have been estimated by multiplying the global cost derived using the SCC (A$131 m) by the share of NSW GSP to world GDP.

Totals may not sum precisely due to rounding.

Detailed calculations to derive production-related benefits that can be attributed to NSW are set out in Appendix A.

Description and rationale for the valuation of external effects are set out in Appendix B.

In interpreting Table 3-3, it is important to bear in mind that the extent to which a project contributes to the welfare of a country or state differs from a private net benefit calculation, which focuses on profits. The extent to which a project contributes to an economy such as NSW is measured with reference to value added: the value that is added to the intermediate inputs that are used, which is also the difference between output and intermediate inputs.[6] The intermediate inputs that MTW uses in the course of the production process (such as short-term labour, materials, fuel etc.) in turn represent the value added of MTW suppliers. Intermediate inputs are therefore not counted in this calculation to avoid double-counting; GDP/GSP is then the sum of the value added of each firm, government institution and producing household in a given country or state. In Table 3-3, therefore, no 'production costs' to NSW are reported in the left hand column, these costs are intermediate inputs to MTW and have been subtracted to derive value added.

With the exception of those arising from traffic impacts, which have been valued separately, external effects have generally been valued on the basis of the financial payments made by Rio Tinto or on the basis of offsets, as set out in Appendix B.

A number of adjustments have been made to ensure that production-related benefits are appropriately attributed to NSW.

Only some of the incremental wage and salary benefits resulting from the proposals can be attributed to NSW, namely:

- the incremental *disposable* incomes (gross wages and salaries net of taxes, superannuation, and Medicare contributions) paid to MTW employees and long-term contractors who reside in NSW; and
- of the total imposts paid by these employers and contractors, the share of income taxes and Medicare contributions that would accrue to NSW.

Incremental wage and salary benefits accruing to NSW have been reduced to avoid overestimating the employment benefits to NSW. Incremental wage and salary benefits are calculated by subtracting total disposable income in the reference case from total disposable income in the proposals scenario. In order to ensure that the resulting estimates err on the side of being conservative, it has been assumed that:

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[6] GDP or GSP is not a direct measure of economic and social 'welfare', but a measure of the production of goods and services (Lequiller and Derek 2007). However, production is an important dimension of welfare because it enables greater consumption, and because strong GDP growth goes hand in hand with declining unemployment. Dimensions of welfare that are not reflected in GDP include social inequality, security of goods and persons, and the quality of the environment.

- A proportion of MTW employees and contractors who would be made redundant if the applications are refused (the reference case) would find alternative employment in NSW (rather than leave the NSW workforce altogether). For the purpose of deriving the central net benefit estimates reported in Table 3-3, we have assumed that 30 per cent of persons made redundant would be re-employed in the same year, and that 40 per cent of persons made redundant would be re-employed in the subsequent year. The remaining 30 per cent are assumed to either leave the workforce altogether or to move interstate.
- A proportion of any additional employees and contractors employed by MTW over the life of the mines would be attracted from other sectors/employers in NSW (rather than be drawn from the unemployment pool or from interstate). For the purpose of deriving the central net benefit estimates reported in Table 3-3, we have assumed that 70 per cent of any additional employees/contractors would be redeployed from other jobs in NSW.

In both cases, it has been assumed that people are either re-employed at the weighted-average Mid and Upper Hunter region salary, or were paid that salary before moving to MTW. The above assumptions are based on a review of the (limited) information that is available about relevant labour market outcomes (see Appendix A). The materiality of these assumptions has been tested using sensitivity analysis (see Section 3.4 below).

Adjustments have also been made to estimate the share of MTW's GOS that would take the form of income to NSW shareholders of Rio Tinto, and to estimate the NSW share of corporate and personal income taxes, and to estimate the NSW share of Medicare contributions.

3.4 Sensitivity analysis

A number of assumptions have a material effect on the results of the CBA. Their impact on the results has been tested by conducting a number of sensitivities.

3.4.1 Variations in the discount rate

A discount rate of 7 per cent per annum has been assumed for the analysis. As required in the Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals (NSW Government 2012) we have tested the sensitivity of the results of the CBA by applying a discount rate of 4 per cent and 10 per cent per annum, respectively. Table 3-4 shows that material net benefits would accrue to NSW irrespective of which discount rate is used.

Table 3-4. Discount rate sensitivity

Discount rate assumption	Incremental benefits of the proposals for NSW (NPV A$ m 2014)
7 per cent	$1,488
4 per cent	$2,064
10 per cent	$1,099

Notes: The discount rate used to derive the SCC has not been varied; given the very small share of damages attributable to NSW, changes in the discount rate would not materially affect the results.

3.4.2 Variations in coal prices and exchange rates

Most of MTW's coal production is exported overseas, and is priced in US dollars. The results of the CBA rely on a price for thermal export coal of US$85/t and a US$/A$ exchange rate of 0.85. Different combinations of coal prices and US$/A$ exchange rates will therefore affect MTW's GOS, including corporate income tax payments and royalty payments to NSW. Table 3-5 and Table 3-6 show the incremental royalty and tax benefits accruing to NSW, and the incremental total production benefits accruing to NSW, respectively.

Table 3-5. Sensitivity to variations in coal prices and US$/A$ exchange rates – Incremental royalty payments, payroll taxes and land taxes/shire rate benefits of the proposals to NSW (NPV A$ m 2014)

Coal price assumptions / Exchange rates (US$/A$)	Thermal coal export price (US$ per tonne) US$ 75	US$ 85	US$ 95
0.75	$682	$767	$852
0.85	$608	$682	$757
0.95	$549	$616	$682

Notes: NPVs have been derived using a discount rate of 7 per cent.
Royalty and tax benefits refer to royalties, NSW share of company income taxes, payroll taxes and land taxes/shire rates.

Table 3-6. Sensitivity to variations in coal prices and US$/A$ exchange rates – Incremental production-related benefits of the proposals to NSW (NPV A$ m 2014)

Coal price assumptions / Exchange rates (US$/A$)	Thermal coal export price (US$ per tonne) US$ 75	US$ 85	US$ 95
0.75	$1,485	$1,662	$1,839
0.85	$1,345	$1,501	$1,658
0.95	$1,235	$1,375	$1,515

Notes: NPVs have been derived using a discount rate of 7 per cent.
Production-related benefits refer to royalty and tax benefits, as well as net compensation of employees/contractors, the NSW share of personal income taxes and Medicare payments, and income accruing to NSW shareholders of MTW.

3.4.3 Variations in re-employment assumptions (NSW)

As noted above, only a subset of employee compensation benefits can be considered to be additional for the purposes of the net benefit calculation. For the purpose of calculating the net benefits of the proposals we have assumed that:

- 30 per cent of employees and long-term contractors who would be made redundant by the closure of MTW would find employment elsewhere within NSW in the same year, and 40 per cent of these employees and contractors would find employment in NSW in the year after being made redundant. We have assumed that all persons would be re-employed at the weighted-average wage and salary income reported for the Mid and Upper Hunter region by the ABS for the corresponding LGAs.[7]

- 70 per cent of any additional employees and long-term contractors employed by MTW may move to MTW from other industries/employers in NSW. Only the incremental income that these employees/contractors would earn when employed by MTW is therefore counted as a net benefit.

The implications of variations in these assumptions are explored in Table 3-7 and Table 3-8 below. Table 3-7 explores variations in the re-employment assumptions. For instance, for the 30/40 split described above, net employment benefits (in terms of disposable income) would amount to A$612 million and net production-related benefits to NSW would amount to A$1,507 million. If it is alternatively assumed that all employees made redundant by the closure of MTW would find alternative employment in the same year, net employment benefits would fall to A$504 million and the net benefits to NSW would be A$1,368 million.

Table 3-7. Sensitivity of production-related benefits to variations in re-employment assumptions

Re-employment assumptions	Incremental benefits of the proposals to NSW (NPV A$ m 2014)	
	70 per cent of additional hires originate from NSW	
	Net employment benefits (disposable income) (NPV A$2014 m)	Net production-related benefits to NSW (NPV A$2014 m)
0%	$825	$1,777
30% Year 1, 40% Year 2	$612	$1,501
50% Year 1, none thereafter	$665	$1,570
70% Year 1, none thereafter	$601	$1,487
100% Year 1	$504	$1,363

Notes: Average alternative wage and salary income is assumed to be $58,853 (A$2014).
NPVs have been derived using a discount rate of 7 per cent.
Production-related benefits refer to royalty and tax benefits, as well as net compensation of employees/contractors, the NSW share of personal income taxes and Medicare payments, and income accruing to NSW shareholders of MTW.

Table 3-8 considers variations in the assumptions about the share of additional employees recruited from NSW assuming the above 30/40 split in re-employment outcomes. If only 50 per cent of any additional employees and contractors are drawn from other sectors in NSW,

[7] The ABS (2013) publishes regional profiles (1379.0.55.001) for Cessnock, Maitland, Upper Hunter, Singleton, and Muswellbrook LGAs. Average wages have been adjusted to A$2014 figures using the ABS wage price index (6345.0).

net employment benefits would amount to A$622 million, and net benefits to NSW would be A$1,507 million.

Table 3-8. Sensitivity of production-related benefits to variations in redeployment assumptions

Redeployment assumptions	Incremental benefits of the proposals to NSW (NPV A$m 2014)	
	30% re-employed in Year 1, 40% re-employed in Year 2	
Percentage of additional hires originating from NSW	Net employment benefits (disposable income) (NPV A$2014 m)	Net production-related benefits to NSW (NPV A$2014 m)
50 per cent	$622	$1,515
70 per cent	$612	$1,501
100 per cent	$596	$1,481

Notes: Average alternative salary is assumed to be $58,853 (A$2014).
NPVs have been derived using a discount rate of 7 per cent.
Production-related benefits refer to royalty and tax benefits, as well as net compensation of employees/contractors, the NSW share of personal income taxes and Medicare payments, and income accruing to NSW shareholders of MTW.

Overall, Table 3-7 and Table 3-8 show that significant employment and other benefits would accrue to NSW irrespective of the precise assumptions that are made about re-employment and redeployment outcomes. This reflects both the substantial employment that would be generated if the proposals are accepted, and high wage and salary outcomes at MTW, relative to average wages and salaries in the Mid and Upper Hunter region.

3.5 Relative contribution of Warkworth Mine to aggregate NSW benefits

The share of aggregate net benefits that can be attributed to Warkworth Mine has been estimated by determining the net benefits attributable to MTO, and subtracting these from the aggregate net benefits derived for the MTW Continuation Project.[8] The calculation to determine the net benefits of MTO is described in Appendix E.

The external effects identified in Table 3-1 can overwhelmingly be attributed to Warkworth

[8] The sum of individual project benefits and costs may not equal the corresponding benefits and costs of the total project when there are benefits from 'joint' production. The benefits of the total project will be greater than the parts if, for example, there are returns to scale and therefore falling average costs of transport. How these benefits are shared between the projects is not a material concern, save for the distribution of profits to investors. Conversely, the costs for the total project may escalate as the level of say, dust, noise or traffic congestion increases. However, so long as these external costs can be offset, how the costs of the offsets are shared between the projects is not a material concern save for the distribution of profit to different investors.

Mine, and have been valued the same manner as for MTW.[9]

Table 3-9 below shows the incremental benefits of Warkworth Mine for NSW. As described in Appendix E, MTO is assumed to operate at arms' length from and offer tolling services to Warkworth Mine. In the event that the applications are accepted, coal would be mined at MTO until 2018; after this time, MTO would provide coal processing and handling services to Warkworth Mine and would accept overburden from Warkworth Mine. These services would be provided in return for a fee for service. The estimated net benefit to NSW that can be attributed to Warkworth Mine is A$1,339 million, around 90 per cent of the total net benefit that would accrue to NSW if both applications are approved (A$1,488).

Table 3-9. Incremental (economic) benefits of Warkworth Mine for NSW

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Production related		**Production related**	
		Compensation of employees/ contractors (disposable income)	$549
		NSW share of personal income taxes	$70
		NSW share of Medicare payments	$2
		Share of Warkworth Mine GOS accruing to NSW:	
		Royalties	$567
		Shareholder income	$11
		Company taxes	$96
		Taxes on production and imports:	
		Payroll taxes	$54
		Land taxes/shire rates	$3
Total production related	**$0**	**Total production related**	**$1,352**
Externalities (costs)		**Externalities (offsets)**	
Noise & vibration	$13	Zone of mitigation work, noise attenuation	$13
Visual amenity	$2	Visual amenity upgrades	$2
Noise & air general	$3	Acquisition of properties	$3
Aboriginal heritage	$1	Cultural Heritage Facility	$1
Ecology	$10	Acquisition of offsets	$10

[9] Mitigation expenditures in the form of upgrades to each mine's equipment have been allocated to Warkworth Mine and MTO, respectively.

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Traffic impacts	$13	Traffic impacts	$0
Groundwater	$0	N/a	$0
Surface water	$0	N/a	$0
European heritage	$0.5	Heritage trust, Great North Road	$0.5
GHG emissions	$0.5	GHG emissions	$0
Total externalities	$42	Total externalities	$29
Grand total	**$42**		**$1,381**
Net economic benefits	**$1,339**		

Notes: NPVs have been derived using a discount rate of 7 per cent.

The damages cost of GHG emissions to NSW have been estimated by multiplying the global cost derived using the SCC (A$ $129.6 m) by the share of NSW GSP to world GDP.

Totals may not sum due to rounding.

Detailed calculations to derive production-related benefits that can be attributed to NSW are set out in Appendix A.

Warkworth Mine's GOS and the basis for the allocation of revenues and costs is set out in Appendix E.

3.6 Relative contribution of MTO to aggregate NSW benefits

The derivation of the share of direct flow-on effects that MTO would contribute to the overall benefits from the MTW Continuation Project is described in Appendix E.

If the applications are accepted, MTO may also give rise to external effects, although these are predicted to be far more limited than for the integrated operation of MTW (Table 3-10, Appendix C). As noted above, external effects relating to noise (1) have been valued with reference to the costs of upgrading dedicated MTO equipment.

Table 3-10. External effects associated with MTO

Category	External effect	Overall nature of impact
1. Noise & vibration	No additional residential properties affected	Local
2. Air quality	No additional residential properties affected	Local
3. Visual amenity	N/a (rehabilitation of MTO is progressing)	N/a
4. Aboriginal heritage	N/a	N/a
5. Ecology	N/a	NSW/Australia
6. Traffic	Minimal traffic impacts on the local road network	Local
7. Groundwater	N/a	Local
8. Surface water	No significant impacts on surface water quality of adjacent water features	Local
9. GHG emissions	Incremental GHG emissions in	Global

Category	External effect	Overall nature of impact
	2019 only	

Notes: Additional detail is provided in Appendix C.

Table 3-11 below shows the incremental benefits of MTO for NSW. The estimated net benefit to NSW that can be attributed to MTO is A$151 million, around 10 per cent of the total net benefit that would accrue to NSW if both applications are approved (A$1,494).

Table 3-11. Incremental (economic) benefits of MTO for NSW

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Production-related		**Production-related**	
		Compensation of employees/ contractors (disposable income)	$63
		NSW share of personal income taxes	$8
		NSW share of Medicare payments	$0.2
		Share of MTO GOS accruing to NSW:	
		Royalties	$50
		Shareholder income	$0.4
		Company taxes	$20
		Taxes on production and imports:	
		Payroll taxes	$6
		Land taxes/shire rates	$1
Total production related	**$0.0**	**Total production related**	**$149**
Externalities (costs)		**Externalities (offsets)**	
Noise & vibration	$3	Zone of mitigation work, noise attenuation	$3
GHG emissions	$0	GHG emissions	$0
Total externalities	**$3**	**Total externalities**	**$3**
Grand total	**$3**		**$152**
Net economic benefits	**$149**		

Notes: MTO is projected to account for 232,704 t $C0_2$ in 2019. The damages cost of GHG emissions to NSW have been estimated by multiplying the global cost derived (A$1.5 m) by the share of NSW GSP to world GDP.

NPVs have been derived using a discount rate of 7 per cent.

Totals may not sum due to rounding.

Detailed calculations to derive production-related benefits that can be attributed to NSW are set out in Appendix A. MTO's GOS and the basis for the allocation of revenues and costs is set out in Appendix E.

4 Regional and local impact analysis of the proposals

This section sets out the REIA for the proposals. The detailed methodology used for deriving the input-output multipliers is described in Appendix D.

4.1 Economic framework

The REIA described in the following identifies the likely incremental flow-on effects of the proposals on the NSW economy, the Mid and Upper Hunter region and the Singleton LGA. These effects refer to the adjustments in the regional and state economies that follow from initial changes in the level of demand for goods, services and wages that result from an extension of mine production if the projects are approved.[10]

4.1.1 Choice of input-output analysis

There are a number of methods that can be used for calculating flow-on effects from mine extensions. They all face a singular issue in that the relative importance of a project increases when moving from a national to a state, and then to a regional perspective. At the same time, the degree of difficulty in estimating flow-on effects increases when moving from the national to the state and regional level. For the most part, this reflects a general lack of information about the specific composition and source of intermediate inputs used by an industry, as well as about trade at a state and regional level. In addition, there may also be local rigidities in employment, capital assets and other fixed resources that are not consistent with the assumptions that underpin methodologies for measuring flow-on effects.

The methodology used here relies on input-output analysis to derive various multipliers. The primary reasons for selecting this methodology are the simplicity and clarity with which the underlying assumptions can be set out and appropriate caveats made. Further, when compared to more complex methods such a general equilibrium (GE) analysis:

- The gross value of the proposals is small in relation to the Australian and NSW economies. Unlike an input-output analysis, a GE analysis takes into account the price impacts of a project on inputs and outputs. However, given the relatively small size of the proposals under consideration here, material price impacts would not be expected and the difference between the results of a GE and an input-output analysis should also be small.

[10] As set out in Section 2, in the case of the proposals, the change in mine production being analysed relates to the ongoing production until 2035 that would occur if the application is approved, versus the shut-down of the mine by 2021 for Warkworth Mine and 2017 in the case of MTO if the applications are not approved.

- Given the lack of information about industry structure and trade at a regional and state level, there is no reason to think that one method would be materially more accurate than another. Both GE and input-output analysis depend critically on accurately modelling flows of production and expenditure.

4.1.2 Adjusting regional/state industry composition and trade

Regional impact analysis depends, in large part, on adjusting the flows of production and expenditure, as represented by national input-output tables, to represent a state or regional economy.[11] However, industries at a regional or state level have differing compositions of inputs and outputs than is the case for the national average; the same difficulty arises for specific projects within a region. Hence, a consistent set of ancillary information that is specific to national, state and regional economies is required to apportion national aggregates. The most commonly used information for this purpose (which is also recommended by the ABS) is industry employment.

As of 2011, the ABS has conducted a census of employment by industry and at the LGA level. This employment information can be used to calculate location quotients (LQs) to adjust national industry structure and trade flow data to derive the corresponding state and regional aggregates. Employment based LQs are ratios that indicate the percentage of people employed in a particular industry at a state/regional level, relative to the percentage of people employed in that industry in the economy as a whole. In the case of the Mid and Upper Hunter region, for instance, the employment based LQ indicates that the share of employment in the mining sector is significantly larger than it is for the Australian economy as a whole. Employment based LQs are then used to proportionally adjust the contribution of an industry to the use of intermediate inputs in a state or region. The consequent shortfall in intermediate inputs is made up by increasing 'imports' from outside the state or region across all industries.

The use of employment LQs has a critical limitation. Input-output tables do not explicitly account for fixed capital, human or physical, although the returns to these assets are implicitly reflected in wages and operating surpluses (profits). As the impact analysis becomes more granular, the geographic location of these fixed assets can become increasingly important. A region may simply not have the fixed assets needed to cost-effectively produce the input required by a local industry and as a consequence they will be 'imported' from other regions, states, or from overseas.

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[11] Input-output tables capture the flows of intermediate inputs between producers and form the basis for deriving multipliers. These tables are generally prepared at a national level; national input-output multipliers are essentially derived from a weighted average of enterprises at the national level. Thus the Australian input-output tables reflect a snapshot in time of the entire Australian economy and the inter-relationships between producers, households, governments, and the outside world. However, while the ABS publishes national input-output tables, similar information about the relationships between economic agents within a region and flows into and out of the region ('imports' and 'exports') is not available.

4.2 Interpretation of input-output multipliers

A change in demand sets the economy in motion as the productive sectors buy and sell goods and services from one another and households earn additional incomes, which gives rise to further flow-on effects (Coughlin et al. 1991). These relationships cause the total effects on the regional and state economy to exceed the initial change in demand.

Regional economic impacts can be measured in terms of income, value added and employment, which in turn gives rise to income, value added and employment multipliers.[12] In the case of the proposals:

- the income multiplier refers to the percentage change in total income arising per dollar change in the wages and salaries paid by MTW;
- the employment multiplier corresponds to the change in total employment (in numbers of FTEs) arising per additional person employed by MTW; and
- the value added multiplier refers to the percentage change in total value added arising per dollar change in the value added created by MTW.

Multipliers are classified into 'types'. Type I multipliers refer only to flow-on effects in the production sectors, while Type II multipliers incorporate subsequent impacts on households. In the case of the proposals:

- Type IA multipliers refer to the 'initial' and 'first round' effects arising from an increase in demand from MTW. The initial effect refers to the additional output from the proposals. The first round effect captures the immediate subsequent impacts on income, employment or value added from all industries whose output is required to produce the additional output from MTW.
- Type IB multipliers refer to the initial and 'production induced' effects, which encompass first round effects and additionally 'industrial support' effects. Industrial support effects capture subsequently induced effects that occur after the first round effects (since the initial output effect from MTW will induce additional output in other industries, which will in turn lead to further rounds of effects and so on).
- Type IIA multipliers incorporate the effects of the initial increase in output of MTW on households, and refer to the sum of production induced and consumption induced effects. Consumption induced effects capture the fact that, as a result of the additional

[12] It is also possible to calculate output multipliers, as representing the amount of additional output induced by the need for other industries to produce the output to meet the demand for an extra dollar of output from a project. However, the value of total business activity implied by output multipliers is larger than the market value of the goods and services that are produced, because some of the re-spending is used for the purchase of intermediate goods and services. Because of the implied double-counting, some commentators consider output multipliers to be misleading, and we do not report them here.

output from MTW and subsequent production induced effects in other industries, wage and salary earners will earn extra income which they spend on goods and services produced by all industries in the state or region.

4.3 Limitations of input-output analysis

The principal advantage of the impact multiplier method is the simplicity with which levels of mining investment, employment and output can be translated into measures of changes in regional income and employment. However, the accounting conventions that form the basis of input-output models and hence how multipliers are derived impose a number of restrictive assumptions. Some of these assumptions pertain to input analysis generally while others relate to the use and interpretation of input-output analysis at a regional/state, as opposed to a national level. The key assumptions are set out below.

4.3.1 Key assumptions

Fixed capital stocks

The National Accounts, on which input-output analysis is based, do not explicitly account for fixed capital stocks. This is an issue with input-output analysis generally as fixed capital has a significant impact on how an industry adjusts over time. A corollary to this is that input-output analysis is static in the sense that it takes no account of the time required for the composition of inputs and outputs of production to shift to a changed level in output. Industries that require large amounts of fixed capital and labour adjust slowly, particularly when they are near full employment or when the supply of skilled labour is tight. These dynamics are hard to predict, but the implication over the short- to medium-term is that input-output effects will be overstated to varying degrees across industries.

The fixed nature of the capital stock is a critical issue in regional impact assessments. In moving from the national to a state or regional level, the location of fixed assets becomes increasing important in establishing the goods and services that are supplied locally and those which are imported. Moreover, there is no information as to whether fixed assets are owned locally or whether the owners are located outside the region or state. As a consequence it becomes increasingly difficult to determine the valued added by local industry.

Supply constraints

Relatedly, when the initial impact considered is an increase in production, the assumption of fixed production patterns requires that there is a sufficient endowment of resources that is either available in (or able to migrate to) a region to meet the increase in demand for inputs whose supply is fixed. These inputs include resources such as land and water, as well as labour with adequate skills. If there is a reduction in production, as is the case here in the reference case, some or all of the fixed resources may be deployed elsewhere within or outside the region of interest. The return to these fixed resources is likely to be lower; however, if these next best opportunities are not taken into account the costs of foregoing the proposals will be overstated.

Homogenous and fixed production patterns

The input coefficients that measure inter-industry flows between sectors are 'fixed' in input-output models; at any level of output, an industry's relative pattern of purchases from other sectors is unchanged. These assumptions are likely to be inconsistent with production patterns in the local economy, since the local economy may not have on offer the range of inputs required for a given industry. Therefore, the impact of the change in output on the local economy will differ from that implied by a national multiplier.

Fixed prices

Input-output analysis assumes that prices in the economy in question are held constant, so that the additional material and labour inputs are available at existing prices and wage rates. In reality, prices of inputs may change with substantive changes in their demand. To the extent that there is an impact on prices, imputed output effects will be overstated. However, this is only a problem in input-output analysis for projects of a sufficient scale to materially shift the demand for inputs into production and the total supply of industry output.

4.3.2 Implications for the regional impact assessment

Many of the above assumptions can lead to an overstatement of the impacts of a project; the resulting regional impact estimates should therefore be interpreted as an upper bound of the likely effects (Bess and Ambargis 2011, Coughlin et al. 1991).

Furthermore, and while, from a theoretical perspective, the total (Type IIA) multiplier is the appropriate choice for calculating flow-on effects (since this measure takes into account the full adjustment of the economy to a change in economic activity), total multipliers are calculated in a manner that compounds any measurement errors and breaches in the assumptions that underpin the analysis. For example, total multipliers are calculated as a progression of first, second and successive round effects, with each embodying any errors in earlier effects. From this perspective, a more conservative approach is to rely only on multipliers that capture first round effects (Type IA multipliers).

As noted above, there are additionally specific issues that arise in deriving value added multipliers. Value added includes profits that are distributed on the basis of ownership of capital assets, which becomes increasingly uncertain as the analysis becomes more granular.[13] The calculation of value added at a regional level is therefore not meaningful.

[13] For instance, there is no way of knowing from generally available public information whether a productive asset (say, a factory) that is located in the Upper Hunter Region is owned by persons living in the Upper Hunter Region, or in NSW, or elsewhere. It then becomes very difficult to attribute the value added generated by the factory on a regional and even state basis.

4.4 Results of the regional and local impact analysis

4.4.1 Income, employment and value added multipliers

Table 4-1 shows the estimated income, employment and value added multipliers for NSW, the Mid and Upper Hunter region, and Singleton LGA for the proposals. Based on this analysis, the approval of the proposals would lead to the following effects on the economy of NSW (Type IA multipliers):[14]

- each additional dollar in wages and salaries paid by MTW induces an additional A$0.63 in total income;
- each additional person employed by MTW induces employment of an additional 0.9 FTEs; and
- each additional dollar of value added created by the proposals induces an additional A$0.3 in value added.

Table 4-1. Income, employment and value added multipliers for NSW, the Mid and Upper Hunter region and for Singleton LGA

Multiplier	Type		
	IA	IB	IIA
		New South Wales	
Income	1.63	2.23	3.54
Employment	1.91	3.81	6.05
Value added	1.30	1.55	2.05
		Mid and Upper Hunter region	
Income	1.49	2.09	2.63
Employment	1.76	3.62	4.79
Value added	1.25	1.45	1.71
		Singleton LGA	
Income	1.67	3.07	4.33
Employment	1.46	1.68	2.37
Value added	1.25	1.39	1.62

Source: BAEconomics analysis.

[14] To calculate the first-round flow-on effects of the MTW Continuation Project, it is necessary to deduct the initial effects from the multipliers (i.e., the additional expenditure from the project itself) by subtracting one.

4.4.2 Net impacts of the proposals (MTW)

The direct impacts of the proposals relative to the wind-down of MTW in the reference case are summarised in Table 4-2. Annualised values have been used to calculate the flow-on effects on an annual basis.

Table 4-2. Summary of net direct annual impacts of the proposals (MTW)

Item	Proposals scenario (NPV, 2014 A$ m)	Reference case (NPV, 2014 A$ m)	Net change (NPV, 2014 A$ m)	Amortised net change (annual A$ m)
Value of output	$13,972	$6,445	$7,527	$664
Input costs	$7,253	$3,441	$3,812	$336
Gross wages & salaries	$2,694	$1,200	$1,494	$132
Gross operating surplus	$3,896	$1,746	$2,150	$190
Taxes on production	$129	$58	$71	$6
Value added + 'imports'	$6,719	$3,004	$3,715	$328

Notes: Expenditures incurred by MTW to mitigate external effects have been excluded from this analysis as they are assumed to equal the costs of the externalities they are intended to mitigate.

Input costs are total operating expenses, excluding wages & salaries. Gross operating surplus is the value of output less intermediate inputs (excluding capital costs). The sum of wages & salaries for employees and long-term contractors, gross operating surplus, taxes on production, and royalties equals value added prior to the deduction of 'imports'. Employment is the average level of FTE employment (employees and long-term contractors) from 2014 to 2035.

Table 4-3 shows the net income (or compensation) benefits and the average annual increase in employment if the proposals are approved, at the state, regional and local level. These estimates are used as the basis for calculating the state, regional and local flow-on effects on income and employment. The apportionment of the change in income and employment associated with the MTW Continuation Project at the state, regional and local levels is based on the labour market assumptions detailed in Appendix A. Adjustments have accordingly been made to account for:

- the size of the MTW labour force residing in NSW, the Mid and Upper Hunter region, and in the Singleton LGA, respectively;
- the expectation that some share of workers who would be made redundant in the event that the proposals are not approved would be re-employed within NSW, the Mid and Upper Hunter region, or Singleton LGA, respectively; and, similarly,
- the expectation that a share of any additional workers employed by MTW would be redeployed from within NSW, from within the region, or from within Singleton LGA.

A large share of the MTW workforce lives within the Mid and Upper Hunter region (74 per cent) and locally in Singleton (35 per cent); the positive income effects associated with the proposals are therefore concentrated regionally and locally. We have assumed that a relatively larger share of any MTW workers made redundant would be re-employed within NSW than within either the Mid and Upper Hunter region or the Singleton region. As a consequence, the regional impacts on employment at the regional level are larger than at the State level.[15] Table 4-3 also includes the proportion of intermediate mine inputs that are estimated to be 'imported' from outside NSW. This figure is used as a basis for calculating the value added or GSP flow-on effect for NSW (as set out in Appendix D).

Table 4-3. Net income benefits, average annual net change in employment and derived 'imports' (MTW)

Area	Net income (NPV, 2014 A$ m)	Net employment (annual average)	Imports (per cent)
NSW	$612	227	4.9
Mid and Upper Hunter region	$464	282	-
Singleton LGA	$126	133	-

Notes: Net income is compensation of MTW employees/contractors, adjusted by (net of) compensation of redeployed persons in the reference case, adjusted by (net of) the compensation differential of additionally employed persons in the proposals scenario.

Net employment (annual average) is the average annual difference in the number of FTEs, adjusted (as above) for redeployed and additionally employed persons in the reference case and proposals scenario, respectively.

Imports is the share of intermediate mine inputs (operating expenses, excluding wages & salaries) estimated to be 'imported' from outside NSW.

Flow-on effects for NSW

To calculate the initial flow-on effects of the proposals for NSW, it is necessary to deduct the direct effects from the multipliers by subtracting one from the first round effect in Table 4-1:

- the initial income multiplier effects are calculated by applying the multiplier to the total value of wages adjusted by the proportion of wages paid to employees living in NSW;
- the initial employment multiplier effects are calculated by applying the multiplier to the total net change in average employment adjusted by the proportion of wages paid to employees living in NSW; and
- initial value added effects for NSW are calculated by first calculating the value added accruing to NSW, and by subsequently deducting imports into mining and then applying the NSW multiplier.

Further, as noted above, it is necessary to consider the issue of the transfer of labour between

[15] To illustrate this effect, assume that there is a business with 10 employees who all live in the Mid and Upper Hunter region. If the business is closed, the Mid and Upper Hunter region initially loses 10 jobs, although some of the employees (say 3) may find a new job in the Mid and Upper Hunter region, so that the net job loss is 7. In addition, however, another 5 employees may find a new job elsewhere in NSW, so that the net job loss for NSW overall is only 2.

industries. The total flow-on income and employment effects have been adjusted to account for the expectation that a share of the FTEs that would be made redundant in the reference case will be re-employed. Total value added (the sum of salaries and wages and GOS) has been adjusted for the corresponding change in incomes. The assumptions made for NSW are consistent with those made in CBA.[16]

Table 4-4 shows the estimated flow-on effects from the proposals for NSW. The estimated net flow-on benefits of the proposals amount to an overall increase in GSP of A$452 million in NPV terms (A$39 million per annum), equivalent to about 12 per cent of the net value added of the project (A$3,715 million). The great majority of the flow-on benefits is attributable to the increased compensation of employees and long-term contractors. It is estimated that the proposals would generate additional income of A$385 million in NPV terms, and a net addition of 206 FTE jobs.

Table 4-4. Initial flow-on effects (Type IA) for NSW (MTW)

	Income (2014 NPV A$ m)		Employment (FTEs)	Value added (GSP) (2014 NPV A$ m)	
	Total	Annual	Annual	Total	Annual
Flow-on effects	$385	$33	206	$450	$39

Flow-on effects for Mid and Upper Hunter region

Table 4-5 shows the estimated flow-on effects from the proposals for the Mid and Upper Hunter region. The net benefits to the Mid and Upper Hunter region are estimated to be:

- around A$227 million in additional income generated (A$20 million per annum); and
- additional annual employment of around 214 full-time equivalent workers.

These effects have similarly been calculated by adjusting the various factors for the percentage of MTW employees living in the Mid and Upper Hunter region. Given the various uncertainties set out above, value added effects have not been calculated on a regional basis.

Table 4-5. Initial flow-on effects (Type IA) for the Mid and Upper Hunter region (MTW)

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$227	$20	214

[16] That is, it is assumed that 30 per cent of employees and contractors that are made redundant are re-employed within one year, an additional 40 per cent of employees/contractors is re-employed in the second year, and 30 per cent of any displaced workers leave the NSW workforce.

Flow-on effects for the Singleton LGA (MTW)

Table 4-6 shows the estimated flow-on effects from the proposals for the Singleton LGA. The net benefits for the Singleton LGA are estimated to be:

- around A$84 million in additional income generated (A$7 million per annum); and
- additional annual employment of around 61 full-time equivalent workers.

These effects have similarly been calculated by adjusting the various factors for the percentage of MTW employees living in the Singleton LGA (35 per cent).

Table 4-6. Initial flow-on effects (Type IA) for the Singleton LGA

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$84	$7	61

4.4.3 Net impacts of Warkworth Mine

This section summarises the results of the regional and local impact analysis for Warkworth Mine. The income, employment and value added multipliers summarised in Table 4-1 were used to derive these flow-on effects by first applying these to MTO, and then deriving the flow-on benefits attributable to Warkworth Mine by differencing. The share of Warkworth Mine workers and contractors living in Singleton, the Mid and Upper Hunter region, and NSW was assumed to be the same as for MTW overall.

Flow-on effects for NSW

Table 4-7 shows the estimated flow-on effects from the proposals for NSW. The estimated net flow-on benefits of the proposal amounts to an overall increase in GSP of A$407 million in NPV terms (A$35 million per annum). It is estimated that the proposal would generate additional income of A$346 in NPV terms, and a net addition of 191 FTE jobs.

Table 4-7. Initial flow-on effects (Type IA) for NSW (Warkworth Mine)

	Income (2014 NPV A$ m)		Employment (FTEs)	Value added (GSP) (2014 NPV A$ m)	
	Total	Annual	Annual	Total	Annual
Flow-on effects	$346	$30	191	$406	$35

Flow-on effects for the Mid and Upper Hunter region

Table 4-8 shows the estimated flow-on effects from the proposals for the Mid and Upper Hunter region. The net benefits to the Mid and Upper Hunter region are estimated to be:

- around A$204 million in additional income generated (A$18 million per annum); and
- additional annual employment of around 198 FTE jobs.

Table 4-8. Initial flow-on effects (Type IA) for the Mid and Upper Hunter region (Warkworth Mine)

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$204	$18	198

Flow-on effects for the Singleton LGA

Table 4-9 shows the estimated flow-on effects from the proposals for the Singleton LGA. The net benefits for the Singleton LGA are estimated to be:

- around A$75 million in additional income generated (A$6 million per annum); and
- additional annual employment of around 57 full-time equivalent workers.

Table 4-9. Initial flow-on effects (Type IA) for the Singleton LGA (Warkworth Mine)

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$75	$6	57

4.4.4 Net impacts of MTO

This section summarises the results of the regional and local impact analysis for MTO. The income, employment and value added multipliers summarised in Table 4-1 were used to derive these flow-on effects. The respective share of MTO employees and contractors living in Singleton, the Mid and Upper Hunter region, and NSW was assumed to be the same as for MTW overall.

Flow-on effects for NSW

Table 4-10 shows the estimated flow-on effects from the proposals for NSW. The estimated net flow-on benefits of the proposal amounts to an overall increase in GSP of A$45 million in NPV terms (A$4 million per annum). It is estimated that the proposal would generate additional income of A$39 in NPV terms, and a net addition of 15 FTE jobs.

Table 4-10. Initial flow-on effects (Type IA) for NSW (MTO)

	Income (2014 NPV A$ m)		Employment (FTEs)	Value added (GSP) (2014 NPV A$ m)	
	Total	Annual	Annual	Total	Annual
Flow-on effects	$39	$3	15	$45	$4

Flow-on effects for the Mid and Upper Hunter region

Table 4-11 shows the estimated flow-on effects from the proposals for the Mid and Upper Hunter region. The net benefits to the Mid and Upper Hunter region are estimated to be:

- around A$23 million in additional income generated (A$2 million per annum); and
- additional annual employment of around 16 FTE jobs.

Table 4-11. Initial flow-on effects (Type IA) for the Mid and Upper Hunter region (MTO)

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$23	$2	16

Flow-on effects for the Singleton LGA

Table 4-12 shows the estimated flow-on effects from the proposals for the Singleton LGA. The net benefits for the Singleton LGA are estimated to be:

- around A$9 million in additional income generated (A$1 million per annum); and
- additional annual employment of around 4 FTE jobs.

Table 4-12. Initial flow-on effects (Type IA) for the Singleton LGA (MTO)

	Income (2014 NPV A$ m)		Employment (FTEs)
	Total	Annual	Annual
Flow-on effects	$9	$1	4

Appendix A Cost-benefit analysis - MTW

A.1 CBA accounting framework

The accounting and definitional conventions set out in the following reflect the framework used in the ASNA, as set out in ABS (2013). These conventions have been applied for deriving the incremental GOS associated with the proposals, as well as the net benefits accruing to the State of NSW.

A.1.1 MTW Incremental gross operating surplus

GOS is a measure of the surplus accruing to incorporated enterprises owners from processes of production before the deduction of various items. GOS is the excess of gross output over the sum of intermediate consumption (gross value added), net of compensation of employees, and taxes less subsidies on production and imports. GOS is calculated before deduction of consumption of fixed capital, dividends, interest, royalties and land rent, and direct taxes payable (ABS 2013):

$$Output - Intermediate\ consumption$$

$$= Gross\ value\ added$$

$$- Compensation\ of\ employees$$

$$-(+)\ Other\ taxes\ (subsidies)\ on\ production$$

$$= Gross\ operating\ surplus$$

The components of GOS are defined as follows:

- *Output*: Output consists of the value of goods and services produced, valued at producer prices.
- *Intermediate consumption*: Intermediate consumption (or 'intermediate use') consists of the value of the goods and services consumed ('used up') as inputs to the production process, including those used directly as inputs, as well as ancillary activities. Intermediate consumption does not include the consumption of fixed capital (depreciation) and royalties.
- *Compensation of employees*: Compensation of employees comprises wages and salaries and employers' social (e.g. superannuation) contributions. Compensation of employees excludes payroll tax, but it includes severance, termination and redundancy payments by employers. Employees are defined as all persons engaged in the activities of incorporated business units. Long-term contractors operating on rostered shifts and under MTW direction have been included in this category.

- *Other taxes (less subsidies) on production*: Other taxes on production include payroll taxes, recurrent taxes on land or buildings, stamp duties and taxes on pollution.

A.1.2 Incremental contribution to NSW GSP

GSP (I) is defined as (ABS 2013):

$$GSP(I) = Compensation\ of\ employees$$

$$+ Gross\ operating\ surplus$$

$$+ Gross\ mixed\ income$$

$$+ (-)\ Taxes\ (Subsidies)\ on\ production\ and\ imports$$

Each of these items has been adjusted to determine the share accruing to NSW, as follows.

Compensation of NSW employees

Compensation of employees is as defined above. The share of MTW employees residing in NSW has been determined on the basis of postcode data provided by MTW.

In order to correctly apportion wage and salary benefits to NSW, gross wages and salaries have been decomposed into disposable income, income taxes, superannuation contributions, and Medicare levies. Only incremental disposable income is assumed to constitute a full benefit to NSW.

Some share of income taxes and Medicare levies paid by MTW employees and long-term contractors to the Commonwealth Government can be deemed to benefit the residents of NSW. However, there is no clear relationship between taxes/levied paid to the Commonwealth and the resulting benefits accruing to residents of NSW. There is no specific 'formula' for determining payments to the states/territories, and to the extent that some of the services provided by the Commonwealth are 'public' goods, all residents of Australia benefit from them, regardless of where they live. Allocations to the states/territories instead take the form of general purpose payments (mainly GST), specific purpose payments, national partnership payments, and other general revenue assistance in some circumstances (NSW Government 2013, Council of Australian Governments n.d.). Given the lack of a clear funding formula, the share of income taxes and Medicare levies paid by MTW employees and contractors that accrues to NSW has been determined on the basis of population share. The most recent ABS statistics indicate that the NSW share of the Australia population is around 32 per cent (ABS 2013).

MTW GOS accruing to NSW

Only a portion of the incremental GOS associated with the proposals accrues to NSW, namely:

- the coal royalties paid by MTW to NSW;
- the share of profits resulting from the proposals accruing to shareholders of Rio Tinto who live in NSW; and

- the share of company taxes paid by MTW to the Commonwealth Government that accrues to NSW.

Some share of MTW's GOS (profits) accrues to NSW shareholders of Rio Tinto, although this calculation is necessarily inexact. The share of surplus has been calculated as follows:

- Warkworth Mine and MTO have different ownership structures, with a minority share of each being foreign-owned. To determine Rio Tinto's share of GOS, the profit split for each mine, as prescribed in the JV agreement, has been applied to Rio Tinto's ownership share of each mine to determine Rio Tinto's overall share of the surplus from MTW.
- The GOS calculated as described above refers to revenues from coal sales, net of intermediate consumption, wages & salaries, and certain taxes, but it includes depreciation/amortisation and inventory adjustments, among other items, which are unknown and are not included in a CBA. Only a share of GOS is therefore available for distribution to Rio Tinto shareholders. Rio Tinto's accounts do not enable any clear conclusions to be drawn between GOS or a similar measure, on the one hand, and dividend payments, on the other, and indeed numerous year-on-year variations would be expected to arise and obscure such a relationship. For the purposes of approximating the relationship between Rio Tinto's share of MTW profits and any payout to Rio Tinto shareholders, the average relationship between consolidated sales revenue and equity dividends paid to shareholders of Rio Tinto as reported in Rio Tinto's annual reports and accounts (2007 to 2013) has been estimated. That ratio is around 4.3 per cent.[17]
- Only a portion of the dividends available for distribution will be paid to Australian shareholders. It is not known what percentage of Australian Rio Tinto shareholders reside in NSW. For the purpose of this calculation, we have therefore approximated the share of NSW shareholders on the basis of the share of the Australian population living in NSW (around 32 per cent), multiplied with the proportion of Rio Tinto shareholders estimated to be Australian residents.

In addition, MTW pays company taxes to the Commonwealth Government, some share of which can be deemed to benefit the residents of NSW. However, as for personal income taxes, there is no direct relationship between any company tax paid by MTW to the Commonwealth and the resulting benefits accruing to residents of NSW. The share of company taxes paid by MTW that accrues to NSW has therefore also been determined on the basis of share of population.

Additional taxes accruing directly to NSW

MTW makes the following payments that accrue directly to different levels of government in NSW:

[17] We note that this calculation does not take into account any share value appreciation or depreciation.

- payroll taxes; and
- land taxes/shire rates.

A.2 Labour market assumptions

This annex describes the available empirical information about labour market outcomes that has informed the assumptions made about re-employment and redeployment of MTW workers.

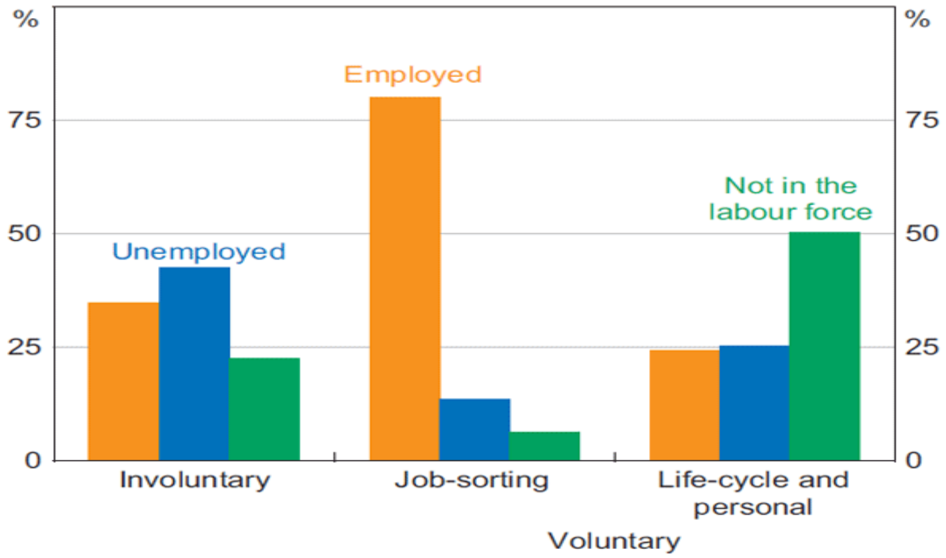
A.2.1 Outcomes following involuntary redundancy

There is only limited information about the eventual labour market outcomes relating to workers who are made redundant at some stage during their working lives.

A recent RBA (2012) analysis indicates that re-employment outcomes differ depending on whether workers separate from their jobs involuntarily (for instance, as a result of being made redundant) or voluntarily (for instance, to look for better employment opportunities). More than 75 per cent of people who leave their jobs voluntarily tend to find new employment in the same year. In contrast, of those employees experiencing an involuntary separation during the year to February 2012 (Figure A-1):

- 35 per cent were re-employed within the year;
- 43 per cent remained unemployed at the end of the year; and
- 23 per cent left the labour force altogether.

Figure A-1. Outcomes following job separations, shares of separations by type, year to February 2012



Source: RBA 2012.

The most recent comparable study of labour market outcomes following a retrenchment was published by the ABS in 2002 (ABS 2002). Of around 600,000 people who had been made redundant in the three years prior to July 2001, and as of July 2001:

- 67 per cent were employed;
- 17 per cent were still unemployed; and
- 16 per cent had left the labour force.

A similar ABS study conducted in July 1997 found that 55 per cent were employed after three years, 29 per cent were unemployed, and 16 per cent had left the labour force.

The Household, Income and Labour Dynamics in Australia (HILDA) survey conducted by the Melbourne Institute of Applied Economic and Social Research additionally provides information on labour market outcomes over time (Melbourne Institute 2013). The HILDA survey suggests:

- The likelihood of remaining unemployed from one year to the next increased to around 35 per cent between 2009 and 2010 for persons aged 25 to 54 years, compared to 34 per cent between 2008 and 2009, and 22 per cent from 2007 to 2008. ABS (2014) statistics additionally indicate that the average period of unemployment is around 38 weeks.
- Also for persons aged 25 to 54 years, the likelihood of moving from 'unemployed' status to 'out of the labour force' status was 21 per cent between 2009 and 2010, 34 per cent between 2008 and 2009, and 30 per cent between 2007 and 2008.

A.2.2 Duration of unemployment

ABS (2014) research suggests that the average duration of unemployment is about 38 weeks.

A.2.3 Labour mobility

Geographical labour mobility of employees is by far the highest for mining sector employees (PC 2013). At the time of the 2011 census, almost 10 per cent of mining sector employees had moved house in the previous year, compared to an average of around 3 per cent for all employed people.

ABS and other sources also suggest that unemployed persons move house relatively more often. A representative sample compiled from the Survey of Income and Housing (SIH) found that in the five years up to 2007-08, 61 per cent of unemployed people moved at least once, compared to 48 per cent of employed people and 33 per cent people not in the labour force who reported a move.

Net outward migration has been a feature of the NSW labour market for some time. The RBA (2012) estimates that the last decade to March 2012, employment growth in New South Wales was negative, of which almost (-)3 per cent was accounted for by interstate migration and (-)1 per cent by overseas migration.[18]

A.2.4 Labour market assumptions

NSW

Re-employment assumptions

In the event that the proposals are not approved, MTW would cease operating in 2021. In that case, MTW employees and long-term contractors would be made redundant and:

- a share of MTW employees and contractors would find alternative employment, either within the Upper Hunter Region or in New South Wales; and
- the remainder of MTW employees and contractors would leave NSW to seek alternative employment or leave the workforce altogether. In either of these cases, the benefit to NSW of additional wage and salary income would be lost.

For the purpose of the CBA and the REIA, the following central modelling assumptions have been applied and tested using a range of sensitivities:

- 30 per cent of employees/contractors who are made redundant in the event that the proposals are not approved are re-employed in NSW in the same year;
- 40 per cent of employees/contractors are re-employed in NSW in the following year; and
- 30 per cent leave the NSW labour force in the same year, either by moving interstate or by leaving the labour force altogether.

Redeployment assumptions

In the event that the proposals are approved, some proportion of any additional employees/contractors can be assumed to move into these positions from existing jobs within NSW, rather than arriving from interstate or being drawn from the unemployment pool. For the purpose of the CBA and the REIA, we have assumed that 70 per cent of any additional MTW employees/contractors would be redeployed from existing jobs in NSW. For these employees/contractors, only the expected additional income from employment at MTW is counted as a net benefit.

Re-employment and redeployment incomes

We have assumed that workers from MTW who are made redundant if the proposals are not approved, and who are re-employed in New South Wales would earn the average wage in the Mid and Upper Hunter region. Adjusted to 2014 prices, average wages & salaries in the region

[18] ABS data indicates net interstate migration from New South Wales of around 11,400 persons between the age of 20 and 64 in 2012.

are around A$58,853, slightly higher than for New South Wales as a whole. The same figure has been applied to estimate the incremental employment benefits for redeployed persons.

Mid and Upper Hunter region and Singleton LGA

Re-employment assumptions

For the purpose of the REIA, the following central modelling assumptions have been applied for the Mid and Upper Hunter region/Singleton LGA:

- 20 per cent of employees/contractors who are made redundant in the event that the proposals are not approved are re-employed in the Mid and Upper Hunter region/in Singleton LGA, respectively, in the same year;
- 30 per cent of employees/contractors are re-employed in the Mid and Upper Hunter region/in Singleton LGA, respectively, in the following year; and
- 50 per cent leave the Mid and Upper Hunter region/the Singleton LGA labour force, respectively, in the same year, either by moving outside the region/Singleton LGA or by leaving the labour force altogether.

Redeployment assumptions

For the purpose of the REIA, we have assumed that 50 per cent of any additional MTW employees/contractors would be redeployed from existing jobs in the Mid and Upper Hunter region/Singleton LGA, respectively. For these employees/contractors, only the expected additional income from employment at MTW is counted as a net benefit.

Re-employment and redeployment incomes

We have assumed that workers from MTW who are made redundant if the proposals are not approved, and who are re-employed in the Mid and Upper Hunter region/Singleton LGA, respectively, would earn the average wage in the Mid and Upper Hunter region. Adjusted to 2014 prices, average wages & salaries in the region are around A$58,853, slightly higher than for New South Wales as a whole. The same figure has been applied to estimate the incremental employment benefits for redeployed persons.

A.3 Net benefits of the MTW Continuation Project for Australia

The CBA described has focused on the benefits of the proposals for NSW. For completeness, we have extended this analysis to the benefits of the proposals for Australia as a whole as shown below.

Table A-1. Incremental (economic) benefits of the proposals for Australia

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Production-related		**Production-related**	
		Compensation of employees/ contractors, net of reemployment benefits	$546
		Personal income taxes	$369
		Medicare payments	$16
		Share of MTW GOS accruing to NSW:	
		Royalties	$617
		Shareholder income	$36
		Company taxes	$362
		Taxes on production and imports:	
		Payroll taxes	$61
		Land taxes/shire rates	$5
Total production related	**$0**	**Total production related**	**$2,012**
Externalities (costs)		**Externalities (offsets)**	
Noise & vibration	$15	Zone of mitigation work, noise attenuation	$15
Visual amenity	$2	Visual amenity upgrades	$2
Noise & air general	$3	Acquisition of properties	$3
Aboriginal heritage	$1	Cultural Heritage Facility	$1
Ecology	$10	Acquisition of offsets	$10
Traffic impacts	$13	Traffic impacts	$0
Groundwater	$0	N/a	$0
Surface water	$0	N/a	$0
European heritage	$0.5	Heritage trust, Great North Road	$0.5
GHG emissions	$1.6	GHG emissions	$0
Total externalities	**$46**	**Total externalities**	**$31**
Grand total	**$46**		**$2,043**
Net economic benefits	**$1,997**		

Notes: NPVs have been derived using a discount rate of 7 per cent.

The damages cost of GHG emissions to Australia have been estimated by multiplying the global cost derived using the SCC (A$131 m) by the share of Australian GDP to world GDP.

Totals may not sum due to rounding.

Appendix B External effects – MTW

The following summarises the key potential environmental impacts identified by EMM and other specialised experts for the MTW Continuation Project.

B.1 Noise & vibration

The operational noise studies considered the potential noise impacts on 220 privately-owned residential locations surrounding the mine over the life of the proposals. The assessment predicted noise emissions based on an equipment fleet with best practice sound suppression on all major plant. MTW is additionally implementing industry-leading innovation for pre-emptive real time noise modelling and is using best practice real time noise monitoring and management techniques.

B.1.1 Impacts

The operational noise at residences study concluded that operational noise will comply with relevant criteria for all the 221 assessment locations during calm weather conditions for each of the day, evening and night periods.

Predictions during prevailing meteorological conditions indicated that operational noise levels from the proposal would result in significant noise level exceedances at three assessment locations. Of these:

- two assessment locations are within the ZOA of a neighbouring mine; and
- one assessment location will be offered acquisition rights by MTW.

It should be noted a further non-residential assessment location, Warkworth Community Hall, is predicted to exceed noise criteria.

Further, the proposals are likely to result in lower noise levels for eastern receivers than current and approved operations due to implementation of plant attenuation.

The assessment predicted that noise impacts are within appropriate criteria for operational blasting (blast vibration and overpressure impacts) and increased traffic volumes on public roads due to traffic detours resulting from the closure of Wallaby Scrub Road.

Predicted noise levels under prevailing weather conditions are below the conservative sleep disturbance criterion at each of the 12 representative assessment locations.

Where low frequency noise is concerned, the review of monitoring data from the 2013 calendar year indicates:

- Of the 11 monitoring locations where noise from Warkworth Mine was observed, measurements exceed the Broner criteria at three non-residential locations to the south-east of Warkworth Mine; however, road traffic noise contributions are likely to contribute to elevated noise level.

- The NSW Industrial Noise Policy's (INP's) assessment criteria was exceeded in three measurement samples. However, in each case, the overall dB(C) value is below the 'Broner' criteria.

Where cumulative noise impacts are concerned:

- The INP's acceptable night time criterion is satisfied at all but two representative assessment locations, predominantly because of operations by Wambo Mine operations. These locations are in the ZOA of neighbouring mines.
- No additional exceedances to the amenity criterion are predicted.

The proposal would not result in any net increase in rail traffic over and above currently approved rail activities servicing the integrated MTW operation.

Appropriate management of blasts would ensure blast noise overpressure and ground vibration limits are satisfied.

The results of noise modelling of two road traffic scenarios predict that day and night criteria would be met for both scenarios. The relative change in noise level is marginal.

B.1.2 Proposed mitigation

MTW noise management plan

The MTW noise management plan details a range of existing acoustic management and monitoring procedures:

- *Real-time noise monitoring*: Directional real-time noise monitoring is used to proactively manage noise emissions from MTW on a continuous basis during night time operations.
- *Supplementary attended noise monitoring*: A programme of targeted supplementary attended noise monitoring is operated at MTW to support the real-time directional monitoring network and ensure the highest level of noise management is maintained.
- *Administrative controls*: Administrative controls implemented at MTW include the Trigger Action Response Process (TARP); heavy mine equipment sound power level screening; shift handover report; and validation surveys of the real-time monitoring network.
- *Substitution controls*: Substitution controls are implemented in response to one or more triggers, and are utilised both proactively and reactively. Substitution measures involve the repositioning or replacement of equipment or reassignment of tasks when conditions require.
- *Engineering measures*: MTW have progressed with the attenuation of its fleet of haul trucks and other mining equipment. All new trucks purchased for use on the site will be commissioned as noise suppressed (or attenuated) units. MTW have also completed works to replace all in-pit reverse alarms with 'quacker' style reverse alarms on its mining fleet. During 2012, engineering works were undertaken to address noise associated with shovel operations. Where additional reasonable and feasible

opportunities for engineering controls are identified in the future, these will continue to be investigated and trialled as appropriate.

- *Elimination controls*: Elimination controls, equipment or task shutdown are implemented in response to one or more triggers.
- *Continuous improvement*: MTW is committed to continuous improvement of the noise management plan and driving industry best practice noise management.
- *Predictive modelling interface*: MTW is developing a predictive modelling interface which allows for proactive planning of mining operations and weather conditions as a leading measure for managing noise emissions.
- *Development and installation of alternate real-time noise monitoring technologies*: Warkworth Mine is investigating alternate noise monitoring technologies to assist with operational control.

Acquisition of properties

One residential location with predicted significant noise level exceedances during prevailing meteorological conditions will be offered acquisition rights by MTW.

B.2 Air quality

The assessment of air impacts considered existing mining areas and the proposed extension area, and incorporated all existing and approved MTW operations. The assessment results represent the potential impacts resulting from the entirety of MTW, including the changes resulting from the proposals. The modelling assessment also includes dust from all nearby existing and proposed mining projects including MTO, Wambo Mine, Hunter Valley Operations, Rix's Creek and Bulga Coal Complex.

B.2.1 Impacts

Table B-1 below describes the projected air quality impacts of the proposals. Air quality monitoring focused on:

- particulate matter, consisting of dust particles of varying size and composition (deposited dust), total suspended particulate matter (TSP), and TSP particles which have a diameter of 10 micrometres (µm) or less (PM_{10}) or 2.5µm or less ($PM_{2.5}$);
- carbon monoxide (CO); and
- nitrogen dioxide (NO_2).

Table B-1. Air quality impacts of the proposals

Predicted impacts	Summary of outcomes (third parties)
Dispersion modelling	Three privately-owned assessment locations may experience concentrations above the relevant criterion for 24-average and annual average PM_{10}. Of these, two are within the ZOA of Wambo Mine, one is not a residential location.

Predicted impacts	Summary of outcomes (third parties)
Maximum 24-hour average PM_{10} contemporaneous assessment (including MTO)	It is unlikely that cumulative impacts would arise at the assessment locations near the Bulga and Wallaby Scrub Road monitoring locations. There is potential for cumulative impacts to arise near the Warkworth, Knodlers Lane and MTIE monitoring stations: - The potential risk of cumulative impacts at the Knodlers Lane and MTIE monitors is deemed relatively low with only two and three additional days, respectively, of predicted impact above the relevant criterion in Year 9 and only one day for Knodlers Lane in Year 14. - The potential risk of cumulative impacts near the Warkworth monitor is greater with one, six and four additional days predicted to exceed the relevant criterion in Years 3, 9 and 14, respectively.
Cumulative $PM_{2.5}$	Background levels of PM2.5 at the Site would be significantly lower than the levels in Singleton, given the concentration of wood heaters, people and cars is considerably less in the near vicinity of the proposal. No assessment location would experience cumulative $PM_{2.5}$ level above the NEPM advisory reporting standards.
Diesel emissions	All assessment locations are predicted to experience maximum 1-hour average and annual average NO_2 concentrations below relevant criteria. Predictions of CO would be well below the air quality goals.
Blast fume emissions	During the middle daytime hours no impacts due to blasting fume emissions are predicted to occur. In the early evening, there is potential for impacts to arise offsite. However, application of blasting restrictions would avert such potential impacts for most assessment locations. MTW are implementing a predictive management system to aid with management of blasting operations. It is anticipated that with implementation of the protocols potential blast impacts would be averted.

The air quality study also considered the health effects associated with exposure to particulates. Finer particles (smaller than 10µm) tend to be of concern in this context. However, and given that the majority of particulate emissions from mining are dust, which originates from the soil, mining techniques used at coal mines generally cannot break down rock, coal or soil material into very fine fractions. As a result emissions from mines are predominantly in the coarse size fraction which would not penetrate as deeply into the lung, or carry additional toxic combustion substances. On average it has been measured that approximately 5 per cent of TSP from mining is in the $PM_{2.5}$ size fraction, and approximately 12 per cent of PM_{10} from mining is in the $PM_{2.5}$ fraction. This contrasts with studies:

- of urban areas, where approximately 50 per cent of the PM_{10} is comprised of particles in the $PM_{2.5}$ size range, and most of these are from combustion; and

- of rural areas, where domestic wood smoke is a key issue of health impact. Recent studies by the CSIRO into the composition of particulate matter in the Hunter Valley found that a key source of fine particulate is wood smoke.

Overall, the assessment results show that:

- Three privately-owned assessment locations, may experience concentrations above the relevant criteria for 24-hour average and annual average PM_{10}. Two of these locations are within a neighbouring mine's ZOA, and one is a non-residential location (Warkworth Hall).
- No impacts are predicted from emissions resulting from the use of diesel powered equipment.
- Impacts from blast fume emissions are expected to be manageable with the operation implementation of MTW's blast management plan.

B.2.2 Proposed mitigation

MTW Air Quality and Greenhouse Gas Management Plan

The management of air quality is integrated across Warkworth Mine and MTO and is undertaken in accordance with the MTW Air Quality and Greenhouse Gas Management Plan (AQMP).

The proposal would apply site-specific best practice measures to manage dust emissions, and would continue to do so over the life of the proposal. A range of improvements have been made at the site in recent years, including:

- mine infrastructure to improve the watering of haul roads, such as six new fill points and four new water carts to replace smaller carts;
- aerial seeding programs to better stabilise mine areas prior to full rehabilitation;
- installation of dust hoods on hoppers into which the trucks unload coal; and
- community response officers on each night shift to assist with operational control.

Acquisition of properties/air quality mitigation measures

Two residential locations which are predicted to experience higher than acceptable concentrations of particulate matter will be offered acquisition rights by MTW.

B.3 Visual amenity

B.3.1 Impacts

The operations of MTW, comprising Warkworth Mine and MTO, form part of the existing landscape.

The visual impact of the proposal would generally be low/moderate for a majority of the primary visual catchment, with more prominent views and greater impacts on residences in elevated locations in and around Bulga village (Table B-2).

Table B-2: Visual amenity impacts

Direction of view	Impacts
North	Limited views from Warkworth village, the Golden Highway, or near- to medium field locations in the rural foothills to Warkworth Mine. Eastern overburden emplacement areas may be visible during the initial period of the proposal. Views would be distant and have a low visual impact in a wider context
North-east	Change in visual effect would be low, given the exposure to existing overburden emplacement areas.
East	Visual effects vary from high at closer assessment locations, such as the Golden Highway and Putty Road, to low for more distant locations. Residences to the east along Putty Road, Golden Highway, and nearby rural roads would have views to the eastern face of the active Warkworth Mine overburden emplacement areas. The sensitivity of these residences is potentially moderate to high.
South	Topography, vegetation and other mining operations generally conceal the current operation and the proposal from the south. Parts of the overburden emplacement areas may be seen where they are raised above existing levels, corresponding to moderate visual effects despite the distance at which they are seen (3 to 5km). The views in this area would generate a high to moderate visual impact for floodplains visual catchment units.
West	The removal of Saddleback Ridge and progression of mining westward would generally be concealed to most viewers to a varying extent by the intervening vegetation and topography. Views from some south-westerly view points along Putty Road, as well as from some parts of Bulga village, would exist; however, the visual effects would be low. The proposed overburden emplacement is largely screened from Wambo Road. Road users from Putty Road to the south of Bulga village and along Inlet Road would have moderate to low sensitivity and visual impacts due to the exposure of overburden emplacements once Saddleback Ridge is removed. Most residential properties to the west would have a high level of sensitivity, with some properties in elevated locations in Bulga potentially experiencing high visual impacts depending on the orientation of the property and intervening vegetation screening.

In summary, potential visual impacts of the proposal would generally be moderate to low, as the impact on visual amenity will be limited and localised. The existing topography and vegetation would continue to provide screening to the mine to varying extents depending on view location and elevation. Some residences west of the Site, such as elevated residences around Bulga village, may potentially experience high visual impacts.

B.3.2 Proposed mitigation

MTW Visual Impact Management Plan

As part of the Warkworth Extension 2010, a MTW Visual Impact Management Plan (VIMP) was developed. The draft VIMP would be revised and adapted to the proposals.

Current onsite mitigation measures include:

- structure design to minimise visual impacts, consistent with engineering principles and practice, and any site constraints;
- direction of lighting away from offsite areas to the greatest degree possible, and the use of sensor lighting where permanent lighting unnecessary; and
- construction of bunds, vegetated and built screens at appropriate locations along the site boundary.

Visual impact mitigation measures would be put in place to mitigate the potential impacts on the overall surrounding landscape including vegetation and bund screening to the boundaries of the Site. Elements of the draft VIMP that apply to the proposal include:

- examination, in detail, of any high sensitivity viewing points and determination of the opportunities for relevant screening treatments including onsite boundary treatments or mitigation measures to individual residences;
- minimisation of the amount of pre-rehabilitation areas exposed to view by establishing grass cover to remove colour contrast; and
- establishment of planting patterns of trees and grasses in rehabilitation areas to create a high level of visual integration with the surrounding landscape.

Site-specific visual assessments

In order to determine mitigation for any viewpoint with high sensitivity, site specific visual assessments (SSVAs) would be undertaken. The VIMP would outline a process to undertake these assessments:

- A landowner in Bulga village affected by visual impacts from the proposal may request a SSVA, which may result in the application of appropriate screening treatments at the affected property or between the property and the source for impacts assessed as high.
- For the small number of individual residences within the primary visual catchment, which may have high visual impacts at some stage of the proposal, suitable mitigation measures would be implemented, subject to agreement with the landowner. This is likely to constitute vegetation screening; however, all mitigation measures would be guided by an SSVA and associated consultation with the affected property owners.

B.4 Aboriginal cultural heritage

B.4.1 Impacts

If the proposals are approved, 110 places containing Aboriginal cultural heritage objects would potentially be impacted. The great majority of these places contain isolated stone artefacts; in addition one site contains grinding grooves and three contain scarred tree. These places are of cultural significance for the Aboriginal people of the Upper Hunter Valley.

The places are concentrated along drainage lines with a particular focus around permanent sources of water. These areas have generally been subjected to a long history of disturbance through a range of land uses.

In general, the majority of the Aboriginal cultural heritage places identified and recorded to date are unlikely to yield significant additional information with regard to patterns of land and resource use either locally or regionally. It is also difficult to date the majority of these cultural heritage places, which limits their scientific value. Therefore, further archaeological research into the scientific values of a majority of the identified Aboriginal cultural heritage places is not considered warranted.

B.4.2 Proposed mitigation measures

Extensive consultation has been undertaken with the Aboriginal community in respect of the proposals.[19] MTW's Aboriginal cultural heritage management consists of a suite of policies, protocols and processes in the areas of community engagement, heritage management and relationships with Aboriginal communities, including:

- implementation of the Cultural Heritage Management System (CHMS);
- ongoing consultation through the Coal & Allied Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG);
- the development of an Archaeology and Cultural Heritage Management Plan (ACHMP) for Warkworth Mine and MTO; and
- preparation and implementation of management plans required under relevant development consents.

[19] These include: extensive consultation processes undertaken as part of the Aboriginal Cultural Heritage Assessment for the Warkworth Extension 2010 (Central Queensland Cultural Heritage Management 2010); consultation undertaken as part of the fulfilment of the conditions of the now disapproved Warkworth Extension 2010; and consultation undertaken recently as part of Modification 6, and subsequent approval of an Aboriginal heritage impact permit for this area by OEH in February 2014. Since 2008 there have been 30 Aboriginal community consultation meetings conducted under the auspices of the CHWG with regard to the Warkworth Extension 2010 and/or the HMP.

A number of management measures are proposed for the places that will be disturbed under the proposal:

- Areas of high scientific and Aboriginal community significance within the MTW mining leases are to be protected in the long term through the establishment of the Wollombi Brook Aboriginal Cultural Heritage Conservation Area (WBACHCA) and the Loders Creek Aboriginal Cultural Heritage Conservation Area (LCACHCA), as agreed with both the Aboriginal community and relevant government agencies (the NSW Office of Environment and Heritage, and NSW Planning and Infrastructure). The WBACHCA will include the Bulga Bora Ground, to the west of the Warkworth Mine fronting Wollombi Brook. The LCACHCA lies within the remaining undeveloped south-eastern portion of MTO. Both these conservation areas will be managed under its own stand-alone and formalised Aboriginal cultural heritage management plan, and will be established for the long-term conservation and management of Aboriginal cultural heritage places and values.
- A suite of management and monitoring strategies developed in consultation with the Aboriginal community will be implemented to protect Aboriginal cultural heritage at MTW. They include an integrated heritage management plan (HMP), developed in consultation with CHWG, extensive and detailed initiatives to manage the impacts on the proposed 2014 disturbance area, and the preparation of a research programme (the Hunter Valley Sand Bodies Research Study).
- In addition, Coal & Allied commits to:
  - only implementing the agreed impact management measures for those places for which development impacts are unavoidable;
  - staging the agreed impact management measures over time;
  - continuing to manage all Aboriginal cultural heritage within the area in accordance with the provisions of the CHMS and ACHMP ;
  - managing areas containing stone artefacts in accordance with the specific provisions for such objects within the ACHMP, and investigating and managing the three areas noted as having the potential to contain archaeological deposits in accordance with the specific provisions for such features within the ACHMP;
  - continuing investigations into the feasibility of moving the grinding grooves;
  - managing other currently unidentified Aboriginal cultural heritage places which may come to light;
  - involving the Aboriginal community in the implementation of all impact management measures; and
  - curating and storing all Aboriginal cultural heritage objects collected in accordance with the Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW.

B.5 Ecology

B.5.1 Impacts

If the proposals are approved, an additional 459 ha of forest and woodland and 151.5 ha of grassland communities would be progressively cleared over the 21 year project life (Table B-3). The Site also includes some areas that were designated as offsets for the 2003 consent.

Two broad types of vegetation occur at the affected site:

- a distinctive type of vegetation reminiscent of coastal vegetation that is referred to as Warkworth Sands Woodland (WSW), an EEC; and
- native vegetation other than WSW ('non-WSW' vegetation).

Table B-3. Vegetation commodities within the MTW disturbance boundary

Vegetation Community	Area (ha)
Forest and Woodland	
Warkworth Sands Woodland (WSW)	72.0
Central Hunter Grey Box - Ironbark Woodland	365.5
Regenerating Central Hunter Grey Box - Ironbark Woodland	6.5
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	15.0
Subtotal Forest and Woodland	459.0
Grassland	
Warkworth Sands Grassland (WSG)	1.0
Central Hunter Grey Box - Ironbark Derived Grassland	151.0
Subtotal Grassland	152.0
Total	**611.0**

Both WSW and non-WSW vegetation provide habitat for threatened fauna and flora, particularly birds and bats. While few old growth trees remain within the site due to extensive clearing in the past, the regenerating vegetation provides habitats for numerous species. In addition to the direct removal of vegetation, there are also potential indirect impacts resulting from the proposals.

B.5.2 Proposed mitigation/offsets

In accordance with the requirements of contemporary government policy, including utilising the Upper Hunter Strategic Assessment (an agreement between the NSW and Commonwealth governments to prepare a Biodiversity Management Plan for the Upper Hunter), Rio Tinto proposes to mitigate the impacts of the loss of native vegetation, EECs and habitats with a biodiversity offset strategy. The strategy would include establishing a number of offsets to satisfy the credit requirements established under the NSW Biodiversity Certification

Assessment Methodology (BCAM). The suitability of the credits supplied within the offsets would be determined using another government-supplied tool called Biobanking Assessment Methodology (BBAM).

Biodiversity certification

Under the biodiversity certification scheme the Minister may confer biodiversity certification on land if the Minister is satisfied that certification will improve or maintain biodiversity values (Department of Environment, Climate Change and Water NSW, 2011). Biodiversity certification may be obtained for land and for native vegetation, and is contingent on the processes prescribed under the BCAM being followed. The BCAM assesses the loss of biodiversity values on land proposed for biodiversity certification and the impact, or likely impact, of proposed conservation measures on land proposed for biodiversity conservation, including conservation measures proposed to be implemented in the future.

Under the BCAM biodiversity offsets are measures that benefit biodiversity by compensating for the adverse impacts elsewhere of actions such as land clearing. These offsets work by protecting and managing biodiversity values in one area in exchange for impacts on biodiversity values in another. The gain in biodiversity achieved by improving a similar area of woodland balances the loss to biodiversity due to the clearing.

The required offset package for the proposals has been estimated using the BCAM and in accordance with the Upper Hunter Strategic Assessment (UHSA), which is preparing a strategic biodiversity offsetting strategy for Upper Hunter mines. BCAM quantifies the projected ecological impacts in terms of 'credits', a measure of habitat quality. Credits may include those for species (species credits) or those for plant communities (ecosystem credits). It is understood that the credit estimates for the offset requirements identified for the proposals will be verified and certified by the Office of Environment and Heritage (OEH) for the UHSA.

Biodiversity offsets

The approach used to determining offsets for the proposals have been designed to consider the two broad types of vegetation that occur at the affected site: WSW and non-WSW vegetation and are assessed in three separate components:

- Component 1: WSW/WSG vegetation impacted by the proposal;
- Component 2: Non-WSW/WSG vegetation impacted by the proposal; and
- Component 3: Non-WSW/WSG vegetation impacted by the 2003 extension.

Component 1: Areas of WSW impacted by the proposal will be offset by conserving the remaining WSW within the Northern and Southern biodiversity areas (NBA and SBA), as well as a suite of supplementary measures. It is understood that Rio Tinto has made a commitment to acquire the required credits, thereby ensuring that the offsets for the remaining vegetation communities will result in a 'maintain or improve' outcome for WSW communities. Most of the credit requirements will be provided through the conservation of WSW in the SBA and NBA, resulting in an increase in the total area of WSW under long term conservation. A range of supplementary measures will be implemented to compensate for the remaining credit requirements, including the re-establishment of WSW from its derived native grassland (Warkworth Sands Grassland) in the SBA and NBA, preparation of an Integrated Restoration Implementation Plan, protection and conservation of Warkworth Sands Grassland to be re-established as part of the current development consent and the development of completion criteria for rehabilitation.

Component 2: To offset the impacts of the proposals on non-WSW vegetation, Rio Tinto has made a commitment to providing acquisition of credits under the UHSA, thereby ensuring that the offsets for the remaining vegetation communities will result in a 'maintain or improve' outcome for these communities.

Component 3: Impacts to non-WSW EECs will be offset in two components: for the 2003 Extension and those for the proposal. Offsets for non-WSW from the 2003 Extension are proposed to be reallocated to the non-WSW portions of the SBA and include mine rehabilitation of woodland communities. In addition to these land-based offsets, approximately 872.5ha of mined land will be rehabilitated. Any residual credits required to offset the impact for the 2003 Extension will be purchased and retired by Rio Tinto.

B.6 Traffic

Two types of traffic impacts have been considered:

- the impacts of additional traffic resulting from the proposals on public roads; and
- the impact of the closure of Wallaby Scrub Road.

B.6.1 Traffic impacts on public roads

The road and intersection traffic surveys for the study were undertaken shortly before the Hunter Expressway opened on 22 March 2014. The expressway may reduce the future regional through traffic usage of routes such as Wallaby Scrub Road and Charlton Road, by providing a faster and safer route for the longer distance traffic travelling between Sydney and some Upper Hunter locations.

Impacts

The following traffic impacts that would result from the proposals were identified (Table B-4).

Table B-4. Public roads traffic impacts

Traffic aspect	Impacts
Proposals-related traffic and transport	There would be no material change to employee traffic and truck traffic over the life of the proposal.
External traffic movements	On most major roads, current MTW daily traffic movements represent 11 to 22 per cent of the total daily traffic movements. On Broke Road and the Golden Highway north of Mount Thorley, MTW represents 3 to 4 per cent of the total daily traffic movements.

Traffic aspect	Impacts
	The effects of heavy vehicle traffic movements represent between 4 and 5 per cent of the total MTW generated daily traffic.
Traffic at intersections	At the Warkworth Mine access/Putty Road and MTO CPP access/ Broke Road intersections there would be no change to the level of service with the future intersection operations. At the Golden Highway/Mitchell Line of Road intersection, level of service and intersection traffic delays would not generally be affected. The degree of saturation for the left turn movements from Mitchell Line of Road would increase from 0.7 to a maximum of 0.781. At the Golden Highway/Broke Road intersection, level of service and intersection traffic delays would not generally be affected.
Impacts of the Wallaby Scrub Road traffic detour	Future traffic proportions travelling from Charlton Road would continue to decline with increasing use of the Hunter Expressway route. Daily traffic increases which would occur on the alternative traffic detour routes following the closure of Wallaby Scrub Road would be small in comparison to the actual capacity of the affected roads. There would be minimal intersection traffic impacts on the alternative traffic detour routes for Wallaby Scrub Road.
Car parking and alternate site access	There are no proposed changes to the MTW car parking areas.
Cumulative impacts	There would be minimal cumulative intersection traffic impacts when the proposal, including the effects of the Wallaby Scrub Road closure, is considered in combination with the Bulga Optimisation Project.
Rail impacts	The daily train movements for coal transport from MTW would be consistent with those loaded previously at MTCL and are not anticipated to increase above historic levels.

In summary, the proposal would result in only minimal traffic impacts on the wider local road network with the primary traffic impacts related to the closure of Wallaby Scrub Road. There would generally be minimal traffic impacts on the traffic detour routes for the Wallaby Scrub Road closure as these roads (and the relevant intersections) have sufficient spare capacity to accommodate this traffic with minimal intersection capacity impacts or delays. Emergency vehicle access to areas west of Wallaby Scrub Road would be maintained by the construction of an appropriate emergency access road/fire trail between Putty Road and the Golden Highway. However, the fire trail route would be slower and less direct than the existing Wallaby Scrub Road route, which would increase emergency response times. The proposal is not expected to cause any rail transport impacts.

Proposed mitigation measures

Measures to manage and monitor potential traffic and transport impacts from the proposals include:

- preparation of a road closure implementation plan for Wallaby Scrub Road, in consultation with emergency services, RMS and Singleton Council, which would include strategies to minimise the potential traffic and road safety impacts of the closure;
- construction of an appropriate emergency access road between Putty Road and the Golden Highway prior to the closure of Wallaby Scrub Road to an appropriate standard, and in consultation with emergency services; and
- review the existing speed advisory and curve warning signs for all the curves on the roads which are likely to be used by detoured traffic (i.e. Putty Road, Broke Road, and Golden Highway) prior to the closure of Wallaby Scrub Road.

B.6.2 Closure of Wallaby Scrub Road

If the proposals are approved, Wallaby Scrub Road would close in 2016. Wallaby Scrub Road is a rural public road managed and maintained by Singleton Council. The road currently serves as a short-cut for people travelling north from Charlton Road/Putty Road or south from the Golden Highway.

Table B-5 shows the origin and destination of vehicles travelling on Wallaby Scrub Road, as well as estimated incremental impacts on travel time and distance as a result of the closure of the road, as estimated by EMM.

Table B-5. Use characteristics of Wallaby Scrub Road and closure impacts on road users

		Closure implications for road users	
Traffic origin/destination	Portion of traffic (through-traffic)*	Increased travel time (minutes per trip)	Distance to travel (km per trip)
To/from east on Putty Road	5%	6	8.8
To/from Bulga/south of Bulga	25%	6	8.8
To/from Charlton Road	71%	4	6.2

Notes: Numbers may not add to 100% due to rounding.
Source: EMM (2014).

Approach to valuing traffic impacts

The impacts of closing Wallaby Scrub Road have been valued using a CBA approach. The approach used here follows that recommended by Austroads (2001, 2012a).[20] Austroads classify the costs and benefits of changed traffic conditions according to three categories:

[20] Austroads is the association of Australian and New Zealand road transport and traffic authorities, including the six Australian state and two territory road transport and traffic authorities.

- *Operator costs*, which refer to road construction and maintenance costs. Closure of Wallaby Scrub Road would eliminate maintenance costs (if any) currently incurred by Singleton Council. We have not attempted to value these avoided costs.
- *Road user costs (RUCs),* which consist of incremental vehicle operating costs (VOCs), the opportunity cost of travel time, the costs of likely accidents, and freight performance impacts. With the exception of freight impacts (which appear to be immaterial), these costs have been considered for the purposes of estimating the closure impacts.
- *Non-user costs*, which refer to incremental noise, air pollution, nature and landscape, climate change and cultural heritage impacts. With the exception of GHG emissions, these non-user costs are subsumed within the broader external effects attributable to the proposals, and have been considered as part of the broader CBA for the proposals.

Valuation assumptions

General assumptions

87 per cent of traffic on Wallaby Scrub Road consists of passenger cars, assumed to be travelling for private purposes. The remainder consists of motorcycle and pedestrian cycles (2 per cent), light goods vehicles (7 per cent), other goods vehicles (1 per cent), and public service goods vehicles (3 per cent). For the purpose of valuing the costs and benefits associated with the closure of Wallaby Scrub Road we have assumed that all traffic consists of passenger cars of a 'large' class (under A$60,000).

The annual average rate of traffic growth is estimated by EMM at approximately 2 per cent.

Incremental vehicle operating costs

VOCs vary by vehicle type and fuel used and are typically computed for specific vehicle 'stereotypes' to represent an appropriate traffic composition (Austroads 2001, 2012a). Incremental VOCs comprising the cost of fuel, tyres, and maintenance for a large car were derived from the most recent NRMA (2013) survey. In 2014 prices, VOCs are estimated at A$0.27/km.

Opportunity cost of incremental travel time

Travel time costs are calculated with respect to vehicle occupants and amalgamated up to a per vehicle level (Austroads 2001, 2012a). For the purpose of this analysis, we have assumed that the travel in question is for private purposes. Table B-6 shows the estimated values of travel time used for the analysis.

Table B-6. Valuation of the opportunity cost of incremental travel time (A$2014)

Type of vehicle	Occupancy rate, non-urban (persons per vehicle)	Time value per occupant ($ per person-hour)	Total time value per vehicle ($ per vehicle hour)
Private car	1.7	$14.66	$24.92

Source: Austroads 2012b, updated to A$2014 values using CPI.

Accident costs

The potential impacts of the Wallaby Scrub Road closure on road safety were assessed by EMM. While detoured traffic will be subject to increased travel distances, generally there will be safer travelling conditions for detoured traffic (and lower accident rates per kilometre travelled) when travelling via the Golden Highway, due to the improved intersection sight distances and higher road construction standards. These improved traffic safety conditions should generally compensate for the greater travel distances travelled by the detoured traffic.

As noted in Section B.6.1, a road closure implementation plan for Wallaby Scrub Road, will be prepared in conjunction with relevant stakeholders in the local community, emergency services, RMS and Singleton Council, which will include strategies to minimise the potential traffic and road safety impacts of the closure. This will include a review of the requirement for speed advisory and additional curve warning signs at all curves on the roads which are likely to be used by detoured traffic (Putty Road, Broke Road and Golden Highway) prior to the detour being implemented.

GHG emissions

For the purposes of valuing GHG emissions arising as a result of longer vehicle travelling distances, the incremental carbon dioxide emissions were estimated. These estimates have been included in the projected emissions arising from the proposals, and valued jointly with these using the SCC (Section B.9).

Estimated net impacts of the closure of Wallaby Scrub Road

Table B-7 summarises the estimated net costs (benefits) of closing Wallaby Scrub Road from 2016 onwards. In NPV terms:

- the opportunity cost associated with the increase in travel times is estimated at A$6.4 million; and
- incremental VOCs are estimated at A$6.3 million.

Table B-7. Net impacts of the closure of Wallaby Scrub Road

Costs/benefits	NPV A$ m (2014)
Incremental travel time cost	$6.4
Incremental VOCs	$6.3
Total	**$12.7**

Notes: Figures may not add up due to rounding. Incremental GHG emissions have been valued jointly with aggregate emissions arising from the proposals (Section B.9).

B.7 Groundwater

B.7.1 Impacts

In summary, the technical study concluded that:

- groundwater within the Wollombi Brook alluvium appears to be relatively unaffected by current mining; and
- the results of the numerical groundwater model indicate risks to groundwater systems are considered to be negligible and manageable subject to the obtainment of the necessary water entitlements.

B.7.2 Mitigation

MTW water management plan

Groundwater at MTW is managed in accordance with the MTW water management plan. Proposed management and monitoring measures that would be implemented under the proposals include:

- monitoring of in-pit mine water seepage to identify seepage rates and water quality;
- trigger level monitoring and reporting, with site-specific investigation into trigger level exceedances; and
- data management and reporting, including the establishment of trigger levels, annual reporting, and storage of all groundwater with suitable QA/QC controls.

Water offsets

MTW operates subject to an existing requirement to acquire groundwater licences under its current development consent. The proposals do not add to the additional groundwater licensing requirements, hence there is no net change from MTW's current obligations with respect to licensing.

Further, it is the responsibility of MTW to ensure that the necessary licences are held with sufficient share component and water allocation to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased.

As required by the AIP, sufficient water licences will be held by MTW to account for any water take during mining. Additional modelling may be undertaken to improve the model in areas where clarification may be required. Should the modelling results alter the predicted take then the licensing requirements will also be adjusted.

B.8 Surface water

B.8.1 Impacts

A significant proportion of mine site water requirements would be sourced from water collected onsite, including rainfall runoff and groundwater inflows to the open cut pits. Possible sources of additional water for the proposal, which would be negotiated on an as-needed basis including water sharing with Hunter Valley Operations, with Bulga Coal Complex, and with Wambo Mine. If required, additional water licences would be sought and purchased by Coal & Allied over the life of the proposals. As all offsite water supplies for the proposal would be obtained from licensed sources, there would be no adverse impact on other licensed users who would still have access to their entitlement.

During active mining operations, MTW would capture runoff from areas that would have previously flowed to Wollombi Brook or the Hunter River. The combined impact of the proposals is a maximum reduction of 0.44 per cent of the Wollombi Brook catchment to the confluence of the Hunter River.

The results of the water balance modelling indicate that no uncontrolled release of saline water would occur over the life of the proposal. Excess saline water is released in accordance with the existing rules of the Hunter River Salinity Trading Scheme (HRSTS). There would be no downstream impacts on surface water quality.

There is a low risk of the proposed MTW water management systems (WMS) accumulating water over the 21 year life of the proposal.

Controlled releases of saline water under the HRSTS are predicted to have the following impacts:

- The impacts of HRSTS discharges on the Hunter River flow characteristics are negligible during both wet periods and dry periods.
- It is not expected that discharges under the proposal would have an additional impact on the stream condition of Doctors Creek, or that controlled discharges would result in adverse hydraulic impacts on the Hunter River, such as increased bed and bank erosion.
- Discharge dam water quality (median) is poorer than the lowest recommended ANZECC trigger value and the Hunter River water quality for chloride, sodium and sulphate. However, it is likely that complete mixing of the discharge water with the river flow would occur within a few hundred metres of the outlet.

The potential interactions between the proposed operations and a 100 year flood event for the Hunter River to the east and Wollombi Brook to the west have been investigated:

- the proposal would not result in any additional flood risk to infrastructure adjacent to the Hunter River; and
- the proposal would not impact on flooding behaviour in Wollombi Brook and would not have any measurable effect on the geomorphology of Wollombi Brook.

In summary, the results of the surface water study indicate that the impacts of the proposal on surface water resources are unlikely to be significantly different to the existing approved operations and would not have a significant impact on surface water quality of the adjacent water features.

B.8.2 Mitigation measures

MTW water management system

The proposed MTW water management system (WMS) has been developed in conjunction with the mine planning and operational teams to develop a surface water management system that has minimal impacts on surface water resources. It consists of:

- a number of new or modified water storages, including saline water storage, and a sediment dam located at Warkworth Mine to capture runoff from future spoil and rehabilitation areas;
- changes in the layout of approved mining operations; and
- the management of groundwater inflows, catchments, and water quality.

The proposed MTW WMS has been designed to minimise the capture of clean runoff wherever possible.

Surface water at MTW is currently managed in accordance with the MTW water management plan. The proposal required the remodelling of the existing operations and the proposal to identify water demand requirements from surface water resources, which would be mitigated through the implementation of the following measures:

- control the flow and storage of water of different qualities across the Site through the proposed MTW WMS;
- a sediment control plan to reduce sediment loads from disturbed area runoff;
- drainage of the final landform; and
- a surface water monitoring programme to continually assess environmental impacts and ensure that the MTW WMS is meeting its objectives of managing impacts on receiving waters.

Water Offsets

It is the responsibility of MTW to ensure that the necessary licences are held with sufficient share component and water allocation to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased.

As required by the AIP, sufficient water licences will be held by MTW to account for any water take during mining. Additional modelling may be undertaken to improve the model in areas where clarification may be required. Should the modelling results alter the predicted take then the licensing requirements will also be adjusted.

B.9 GHG emissions

B.9.1 Impacts

The incremental (Scope 1, 2, fugitive and traffic) emissions over the life of the proposals have been estimated at around 15.9 Mt CO_2-e. This estimate includes estimated increases in greenhouse gas emissions as a result of additional travel time due to the closure of Wallaby Scrub Road. For the purpose of the analysis in this report, various options for valuing the GHG emissions arising from the MTW Continuation Project have been explored. The option used in this report relies on the SCC.

B.9.2 Estimates of global damages

One approach for quantifying the impacts of GHG emissions is to rely on global damage functions, which assess the impact on GDP for a specified rise in global mean temperature (e.g. IPCC 2007, Tol 2009). Global damage estimates of GHG emissions rely on either the 'enumerative' method, whereby the range of physical effects of climate change are modelled, valued, and summed over countries or regions; or the 'statistical' method, whereby the welfare impacts of climate change are directly estimated (on the basis of observed variations), and extrapolated to other countries/regions.

Global damage functions

Part II of the IPCC's Fourth Assessment Report (Climate Change 2007, AR4) presents a range of damage functions (Table B-8). The IPCC's Fifth Assessment Report (AR5, WGII Chapter 25) did not present new estimates of the damage of global warming.

Table B-8. Indicative world impacts of temperature changes, by region (per cent of current GDP)

	IPCC SAR	Mendelsohn et al. (2000)		Nordhaus and Boyer (2000)	Tol (1999)[a]
	2.5°C Warming	1.5°C Warming	2.5°C Warming	2.5°C Warming	1°C Warming
North America					3.4 (1.2)
United States			0.3	-0.5	
OECD Europe					3.7 (2.2)
European Union				-2.8	
OECD Asia Pacific					1.0 (1.1)
Japan			-0.1	-0.5	
Eastern Europe					2.0 (3.8)
Eastern Europe				-0.7	
Russia			11.1	0.7	
Middle East				-2.0[b]	1.1 (2.2)
Latin America					-0.1 (0.6)
Brazil			-1.4		
Asia					-1.7 (1.1)
India			-2.0	-4.9	
China			1.8	-0.2	2.1 (5.0)[c]
Africa				-3.9	-4.1 (2.2)
Developed cntrs.	-1.0 to -1.5	0.12	0.03		
Developing cntrs.	-2.0 to -9.0	0.05	-0.17		
World					
Output weighted	-1.5 to -2.0	0.09	0.1	-1.5	2.3 (1.0)

	IPCC SAR	Mendelsohn et al. (2000)		Nordhaus and Boyer (2000)	Tol (1999)[a]
	2.5°C Warming	1.5°C Warming	2.5°C Warming	2.5°C Warming	1°C Warming
Pop. weighted				-1.9	
World av. prices					-2.7 (0.8)
Equity weighted					0.2 (1.3)

Notes: [a] Figures in parentheses denote standard deviations. [b] High-income countries in Organization of Petroleum Exporting Countries. [c] China, Laos, North Korea, Vietnam. Estimates are incomplete and confidence in individual numbers is very low. There is a considerable range of uncertainty around estimates. Figures are expressed as impacts on a society with today's economic structure, population, laws, etc. Positive numbers denote benefits; negative numbers denote costs. Tol's (1999a) estimated standard deviations are lower bounds to real uncertainty. Mendelsohn et al. (2000) estimates denote impact on a future economy.

Source: Table 19-4. McCarthy, 2001.

The damage estimates shown above are essentially unchanged from those reported in the IPCC's Third Assessment Report (Climate Change 2001, TAR); they suggest that:

- The impacts of future climate change will be mixed across world regions. For increases in global mean temperature of less than 1-3°C above 1990 levels, some impacts are projected to produce benefits in some places and some sectors, and produce costs in other places and other sectors.
- It is very likely that all regions will experience either declines in net benefits or increases in net costs for increases in temperature greater than about 2-3°C. While developing countries are expected to experience larger percentage losses, global mean losses could be 1-5% of GDP for 4°C of warming.

The IPCC's 'Special Report on Regional Impacts of Climate Change estimate' (IPCC 1997) contained cross-sectoral estimates of climate change impact costs. Estimates of the annual impact for Australia and New Zealand combined fell in the range of -1.2 per cent to -3.8 per cent of GDP for an equivalent doubling of CO_2. The report noted that the real uncertainty in these estimates is much greater than the range given, and that important costs may be underestimated, including changes in weeds, pests, and diseases; storm surges; and urban flooding. Damages may also increase nonlinearly with increased global warming. On the other hand, adaptations to climate change are not included in the calculations.

AR5 (WGII Chapter 25) also notes that there are relatively few damage estimates for Australia. AR5 cites economy-wide net costs for Australia of a loss in gross national product (GNP) of 7.6 per cent by 2100 under an unmitigated climate change scenario, and of a loss in GNP of 2 per cent for stabilisation scenarios at 450 or 550 ppm CO_2-e. It is noted that these estimates are highly uncertain and depend strongly on valuation of non-market impacts, the treatment of potentially catastrophic outcomes, and assumptions about adaptation, global changes and flow-on effects for Australia.

GHG impact valuation on the basis of global damages

Calculating the global damages associated with the incremental GHG emissions arising from the proposals requires an assessment of the corresponding increase in global temperatures.

The expected increase in global average temperature associated with the project has been calculated using MAGICC 6 (Meinshausen, Raper and Wigley 2011; www.magicc.org). MAGICC 6 is a software package that takes emissions scenarios for greenhouse gases, reactive gases, and sulfur dioxide as input and gives global-mean temperature, sea level rise, and regional climate as output. MAGICC is a coupled atmospheric-ocean carbon cycle model. It has been used in all IPCC reports to produce projections of future global-mean temperature and sea level change.

The climate scenario selected for this evaluation exercise is RCP6.0. It is one of the four Representative Concentration Pathways (RCPs) adopted by the Intergovernmental Panel for Climate Change (IPCC) for its fifth Assessment Report (AR5). Information about the RCPs and the scenario development process for the IPCC AR5 can be found in the IPCC Expert Meeting Report on New Scenarios.

Table B-9 shows the results from the MAGICC analysis. The modelling results from MAGICC show that the changes in global temperature and radiative forcing between the two scenarios are negligible. The temperature rises by 2035 in both scenarios are 1.4434 degrees, relative to pre-industrial levels. By 2035, the total radiative forcing under the reference scenario is 3.55562 Wm^{-2} while the total radiative forcing under the proposals scenario is 3.55566 Wm^{-2}. The overall implication is that the proposals will have no discernible impact on global mean temperature increase over the period of the project. There are therefore no measurable adverse additional impacts on Australia or on NSW, and the costs associated with an increase in GHG emissions are not significantly different from zero during the life of the proposal if this project is considered in isolation.

Table B-9. Temperature rises and radiative forcing

Relative to pre-industrial levels	Temperature rises ($^{\circ}$ C)		Radiative forcings (Wm^{-2})	
	2025	2035	2025	2035
Reference case	1.22132	1.44338	3.27549	3.55562
Proposals case	1.22132	1.44340	3.27550	3.55566

Source: BAEconomics analysis.

GHG impact valuation on the basis of carbon offsets

The current Australian Government has announced its intention to repeal the Carbon Pricing Mechanism (CPM). Entities operating in Australia who wish to offset their emissions can then purchase carbon credits issued under Australian Government programs, internationally recognized Kyoto Protocol units, or ‘voluntary’ offsets. The following offset options are expected to be available:

- Australian Carbon Credit Units (ACCUs) issued under the Carbon Farming Initiative (CFI);
- international offsets recognised under the Kyoto Protocol, mainly Certified Emissions Reductions (CERs) from Clean Development Mechanism (CDM) projects; or
- voluntary offsets.

Prices of emissions offsets

Around 1.75 million ACCUs were issued in 2012-13, the first compliance year of the CPM. The great majority of these related to landfills and were emissions avoidance projects. These ACCUs typically traded in the range of A$ 22.50 to $22.75/t CO_2-e, just below the fixed carbon price established for the CPM of A$23/t CO_2-e. Little or no new investment in CFI projects occurred in the 18 months prior to December 2013 (Reuters Point Carbon 2013a). It is generally considered that investment in new CFI land-based forestry projects will not be viable without a significant carbon price (CSIRO 2011, Reuters Point Carbon 2013a).

CERs traded at around A$17/t CO_2-e in 2010, but average prices have since fallen considerably to around A$12/t CO_2-e in 2011 and A$3/t CO_2-e in 2012 (Parliament of Australia 2013). CER futures for delivery in June 2014 are trading at around A$0.22/t CO_2-e (Intercontinental Exchange 2014).

Offsets in voluntary market traded at a weighted average price of around A$5.9/t CO_2-e in 2012 and at A$6.2/t CO_2-e in 2011 (Forest Trends' Ecosystem Marketplace & Bloomberg New Energy Finance 2013). Table B-10 shows average prices and volumes transacted for the range of international voluntary offsets traded since the inception of various schemes and in 2012. The Australian Government currently only recognises offsets issued under two voluntary standards – the Gold Standard and the Verified Carbon Standard (VCS), which accounted for the majority of transactions. As of June 2013, prices for Gold Standard offsets ranged from around A$12 to A$15/t CO_2-e, while prices for VCS offsets ranged from A$1 to A$8/t CO_2-e (Bloomberg 2013).

Table B-10. Average prices and volumes for voluntary offsets

Standards/registries	Time period	Average price (A$)	Transactions (Mt CO_2-e)
American Carbon Registry	All years	4.4	12.3
	2012	7.4	0.5
CarbonFix Standards	All years	13.9	0.5
	2012	17.5	0.04
Chicago Climate Exchange	All years	1	21
	2012	0.12	8
The Gold Standard	All years	11.4	36
	2012	9.3	9
Verified Carbon Standard (VCS)	All years	5	155
	2012	5.2	34
VER+	All years	5.7	3.5
	2012	18.1	0.02

Notes: The timeframe covered by 'all years' differs by type of standard. For instance, the American Carbon Registry was created in 1995, whereas the Gold Standard exists since 2003.

Source: Forest Trends' Ecosystem Marketplace & Bloomberg New Energy Finance 2013.

Application to MTW emissions

There is only a limited range of credible options for acquiring offsets to mitigate the additional emissions expected from the MTW Continuation Project:

- The Department of Climate Change and Energy Efficiency (DCCEE) estimates that for a carbon price starting at A$20/t CO_2-e in 2013 and increasing to A$30 t CO_2-e in 2020, the scope for additional offsets under the CFI is low. In 2011, DCCEE estimated that abatement from Kyoto compliant activities could range from less than 5 Mt CO_2-e to less than 15 Mt CO_2-e in 2020, while abatement from non-compliant activities would range from less than 2 Mt CO_2-e to less than 7 Mt CO_2-e in 2020 (DCCEE 2011). DCCEE note that these estimates are highly uncertain
- CERs issued under the CDM have come under criticism for the quality of many of the corresponding projects, including because of concerns about the 'additionality' of claimed emissions abatement (Reuters Point Carbon 2013b). A combination of excess supply and limited demand has led to a collapse in CER prices that may not be reversed in the near future.
- Companies who are not required to do so by law are instead turning to voluntary offset markets, where prices are higher than those for CERs, but which are backed by a credible certifying organisation, such as the Gold Standard or VCS (Bloomberg 2013).

In our judgement, the most credible and reliable option at this point in time relates to the price of voluntary offsets issued either under the VCS or the Gold Standard, which are recognised by the Australian Government. The most recent published prices for these offsets ranged from A$1 to A$15/ t CO_2-e. Taking the mid-point of A$7.5/t CO_2-e as a central estimate yields an overall estimate for the value of the additional GHG emissions attributable to the proposals of $46.4million, of which the share attributable to NSW would be A$0.1 million.

B.9.3 GHG impact valuation on the basis of the social cost of carbon

A final option for valuing the GHG emissions associated with the proposals, which forms the basis for the estimate presented in this report, is on the basis of the 'social cost of carbon' (SCC). We have relied on estimates of the SCC as determined by the US Interagency Working Group on Social Cost of Carbon (2013). The SCC is an estimate of the monetised damages associated with an incremental increase in carbon emissions in a given year. It includes changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change. These estimates were derived for the purposes of incorporating the social benefits and costs of CO_2 emissions into cost-benefit analyses. Table B-11 below summarises these estimates.

Table B-11. Social cost of CO2, 2010 to 2050 (US$ 2007 per metric tonne of CO_2)

Year \ Discount rate	5 per cent	3 per cent	2.5 per cent
2010	11	33	52
2015	12	38	58

Year \ Discount rate	5 per cent	3 per cent	2.5 per cent
2020	12	43	65
2025	14	48	70
2030	16	52	76
2035	19	57	81
2040	21	62	87
2045	24	66	92
2050	27	71	98

Source: Interagency Working Group on Social Cost of Carbon (2013)

The SCC estimates in Table B-11 are expressed in constant 2007 US dollars, and are estimated for emissions at different points in time; at five year intervals starting in 2010 and ending in 2050. The flow of future social costs was discounted back to each point in time at three discount rates, namely 2.5, 3.0 and 5.0 per cent. Costs in the intervening years were calculated by linear interpolation. The discount rate for social cost benefit analysis specified by the NSW government is 7 per cent. To achieve consistency between the GHG valuation and the NSW CBA, it is necessary to impute these costs at a 7 per cent discount rate. This can only be achieved through approximation, as the technical paper does not provide the flows of future damages. In order to impute the SCC at a 7 per cent discount rate, the approximating function was calibrated from the average costs across each time period at each discount rate. The functional form was chosen to fit the general pattern of the relationship between discount rates and costs:

$$Cost_i = \alpha_o + \alpha_1 \frac{1}{r_i} + \alpha_2 \frac{1}{r_i^2} \quad \#$$

Where $Cost_i$ is the average cost and r_i is the discount rate. The calibration is an exact solution to three linear equations.

The equation was used to calculate a base cost at a 7 per cent discount rate. This was in turn expressed as a proportion of the average cost at a 5 per cent discount rate. This proportion was applied to costs at 5 per cent discount rate in each of the base years to obtain the imputed SCC. Costs in the intervening years were calculated by interpolation. Costs were converted from US$ 2007 to US$ 2014 using the US GDP deflator. Table B-12 summarises the results. Using the estimates below and converting these into A$ yields a total GHG emissions damage estimate of A$131 million. This global damage estimate has been multiplied with the ratio of NSW GSP to world GDP, estimated at 0.36 per cent by, first, deriving the share of Australian to world GDP at purchasing power parity (PPP) converted prices of 1.2 per cent (Heston et al. 2012), and second, adjusting for the share of NSW GSP to Australian GDP (around 30 per cent, ABS 5206.0. This calculation gives an estimate of the damages that are attributable to NSW of around A$0.5 million.

Table B-12. Imputation of 3 per cent discount rate SCC estimates to 7 per cent discount rate SCC estimates

	Imputed 7 % Discount Rate	
Year	US$ 2007	US$ 2014
2010	4.69	4.89
2011	4.70	4.91
2012	4.72	4.93
2013	4.76	4.97
2014	4.79	5.01
2015	4.84	5.05
2016	4.89	5.11
2017	4.96	5.18
2018	5.03	5.25
2019	5.11	5.34
2020	5.20	5.43
2021	5.31	5.55
2022	5.43	5.67
2023	5.57	5.82
2024	5.72	5.98
2025	5.89	6.15
2026	6.06	6.33
2027	6.24	6.52
2028	6.43	6.71
2029	6.62	6.92
2030	6.82	7.12
2031	7.02	7.33
2032	7.22	7.54
2033	7.42	7.75
2034	7.63	7.97
2035	7.84	8.18

B.9.4 MTW mitigation measures

Current GHG management practices to minimise the overall generation of CO2-e emissions would continue under the proposal. The MTW, through the operator's larger climate change program has objectives in four key areas delivered through ongoing integration into existing business processes:

- supporting research and promotion of technologies that reduce carbon dioxide emission from the use of coal;
- improved use of energy at operations, projects and supply chain;

- designing future projects with energy efficiency and climate change risks considered; and
- raising awareness amongst stakeholders.

Specific management measures that would continue to be employed at MTW include:

- monitoring and monthly reporting of bulk consumption of diesel with the onsite fuel management system monitoring the quantity of fuel dispensed from tanks and service trucks through metering;
- vehicles and plant equipment fitted with identification tags to assist in tracking diesel consumption;
- regular maintenance of diesel equipment operational efficiency;
- monitoring and monthly reporting of total electricity consumption with significant infrastructure and equipment such as the CPPs, draglines and electric rope shovels fitted with various meters to monitor electricity consumption;
- development and implementation of energy efficiency performance metrics for fuel and electricity consumption which are tracked monthly against internal targets; and
- waste management for energy efficiency through measures such as planning when purchasing items to avoid or minimise waste with preference given to products that are recyclable and reusable over ones that are not; consideration of minimum of packaging or packaging which is reusable or recyclable; and segregating waste to facilitate maximum reuse or recycling.

Research program funding is also provided by Rio Tinto Australia for the COAL21 Fund, the Australian Coal Association Research Programme, and the Cooperative Research Centre for Greenhouse Gas Technologies to support and develop the research of low emissions coal technologies.

B.10 Historical heritage

B.10.1 Impacts

An assessment of the heritage impacts of the proposals found:

- no registered heritage item or places within the proposed 2014 disturbance area;
- two non-registered state significant features (former RAAF base Bulga Complex and Great North Rd) and two non-registered local significant features (P1 Huts #1 and #2);
- one registered heritage item or place on the boundary of the study area - the Brick Farm House (listed as a local item under Singleton LEP 2013); and
- seven registered heritage items and places within a 7.5km radius from the centre of the proposed 2014 disturbance area.

In summary, while small portions of the Former RAAF Base Bulga Complex and Great North Road Complex would be impacted by the proposal, heritage impacts are likely to be minor. The study found that impacts on the P1 Huts are likely to be moderate. Within the study area, but outside of the proposed 2014 disturbance area, there are no state significant heritage features and one local significant feature; the Brick Farm House that would not be directly impacted by the proposal. The study found that subject to the implementation of the mitigation measures, potential heritage impacts within the study area are likely to be low.

B.10.2 Offsets and management

CMPs have been prepared for a portion of the Great North Road Complex, former RAAF Base Bulga Complex and the Brick Farm House.

Recommendations within these plans would be implemented to ensure the heritage values of these places are maintained and conserved. Coal & Allied would also prepare a CMP for Springwood Homestead.

The following additional management measures would be undertaken:

- a Chance Finds Procedure would be implemented to assist in the process for identifying and reporting unexpected finds;
- the establishment of the Mount Thorley Warkworth Historic Heritage Conservation Fund, in order to provide resources for local historical research and heritage conservation projects proposed by the local community; and
- the establishment of the Great North Road Conservation Fund, in order to provide resources for heritage conservation works on significant surviving elements of the convict built Great North Road located within Singleton LGA (and potentially other areas including the Great North Road World Heritage Area).

Appendix C External effects – MTO

C.1 Noise & vibration

C.1.1 Impacts

The results for operational noise studies indicate that:

- For all Bulga locations, predicted noise levels would satisfy or be within 1-2 dB(A) of PSNLs during prevailing meteorology.
- At all other locations, operational noise levels would result in a marginal or moderate exceedance of the PSNLs at a number of locations during prevailing conditions. One location has been predicted to have a significant noise level exceedance. However, this residential location is already within the ZOA for MTO.

Predicted noise levels under prevailing weather conditions are below the conservative sleep disturbance criterion at each of the 11 representative assessment locations.

Where low frequency noise is concerned, measured noise levels at eight locations indicate that there were no instances when relevant assessment criteria were exceeded.

The proposal would not result in any net increase in rail traffic over and above currently approved rail activities servicing the integrated MTW operation.

In summary, overall, operational noise at eastern assessment locations is expected to remain relatively unchanged from existing and approved activities. No significant exceedances are predicted for assessment locations in Bulga. Further, the proposal is likely to result in lower noise levels for eastern receivers than current and approved operations due to implementation of plant attenuation.

C.1.2 Proposed mitigation

Noise impacts would be managed under MTW's noise management plan, which incorporates a range of acoustic management and monitoring procedures, as described in Section B.1.2.

C.2 Air quality

C.2.1 Impacts

The assessment results represent the potential impacts resulting from MTO, including the changes resulting from the proposal. The modelling assessment also includes dust from all nearby existing and proposed mining projects including Warkworth Mine, Wambo Mine, Hunter Valley Operations, Rix's Creek and Bulga Coal Complex.

In summary, the study undertaken for the proposal predicted dust emissions at a number of assessment locations in the vicinity of MTO using air dispersion modelling:

- Fifteen mine-owned assessment locations may experience concentrations above the criterion for annual average PM_{10}. A subset of these assessment locations may also experience concentrations above the relevant criteria for 24-hour average PM_{10}, annual average TSP, and annual average dust deposition.
- Three privately-owned assessment locations may experience cumulative concentrations above the criterion for annual average PM_{10}. Two are currently within Wambo Mine's ZOA, and one is not a residential location (Warkworth Hall). MTO is a minor contributor to dust for these three assessment locations with contributions predicted to be approximately 1 µg/m3. No residential locations are predicted to exceed criteria due to MTO in isolation.
- No impacts are predicted from emissions resulting from the use of diesel powered equipment.
- Impacts from blast fume emissions are expected to be manageable with the operation of MTW's blast management plan.

C.2.2 Proposed mitigation

MTW Air Quality and Greenhouse Gas Management Plan

The management of air quality is integrated across Warkworth Mine and MTO and would be undertaken in accordance with the MTW Air Quality and Greenhouse Gas Management Plan (AQMP), as described in Section B.2.2.

Acquisition of properties/air quality mitigation measures

One residential location that would be significantly affected will be offered acquisition rights by MTW.

C.3 Visual amenity

No properties are predicted to be significantly affected by MTO.

C.4 Aboriginal cultural heritage

C.4.1 Impacts

The proposal would not result in any disturbance beyond currently approved limits. Therefore, the proposal would not explicitly impact on Aboriginal cultural heritage. Irrespective of this, additional studies and extensive consultation has been undertaken with the Aboriginal community in respect of the proposals.[21]

103 places containing Aboriginal cultural heritage objects have been identified and recorded to the west of the MTO operations. Of these, 55 have previously been destroyed under consents granted under the NP&W Act. The 48 extant places primarily consist of stone artefacts.

The area within the proposed MTO development consent boundary has been extensively mined and, in places, substantially rehabilitated. With the exception of one partially destroyed potential archaeological deposit, the remaining extant Aboriginal cultural heritage places are predominantly across the south-eastern corner of the Site. The extant Aboriginal cultural heritage places identified within the Site would not be disturbed if the proposal is accepted.

C.4.2 Mitigation measures

While the proposal would not result in any disturbance beyond currently approved limits and would not explicitly impact on Aboriginal cultural heritage, Aboriginal cultural heritage impact management measures have been developed for the collective management of Aboriginal cultural heritage for MTO. These include:

- the finalisation of the MTW integrated heritage management plan (HMP);
- management of Aboriginal cultural heritage within the site;
- management of Aboriginal cultural heritage within the Loders Creek cultural heritage conservation area (ACHCA); and
- management of Aboriginal cultural heritage at other Coal & Allied owned lands, including extant places within the development consent area.

Coal & Allied will complete the systematic and comprehensive reassessment of the south eastern corner of the Site, which commenced in mid-2013. All extant Aboriginal cultural heritage would continue to be managed consistent with the provisions of the current ACHMP.

In addition, the Loders Creek Aboriginal cultural heritage conservation area (ACHCA) is proposed to be conserved irrespective of the absence of any predicted impacts of the proposal. The Loders Creek ACHCA would be protected permanently from future mining, exploration drilling and associated disturbances. It would be managed in accordance with a

[21] These include: extensive consultation processes undertaken as part of the Aboriginal Cultural Heritage Assessment for the Warkworth Extension 2010 (Central Queensland Cultural Heritage Management 2010); consultation undertaken as part of the fulfilment of the conditions of the now disapproved Warkworth Extension 2010; consultation undertaken recently as part of Modification 6, and subsequent approval of an Aboriginal heritage impact permit for this area by OEH in February 2014; consultation specific to the proposal undertaken at CHWG meetings held on 3 April and 7 May 2014. Since 2008 there have been 30 Aboriginal community consultation meetings conducted under the auspices of the CHWG with regard to the Warkworth Extension 2010 and/or the HMP.

specific management plan developed in consultation with the CWHG and other stakeholders.

C.5 Ecology

C.5.1 Impacts

The vegetation and habitats of the Site have been cleared progressively in accordance with the development consent and Coal & Allied's vegetation clearing protocols. The proposal would not result in additional vegetation clearance and is expected to have negligible impact on the ecology of the Site and the local area (Table C-1). The proposal is expected to improve the biodiversity values of the regional area, as rehabilitation is further developed and implemented across the Site.

Table C-1. Potential ecological impacts and mitigation

Project component	Potential direct impact	Potential indirect impact	Mitigation/ management measures to be implemented	Residual impact potential
Mining	Inadvertent harm to mobile fauna that could move into the Site on occasion e.g. kangaroos	Dust from mining/ truck movements affecting vegetation /fauna in surrounding areas	Coal & Allied protocols – dust suppression, noise and air quality monitoring, fauna management	Very low
Overburden placement	Runoff from overburden entering vegetation in remnant areas to the north, west and south of MTO	Changes in vegetation community composition/ habitats	Monitoring of overburden and a buffer area for remnant vegetation and implementation of MTW WMS	Very low
Bulga Coal Complex interactions	No additional impacts expected	No additional impacts expected	N/a	None
Tailings management	No additional impacts expected	No additional impacts expected	Ground- and surface water monitoring and management	None
Upgrades to water management (Loders Creek)	Potential erosion/ sedimentation increase in receiving waters	Changes to habitat quality for aquatic species	Ground- and surface water monitoring and management	None
MTO CPP upgrade	No additional impacts expected	No additional impacts expected	Coal & Allied protocols for environmental management for new construction	None

C.5.2 Proposed mitigation

To minimise impacts on the local environment, rehabilitation would be undertaken progressively across the mined area:

- 483ha of mined land would be rehabilitated to locally occurring ecological communities, including some areas of EEC; and
- 97ha would be rehabilitated to trees over grass, providing additional stepping stone habitat for mobile species.

Specific performance indicators would be developed and measured to track the progress of rehabilitation with performance monitoring reported annually. The final landform would be developed with recognition of pre-mining landform and incorporating existing rehabilitation areas consistent with adjacent vegetation communities. The proposals include:

- the use of locally occurring species for rehabilitation;
- implementation of a seed collection programme to ensure species abundance and diversity;
- provision of a regional habitat corridor, providing for the movement of flora and fauna species over a large area at the conclusion of mining;
- fauna habitat enhancement;
- The development of performance indicators and ongoing monitoring.

C.6 Traffic

C.6.1 Impacts

Impacts relating to proposal related traffic and transport, traffic impacts on road networks, traffic impact at intersections, cumulative impacts, car parking and alternate site access, and rail impacts are assessed as the same as the impacts identified for MTW (Section B.6.1). Employee traffic generated by Warkworth Mine and MTO on external public roads would not change under the proposal. Truck traffic generated would generally remain at similar levels under the proposal. Further, the proposal would not result in an increase in annual train movements.

C.6.2 Mitigation

Measures to manage and monitor potential traffic and transport impacts are the same as those identified for MTW (Section B.6.1).

C.7 Groundwater

C.7.1 Impacts

The following impacts were identified:

- *Alluvium*: The maximum water take under the proposal from the Wollombi Brook alluvium is estimated at 194 ML/year. Maximum take from the Hunter River alluvium is undetectable.
- *Groundwater users*: The modelling predicted no drawdown in any privately-owned water supply bores within alluvium or the porous and fractured rock aquifers in the Permian aquifer.
- *Groundwater dependent ecosystems*: The Hunter Valley Oak Forest community would not be affected by the proposal. No significant change is expected in the water table for the Wollombi Brook alluvium or Hunter River alluvium.
- *Pit inflows*: Modelling results indicate inflows from the Permian are initially 389 ML/year in 2015. After the Loders Pit is backfilled and mining ceases, the seepage from the Permian gradually reduces until the voids in the spoil fill with water.
- *Post mining recovery*: The mounded groundwater or ponded open water in the backfilled depression in Loders Pit was calculated to have a median salinity of 3,000µS/cm. The outflow of this water to the Wollombi Brook alluvium is not considered a salinity risk.
- *Water quality post mining*: The predicted reduction in base flow of more saline groundwater to Wollombi Brook means there is limited potential for surface water salinity to increase in the Wollombi Brook during the life of the proposal. The landform that would remain post mining would not degrade the beneficial use of the alluvial groundwater post mining. The impact of mining on the salinity of the base flow in the Wollombi Brook would be practically undetectable.

In summary, the modelling of groundwater impacts indicates that the groundwater system appears relatively unaffected by current mining, and contains brackish to saline groundwater. The proposed backfilling of the Loders Pit reduces the long term take of groundwater from the alluvium, and offers a net environmental benefit reducing water take from the groundwater systems post mining (relative to the current development consent).

C.7.2 Mitigation

MTW water management plan

As described in Section B.7.2, groundwater at MTW is managed in accordance with the MTW water management plan. The same management and monitoring measures would be implemented for MTO as described for MTW.

Water offsets

MTO operates subject to an existing requirement to acquire groundwater licences under its current development consent. As there is no change to the current 1995 approved mining footprint, the existing water take remains as approved.

C.8 Surface water

C.8.1 Impacts

Identified surface water impacts are the same for MTO as for MTW (Section B.8.1). The proposed MTW WMS has been developed in conjunction with the mine planning and operational teams to minimise impacts on surface water resources. The proposed MTW WMS is a continuation of the current MTW WMS, and the results of the surface water study indicate that the impacts of the proposal on surface water resources are unlikely to be significantly different to the existing approved operations and would not have a significant impact on surface water quality of the adjacent water features. The capture of runoff from undisturbed natural catchment draining to any of MTW's water management dams and mining areas may require a water access licence.

C.8.2 Mitigation measures

The proposed MTW water management system (WMS) has been developed in conjunction with the mine planning and operational teams to develop a surface water management system that has minimal impacts on surface water resources, as described in Section B.8.1.

C.9 GHG emissions

The incremental (Scope 1, 2, fugitive and traffic) emissions over the life of MTO's operations have been estimated at 232,704 Mt CO_2-e in 2019. MTO is projected to account for 232,704 t C02 in 2019. The damages cost of GHG emissions to NSW have been estimated by multiplying the global cost (A$1.5 m) by the share of NSW GSP to world GDP.

Appendix D Regional impact analysis

D.1 Derivation of multipliers

This annex describes the methods used to calculate the flow- on effects of changes in the level of mining investment and production in NSW and the Mid and Upper Hunter region.

A number of practical difficulties arise in estimating regional or state-wide input-output multipliers for the purpose of conducting a regional impact analysis. Regardless of the approach that is adopted, regional impact analysis depends on national account statistics that, in Australia, are derived for the economy as a whole. The difficulty that then arises in assessing regional economic impacts is the inability to accurately account for the flow of goods and resources within and between regions.

In the past, apportioning national input-output multipliers to a regional or state level required assumptions that could not be verified. However, the collection of regional employment statistics in the 2011 census now provides a consistent and transparent method of deriving regional economic impacts at a reasonably granular level. The approach we have adopted here therefore makes use of 2011 census figures at an LGA level and the most recent national accounts figures compiled by the ABS for 2009-10, as set out below.

D.1.1 Concordance of the national accounts with census employment data

The Australian National Accounts input-output tables set out the flows of industry inputs (columns) and outputs (rows) for 114 industry classifications. The ABS census records employment an aggregated level with 19 industry classifications. The concordance between the census and the accounts is set out in Table D-1.

Table D-1. Industry concordance between the industries in the National Accounts and industry level employment data in the 2011 census

2011 ABS census	ABS National Accounts industry codes	
Aggregate Industry	**Starting From**	**Ending With**
Agriculture, forestry and fishing	101	501
Mining	601	1001
Manufacturing	1101	2502
Electricity, gas, water and waste services	2601	2901
Construction	3001	3201
Wholesale trade	3301	3301
Retail trade	3901	3901
Accommodation and food services	4401	4501
Transport, postal and warehousing	4601	5201
Information media and telecommunications	5401	6001
Financial and insurance services	6201	6401

Rental, hiring and real estate services	6601	6702
Professional, scientific and technical Services	6901	7001
Administrative and support services	7210	7310
Public administration and safety	7501	7701
Education and training	8010	8210
Health care and social assistance	8401	8601
Arts and recreation services	8901	9201
Other services	9401	9502

Source: 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2009-10. 2011 ABS census.

To construct the flows of industry inputs and outputs at the same level of the census, the rows and columns are summed. For example, there are seven industries classified as being part of the broader agriculture classification. Summing the seven rows aggregates the outputs of agriculture as a whole into each of the 114 industries. Summing the resulting new rows across the seven individual agricultural industries give the total input requirements for agriculture as a whole from each the 114 regions. The final result is a balanced flow table with 19 industry classifications.

The balancing items include rows and columns that are important for the regional impact analysis:

- there are rows for wages and salaries, imports and value added, respectively; and
- there are columns for household consumption, as well as for other final demands.

D.1.2 Requirements matrix and first round (Type IA) output multipliers

The initial requirement for an extra dollar's worth of output of a given industry is called the initial output effect. It equals one in total for all industries, since an additional dollar's worth of output from any industry will require the initial one dollar's worth of output from that industry plus any induced extra output. The first round effect is the amount of output required from all industries of the economy to produce the initial output effect.

First round effects can be measured by deriving the 'direct requirements matrix'. In this matrix, the coefficients in a given industry's column show the amount of extra output required from each industry to produce an extra dollar's worth of output from that industry. The requirements matrix has been constructed from the Australian input-output (flows) table by standardising the inputs into each industry to produce one unit of output in each industry. This is achieved by dividing each row of the table by the total output on an industry-by-industry basis.

The first round impact multiplier is then the sum of the standardised inputs for a given industry. For example, each element of the column for agriculture is divided by total agricultural output and then summed to obtain the total input requirement for one addition unit of output. The initial multiplier can be interpreted as the direct costs of an additional unit of production at current prices. Given these inputs are supplied domestically, the costs are other industry outputs and therefore contribute to total economic output. The sum of the initial output effect (which equals one) and the first round effect is the Type IA output multiplier. This is simply the total first round contribution of a project to the economy. For a project that is small when compared to the size of the industry, the first round and Type IA impact multipliers are valid given the requirements are representative of those used in the project.

D.1.3 Simple output or Type IB multiplier

The simple Type IB multiplier takes into account the inputs required for the increased agricultural output (for example) that must also be produced, which requires the expansion of these industries and those that support them. These may be seen as series of flow-on effects that continue until the overall industry flows are again balanced.

Calculation of the simple multipliers requires solving a matrix equation. Let A be the 19 by 19 matrix of industry requirements (as discussed above), x a vector of inputs used in each of the industries and y a vector of net outputs from the economy. Net output can be standardised to 1 for each industry, giving rise to the simple linear input-output equation:

$$Ax - x = 1$$

Solving for the overall input requirement to one additional unit of output from each industry:

$$x = (I - A)^{-1}$$

where I is an identity matrix with ones along the main diagonal and zeros elsewhere, and the superscript -1 denotes the matrix inverse. Summing the columns of $(1 - A)^{-1}$ gives the simple multipliers. For example summing the agricultural column gives the total inputs from all industries needed to sustain the production of one additional unit of net agricultural output at the national level.

The simple multiplier represents a shift in the composition of industry output, as well as the total level of industry output assuming constant prices. This may be reasonably valid for a small increase in, for example agricultural, output. However, for large change like what has occurred in the Australian mining industry, output prices for most industries will adjust in an offsetting manner. That is, the relative prices for the outputs that are used more extensively in mining will rise, while prices for those that are less extensively use will fall. The implication is that the simple multiplier will, for a given increase in mining output, overstate the flow-on effects in industries where relative prices rise and understate flow-on effects where relative prices fall.

For a project that is small relative to the size of industry the price effects will be small and the bias in the simple multiplier may be ignored. However, the composition of flow effects will vary if the input requirements for the project differ from those of the industry. A comparison can lead to useful caveats regarding the simply multiplier effects on other industries.

D.1.4 The total or Type IIA output multiplier

The total multiplier takes into account the relationship between wages and household demand, that is, the increase (decline) in household demand that results from a rise (fall) in household income. This is derived by adding the wages row and the household expenditure column to the A matrix from the requirements table. Let the expanded matrix be denoted B. The total multipliers are analogous to the simple multiplier and given by the column sums of the matrix $(I-B)^{-1}$.

The key issue with the total multiplier is that wage rates and output price changes will tend to offset the effect. In a limiting case, an increase in wage rates will result in an increase in output prices and leave total output and real household expenditure unchanged. However, if the project is small relative to the size of the economy the effects on household income and wages can be ignored.

D.1.5 Employment, income and value added multipliers

First round, simple and total employment, income and value add multipliers can be calculated in much the same way as the output multipliers. The caveat noted for wage rates and employment in the previous section applies.

Employment multipliers

To calculate employment multipliers requires information about employment by industry that is provided in the ABS National Accounts (Table 20). For each industry, the FTE level of employment is divided by total industry output. This creates a vector of employment requirements per unit of output (denoted h) that can be used to convert the physical input requirements per additional unit of industry output into requirements for labour. The sum of these labour requirements constitute the employment multipliers, written in matrix notation as:

- Type IA: hA;
- Type IB: $h(I-A)^{-1}$; and
- Type IIA: $h(I-B)^{-1}$.

These multipliers give the FTEs of employment needed to support an additional unit of output. These multipliers can be adjusted to Type IA, Type IIA multipliers by expressing the multiplier as the total employment needed per person directly employed on the project. This is done by dividing each of the multipliers above by the number of workers required per unit of output. They are not the number of jobs created as this will be impacted by the number of part-time work that are converted to full-time workers or vice versa.

Income multipliers

The calculation of the income multiplier is done in the same way. The wage and salary requirement per unit are given in the requirements table. Designating these as a vector w the income multipliers written in matrix notation are:

- Type IA: wA;

- Type IB: $w(I-A)^{-1}$; and
- Type IIA: $w(I-B)^{-1}$.

These multipliers can be adjusted to Type IA, Type IIA multipliers by expressing the multiplier as the total income per dollar of salaries and wages expended directly on the project. This done by dividing each of the multipliers above by the salaries and wages required per unit of output.

Value added multipliers

Value added is the value of industry output less the costs of inputs, whether produced domestically or imported (the contribution to regional GDP). This can again be calculated, as a vector, v, from the requirements table as value added per unit of industry output. The multipliers are then calculated in an identical way to employment and income:

- Type IA: vA;
- Type IB: $v(I-A)^{-1}$; and
- Type IIA: $v(I-B)^{-1}$.

These multipliers can be adjusted to Type1A, Type 2a multipliers by expressing the multiplier as the total income per dollar of value added by the project. This done by dividing each of the multipliers above by the valued added per unit of output.

D.1.6 Regional impacts

It is not possible to maintain the level of consistency that exists in national input output tables at a regional level. Comprehensive data on industry composition, household consumption and the flow of goods and services to and from regions is not available.

A standard approach that can be reproduced across different regional definitions in a consistent manner is to use employment by industry data to form what are known as location quotients (LQs). LQs are used to translate economy-wide input-output relationships into regional relationships. For instance, while coal mining only accounts for a small share of employment at a national level, employment in coal mining in the Mid and Upper Hunter region is very significant. Hence national input-output tables need to be adjusted to better reflect the characteristics of the local economy.

Locational Quotients

A raw LQ is simply the percentage of FTE employment in a given industry and region, divided by the percentage of FTE employment in a given industry at the national level. This may be written for the i^{th} industry and the j^{th} region as:

$$LQ_{i,j} = \frac{\dfrac{\text{employment}_{i,j}}{\sum_i \text{employment}_{i,j}}}{\dfrac{\sum_j \text{employment}_{i,j}}{\sum_i \sum_j \text{employment}_{i,j}}}$$

The LQ has a natural interpretation for an industry within a region:

- if the LQ is less than one, the goods and services from that industry will tend to be imported into the region to meet demand; while
- if the LQ is greater than one, the goods and services from that industry will tend to be exported into the region to meet demand elsewhere.

Given that goods and services and labour requirements are the same in all regions, the relationship will tend to be proportional so long as the actual size of the labour force does not represent a constraint. These are standard assumptions in an input output analysis. However, at the regional level, the violation of these assumptions can often be more apparent. For example, specialised good or services demanded for a project may simply not be produced domestically and may have to imported, with a consequent reduction in regional flow-on effects. However, this can be addressed within the context of the requirements table if project information on where purchases are made is available.

Total employment may not be a constraint for a large region, such as a state. However, while a large proportion of people may be employed in an industry in a small region, the overall workforce in that industry may not be sufficient to meet labour requirements. While this may in part be offset by migration, it can simply be more efficient to import goods and services into the region.

It is recommended practice (Bess and Ambargis 2011) to adjust the raw LQs in small regions by the following formula:

$$LQ_{i,j} = \begin{cases} LQ_{i,j} & \text{if } \; LQ_{i,j} < 1 \\ 1 & \text{if } \; LQ_{i,j} >= 1 \end{cases}$$

LQs consist of the ratio of an industry’s share of regional earnings to the industry’s share of national earnings. This adjustment has the effect of holding constant or reducing regional flow-on effects. The basic idea is that industries in the region are not likely to produce all of the intermediate inputs required to produce the change in final demand. In these cases, local industries must purchase intermediate goods and services from producers outside the region, thereby creating leakages from the local economy.

Regional Multipliers

Give LQ is a vector of location quotients, the regionally adjusted Type IA and Type IB input multipliers are calculated by multiplying the industry requirements by the quotients. The output multipliers are the column sums of:

- Type IA: $LQ \times A$;
- Type IB: $(I - LQ \times A)^{-1}$; and
- Type IIA: $(I - LQ \times B)^{-1}$.

Where $\times$ denotes element-by-element multiplication of each column of A by LQ.

The income, employment and value add multipliers are calculated in the same manner as the national multipliers.

D.1.7 Adjusted Mining Industry Expenditures

The LQ adjusts for locally sourced intermediate inputs. Therefore the expenditure column of the input-output matrix, which includes wages, gross operating surplus, taxes and imports needs to be rebalanced to sum to total industry output. The balancing item is imports. The Australian and the adjusted State and regional mine expenditure are shown in Table D-2.

Table D-2. Australian, NSW, Mid and Upper Hunter region, and Singleton LQ adjusted mine expenditures

Expenditure	Australia	NSW	Mid and Upper Hunter region	Singleton LGA
Agriculture, forestry and fishing	0.1%	0.1%	0.1%	0.1%
Mining	11.7%	11.7%	11.7%	11.7%
Manufacturing	4.5%	3.9%	4.5%	3.2%
Electricity, gas, water and waste services	1.6%	1.3%	1.6%	1.6%
Construction	4.7%	3.5%	3.7%	3.0%
Wholesale trade	1.2%	1.3%	0.9%	0.9%
Retail trade	0.3%	0.4%	0.3%	0.3%
Accommodation and food services	0.2%	0.3%	0.2%	0.2%
Transport, postal and warehousing	2.7%	2.5%	2.0%	1.6%
Information media and telecommunications	0.2%	0.2%	0.1%	0.0%
Financial and insurance services	2.8%	3.8%	1.2%	0.9%
Rental, hiring and real estate services	1.5%	1.5%	1.4%	1.5%
Professional, scientific and technical Services	4.0%	4.2%	2.2%	1.9%
Administrative and support services	0.5%	0.5%	0.5%	0.5%
Public administration and safety	0.3%	0.3%	0.2%	0.2%
Education and training	0.1%	0.1%	0.1%	0.0%
Health care and social assistance	0.0%	0.0%	0.0%	0.0%
Arts and recreation services	0.0%	0.0%	0.0%	0.0%
Other services	1.0%	1.0%	1.0%	1.0%
Total Domestic Inputs	37.4%	36.5%	31.6%	28.7%

Expenditure	Australia	NSW	Mid and Upper Hunter region	Singleton LGA
Total Inputs	41.4%	41.4%	41.4%	41.4%
Wages and Salaries	11.6%	9.8%	9.8%	11.6%
Gross Operating Surplus	46.4%	46.4%	46.4%	46.4%
Taxes	0.6%	0.6%	0.6%	0.6%
Imports	4.0%	4.9%	9.8%	12.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

D.2 Estimates of multipliers

The multipliers reported in the following were derived from national level multipliers in accord with guidelines provided by the ABS (n.d.). State and regional multipliers were derived using employment LQs to translate economy-wide input-output relationships into regional relationships. Table D-3 shows national multipliers derived from the 2010 National Accounts tables for:

- gross output (production);
- income;
- employment (FTE equivalent); and
- value added (contribution to GDP).

Table D-3. National input-output multipliers

Multiplier	Type IA: Direct + Type IA effects	Type IB: Direct + Type IA + industry support effects	Type IIA: Direct + Type IA + industry support + consumption induced effects
Output	1.36	1.69	2.62
Income	1.63	2.23	4.37
Employment	1,93	3.90	6.11
Value Added	1.30	1.54	2.05

Source: ABS 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2009-10, Table 9.

Table D-4 shows these multipliers for NSW.

Table D-4. NSW input-output multipliers

Multiplier	NSW		
	Type IA	Type IB	Type IIA
Output	1.31	1.56	2.46
Income	1.63	2.23	3.54
Employment	1.91	3.81	6.05
Value Add	1.30	1.55	2.05

Source: ABS 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2009-10, Table 9; 2011 ABS Census.

Table D-5 shows these multipliers for the Mid and Upper Hunter region.

Table D-5. Mid and Upper Hunter region input-output multipliers

Multiplier	Mid and Upper Hunter region		
	Type IA	Type IB	Type IIA
Output	1.32	1.51	1.92
Income	1.49	2.09	2.63
Employment	1.67	3.07	4.33
Value Add	1.23	1.34	1.62

Source: ABS 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2009-10, Table 9; 2011 ABS Census.

Table D-6 shows these multipliers for Singleton LGA.

Table D-6. Singleton LGA input-output multipliers

Multiplier	Singleton LGA		
	Type IA	Type IB	Type IIA
Output	1.28	1.42	2.02
Income	1.67	3.07	4.33
Employment	1.46	1.68	2.37
Value Add	1.28	1.42	2.02

Source: ABS 5209.0.55.001 - Australian National Accounts: Input-Output Tables, 2009-10, Table 9; 2011 ABS Census.

Appendix E CBA and REIA – MTO

The following describes the approach and the results of the CBA and REIA, respectively, for MTO. While MTO would continue to operate as part of an integrated mining complex consisting of the Warkworth Mine and MTO, the analysis described in the following identifies the net benefits and flow-on effects that can be attributed to MTO.

E.1 Attribution of costs and revenues

If the applications are successful, mining would continue at MTO until 2018. After this time, and until the projected closure of the combined operation, mining would only take place at Warkworth Mine. From 2018 onwards, MTO would receive overburden from Warkworth Mine to assist in rehabilitation and development of the final landform. In addition, the following activities would take place at MTO:

- the operation of the integrated MTW water management system (WMS);
- the operation of the integrated MTW tailings management system;
- the operation of the MTO CHPP facility; and
- the ongoing coal transfer from Warkworth Mine for transport to the Port of Newcastle.

Given the closely integrated nature of the Warkworth Mine and MTO operations, and in order to estimate the revenues and costs that would accrue to MTO separately, a conceptual 'tolling' arrangement has been introduced. Under this tolling arrangements, MTO is deemed to charge Warkworth Mine a toll for processing coal originating from Warkworth Mine, as well as for accepting mine waste from Warkworth Mine. These (notional) processing payments are treated as revenues accruing to MTO, and as costs falling on Warkworth Mine. MTO is also assumed to retain a small labour force to operate its processing plant after mining at MTO has been completed. Tax and other payments to the NSW and Commonwealth governments have been adjusted accordingly. However, the bulk of taxation payments, in particular royalty payments, remain with Warkworth Mine, given that, from 2019 onwards, all coal will originate from Warkworth Mine.

Additionally, the cost of mitigating external effects that can be attributed to the continued operation of MTO have been incorporated in the costing. These costs relate to noise impacts, as well as the costs of obtaining additional water licences (Appendix C). All other assumptions are identical to those used in the CBA and REIA for the combined (Warkworth Mine and MTO) operations.

Table E-1 below summarises the approach that has been taken for the purpose of attributing these costs.

Table E-1. Approach to MTO revenue and cost attribution

Item		Modelling approach
Revenues from coal mining		Allocated to MTO on the basis of ROM coal
Tolling revenues		
	Coal processing tolling revenues	Coal processing tolling charge derived as: - CHPP Complex processing labour costs, - plus CHPP non-labour costs (services, consumables, raw materials, energy costs, other opex) based on detailed CHPP cost modelling, and - assuming that MTO earns a 30 per cent margin on processing operating costs
	Coal dumping tolling revenues	Coal dumping tolling charge estimated as: - estimated Warkworth Mine waste transferred to MTO (as per mine plan), - charged at a variable dumping charge of \$0.2/bcm (real \$2014).
Operating costs	Administration/overhead, wages & salaries, payments to contractors, services, consumables, raw materials, energy costs, other operating costs	Allocated to MTO on the basis of ROM coal produced by Warkworth Mine/MTO after adjusting for coal processed by MTO
Council taxes/shire rates		Allocated on the basis of JV ownership shares
External effects (MTO)		
	Air/noise	Acquisition of one residential property
	Noise and vibration	Noise attenuation specific to MTO equipment

E.2 Results of the CBA (Warkworth Mine)

This section summarises the results of the CBA for Warkworth Mine. The ongoing operation of Warkworth Mine has been evaluated with reference to its impact on NSW GSP. The results shown in the following have been obtained by differencing the net benefits obtained for MTO from those of MTW.

E.2.1 Gross operating surplus accruing to Warkworth Mine

One of the components of NSW GSP is the share of MTO's GOS that can be attributed to NSW. As set out in Section 3, GOS is calculated as output valued at producer prices, net of intermediate consumption (operating expenditure), net of employee compensation, and net of taxes on production (ABS 2013). Table E-2 summarises the GOS attributed to Warkworth Mine.

Table E-2. Gross operating surplus attributed to Warkworth Mine

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Operating expenditure	$3,667	Value of mining output	$6,892
Wages & salaries	$1,346		
Other taxes less subsidies on production	$58		
Total	**$5,071**		**$6,892**
Gross operating surplus	**$1,821**		

Notes: NPVs have been derived using a discount rate of 7 per cent.
Totals may not sum precisely due to rounding.

E.2.2 Net impacts of MTO on NSW GSP

The net economic benefit from the ongoing operation of MTO for NSW is estimated at A$1,343 million in NPV terms (Table 3-9). The key components of these benefits are the additional wages and salaries paid by MTO to NSW employees, as well as royalty payments (for the limited number of years when MTO is projected to produce coal).

The valuation approach applied here is the same as that used for the combined operation of Warkworth Mine/MTO:

- external effects have generally been valued on the basis of the financial payments made by Rio Tinto or on the basis of offsets;
- only incremental disposable income accruing to MTO employees and long-term contractors who reside in NSW represents a net benefit to NSW, as well as the share of income taxes and Medicare contributions that would accrue to NSW; and
- additionally, incremental wage and salary benefits accruing to NSW have been reduced to avoid overestimating the employment benefits to NSW.

E.3 Results of the CBA (MTO)

This section summarises the results of the CBA for MTO. The ongoing operation of MTO has been evaluated with reference to its impact on NSW GSP.

E.3.1 Gross operating surplus accruing to MTO

One of the components of NSW GSP is the share of MTO's GOS that can be attributed to NSW. As set out in Section 3, GOS is calculated as output valued at producer prices, net of intermediate consumption (operating expenditure), net of employee compensation, and net of taxes on production (ABS 2013). Table E-3 summarises the GOS attributed to MTO. Table E-3 indicates that the incremental GOS attributable to MTO is around A$332 million in NPV terms.

Table E-3. Gross operating surplus attributed to MTO

Costs	NPV (A$ m real 2014)	Benefits	NPV (A$ m real 2014)
Operating expenditure	$393	Value of mining output	$635
Wages & salaries	$148	Revenues from tolling, coal processing	$248
Other taxes less subsidies on production	$8		
Total	**$549**		**$883**
Gross operating surplus	**$334**		

Notes: NPVs have been derived using a discount rate of 7 per cent.
Totals may not sum precisely due to rounding.

E.3.2 Net impacts of MTO on NSW GSP

The net economic benefit from the ongoing operation of MTO for NSW is estimated at A$151 million in NPV terms (Table 3-11). The key components of these benefits are the additional wages and salaries paid by MTO to NSW employees, as well as royalty payments (for the limited number of years when MTO is projected to produce coal). The valuation approach applied here is the same as that used for the combined operation of Warkworth Mine/MTO.

References

Australian Bureau of Statistics 2014, 62220DO007_201307 Job Search Experience, Australia, July 2013, 5 February.

_____, 2013, Australian System of National Accounts, Concepts, Sources and Methods, Catalogue No. 5216.0.

_____, 2013, 3101.0 - Australian Demographic Statistics, June 2013; released on 17/12/2013.

_____, n.d., Information Paper, Australian National Accounts, Introduction to Input-Output Multipliers, Catalogue No. 5246.0.

_____, 2010, 3412.0 - Migration, Australia, 2008-09, 29 July.

_____, 2002, Retrenchment and Redundancy July 2011, 6266.0, 2 August 2002.

Australian Journal of Mining, 2014, Feast turns to famine for mining graduates, January/February.

Australian Mining, 2013, Apprentices feel mining slowdown in the Hunter, 10 September.

Austroads, 2012a, *Guide to Project Evaluation Part 2: Project Evaluation Methodology*, AGPE02-12.

_____, 2012b, *Guide to Project Evaluation Part 4: Project Evaluation Data*, AGPE04/12.

_____, 2001, *Austroads Project Evaluation Compendium*, AP–R191/01.

Bess, Rebecca, and Zoë O. Ambargis, 2011, Input-Output Models for Impact Analysis: Suggestions for Practitioners Using RIMS II Multipliers; in: 50th Southern Regional Science Association Conference, New Orleans, Louisiana.

Bloomberg, 2013, Carbon Offset Projects Look for Exit As UN Prices Crash 98%, June 13; at: http://www.bloomberg.com/news/2013-06-12/carbon-offset-projects-look-for-exit-as-un-prices-crash-98-.html; accessed on 14 March 2014.

Carbon Market Institute (2013), The State of the Australian Carbon Market.

Commonwealth of Australia 2006, Handbook of Cost-Benefit Analysis, January.

Council of Australian Governments n.d., Intergovernmental Agreement On Federal Financial Relations, Schedule D.

Coughlin, Cletus, and Thomas B. Mandelbaum 1991, A consumer's guide to regional economic multipliers, Federal Reserve Bank of St. Louis Review, January/February, 73(1).

CSIRO, 2011, updated 2013, Climate Change: Science and Solutions for Australia, 20 September.

Department of Climate Change and Energy Efficiency 2011, Carbon Farming Initiative, Preliminary estimates of abatement, Discussion Paper, April.

Department of Environment, Climate Change and Water NSW 2011, Biodiversity Certification Assessment Methodology, February.

Department of Environment 2013, Climate change impacts in NSW; http://www.climatechange.gov.au/climate-change/climate-science/climate-change-impacts/new-south-wales; accessed on 5 April 2014.

Department of Transport and Infrastructure 2011, Light vehicle CO2 emissions standards for Australia, Key Issues, Discussion Paper.

Department of Treasury and Finance, Victoria 2013, Economic Evaluation for Business Cases, Technical guidelines, August.

Gunasekera, Don, Yeon Kim, Catherine Tulloh, and Melanie Ford, 2007, 'Climate change-impacts on Australian agriculture', *Agricultural Commodities* 14, no. 4.

Alan Heston, Robert Summers and Bettina Aten, 2012. Penn World Table Version 7.1, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, November.

Hunter Valley Research Foundation 2013, 2013 Hunter Valley Socio-Economic Baseline Study for Rio Tinto Coal Australia.

_____ 2013a, Mid and Upper Hunter region Economic Indicators, June Quarter 2013.

_____ 2013b, Hunter Region Economic Indicators, December Quarter 2013.

_____ 2014, Adapting to the 'new normal', 20 March.

Interagency Working Group on Social Cost of Carbon, United States Government 2013, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, May.

Intercontinental Exchange 2014, at: https://www.theice.com/emissions.jhtml; accessed on 14 March 2014.

IPCC, 1997, The Regional Impacts of Climate Change: An Assessment of Vulnerability, R.T.Watson, M.C.Zinyowera, R.H.Moss (Eds.), Cambridge University Press.

Lequiller, François, and Blades Derek 2007, Understanding national accounts. OECD Publishing.

McCarthy, James J., ed. 2001, *Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Meinshausen, M., Raper, S.C.B. and Wigley, T.M.L., 2011, 'Emulating coupled atmospheric-ocean and carbon cycle models with a simpler model, MAGICC 6 – Part 1: Model description and calibration', *Atmospheric Chemistry and Physics*, 11, 1417-56.

Melbourne Institute of Applied Economic and Social Research 2013, Families, Incomes and Jobs, Volume 8: A Statistical Report on Waves 1 to 10 of the Household, Income and Labour Dynamics in Australia Survey.

National Transport Commission 2013, Carbon Dioxide Emissions from New Australian Vehicles 2012, Information Paper, March.

National Water Commission 2014, http://www.nwc.gov.au/publications/topic/water-industry/australian-water-markets-report-2012-13/4.4-new-south-wales#s3; accessed on 19 May 2014.

NRMA Motoring + Services 2013, Private Whole of Life Fixed Vehicle Operating Costs, July.

NSW Government 2013, Report on State Finances, 2012-13, October.

_____2012, Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals, November.

NSW Treasury 2007, NSW Government Guidelines for Economic Appraisal, July.

Parliament of Australia 2013, Emissions trading schemes around the world, 6 June.

Pearce, D., G. Atkinson and S. Mourato 2006, Cost-benefit Analysis and the Environment: Recent Developments, OECD.

PlanningNSW 2002, Guideline for economic effects and evaluation in EIA, November.

Productivity Commission 2013, Geographic Labour Mobility, Draft Research Report.

Reserve Bank of Australia 2012, Labour Market Turnover and Mobility, Bulletin – December Quarter.

Rio Tinto 2013, Mount Thorley Warkworth, 2012 Annual Review, 28 March.

Saunders, A., 2014. Take-or-pay means miners use and loose. Australian Financial Review, 17 May.

Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A.Suarez and F. Yamin 2007, Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK.

Singleton Council 2013. General Purpose Financial Statements for the year ended 30 June 2013, October.

Tol, Richard S.J. 2009, 'The economic effects of climate change', *The Journal of Economic Perspectives*.

Yohe, G.W., R.D. Lasco, Q.K. Ahmad, N.W. Arnell, S.J. Cohen, C. Hope, A.C. Janetos and R.T. Perez 2007, Perspectives on climate change and sustainability. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the*

Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 811-841.

Appendix F

Noise and vibration study

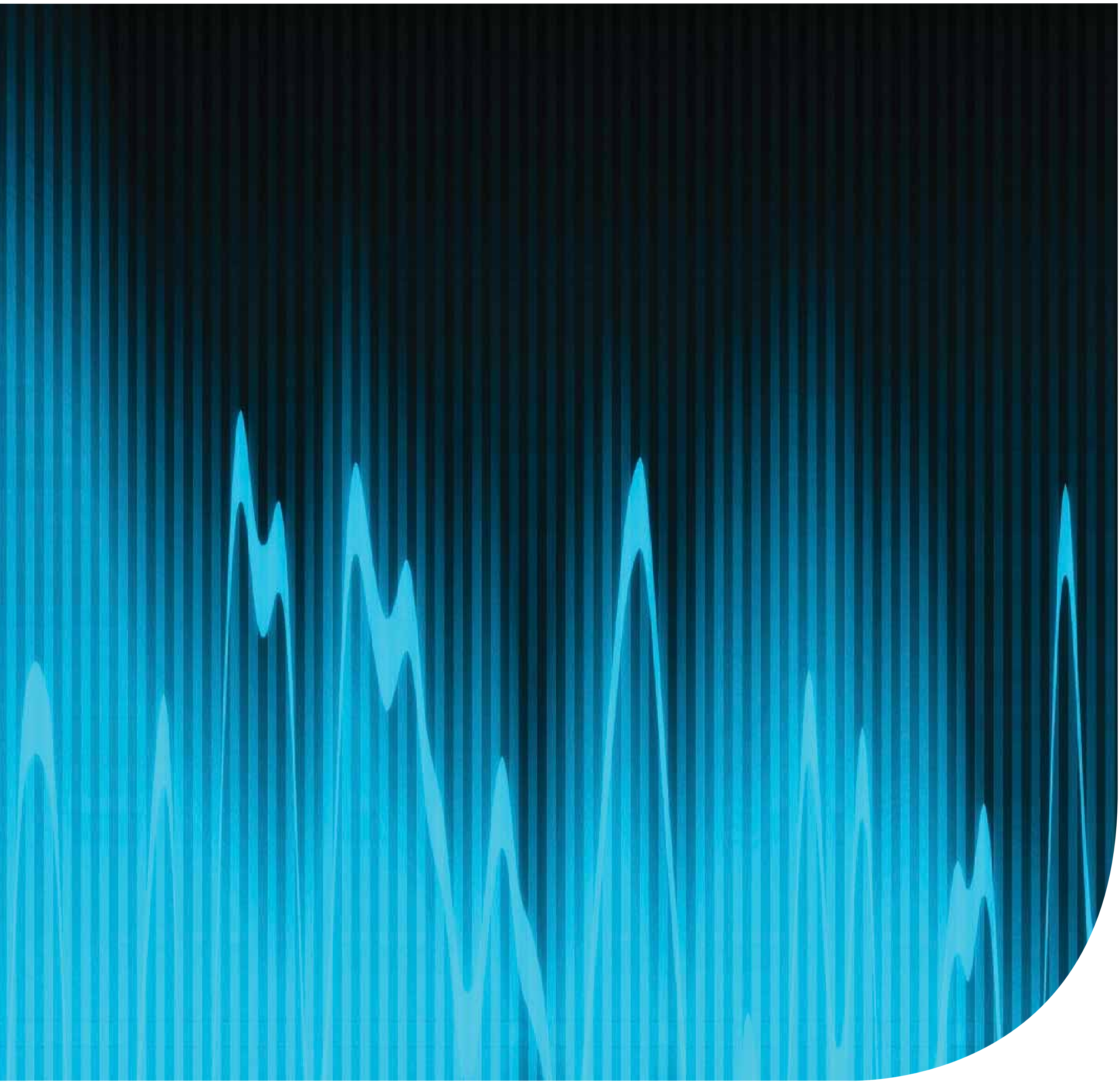
Appendix F — Noise and vibration study

F

Warkworth Continuation 2014

Noise and vibration study

Prepared for Warkworth Mining Limited | 12 June 2014



Planning + Environment + Acoustics

Warkworth Continuation 2014

Noise and vibration study

Prepared for Warkworth Mining Limited | 12 June 2014

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Warkworth Continuation 2014

Final

Report J14013RP1 | Prepared for Warkworth Mining Limited | 12 June 2014

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1 Introduction

1.1 Background

Warkworth Mine is an open cut coal mine approximately 8 kilometres (km) south-west of Singleton in the Hunter Valley, NSW. The mine is operated by Coal & Allied on behalf of Warkworth Mining Limited (WML). The Site currently operates under Development Consent No. DA 300-9-2002-i (the development consent) issued by the then Minister for Planning in May 2003 under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The Site also operates under two separate Commonwealth approvals (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)): EPBC 2002/629 and EPBC 2009/5081.

Warkworth Mine has been in operation since 1981 and the originally approved operation has been modified several times. Immediately to the south of Warkworth Mine is Mount Thorley Operations (MTO). Since 2004, the two mines have integrated at an operational level and are known as Mount Thorley Warkworth (MTW), with a single management team responsible for all the operations. Equipment, personnel, water, rejects and coal preparation are all shared between the mines. The operations involve an existing workforce of approximately 1,300 persons, which includes full-time personnel and a small number of short-term contractors. Ownership of the two mines remains separate.

Warkworth Mine currently operates three integrated open cut mining areas, namely North, West and South pits with West and North pits being the focus of production. Run-of-mine (ROM) coal from Warkworth Mine is transported to either the Warkworth or Mount Thorley coal preparation plant (CPP) for processing. Product coal from the CPPs is transported via conveyor to either the Mount Thorley Coal Loader (MTCL) or to the Redbank Power Station. Coal loaded onto trains at the MTCL is transported to the Port of Newcastle for export.

The Warkworth Continuation 2014 (the proposal) seeks an approval under Part 4, Division 4.1 of the EP&A Act to extend mining beyond the current approved limits.

This assessment forms part of the Environmental Impact Statement (EIS) prepared by EMGA Mitchell McLennan Pty Ltd (EMM) for the proposal.

This noise and vibration assessment has been prepared with reference to the NSW Department of Planning and Environment's (DP&E) State Significant Development - Secretary's requirements Warkworth Continuation Project (SSD 6464) and in general accordance with the NSW EPA's *Industrial Noise Policy* (*INP*), published in January 2000.

As part of the development of the mine plan for the proposal an order of magnitude style noise impact work package was undertaken by WML with a comprehensive series of noise modelling scenarios developed and assessed by EMM. The purpose of this work was to inform the mine planning process with regards to potential noise impacts including noise management techniques to minimise impacts, a key risk as noted in the proposal risk assessment.

1.2 Project description

Warkworth Mine has approval to operate until 19 May 2021 under its development consent. The proposal seeks a 21 year development consent period from the date of any approval. If approval is granted in late 2014, operations at Warkworth Mine are forecast to continue to 2035, a 14 year extension over the current approval. The proposal seeks a continuation of all aspects of Warkworth Mine as it presently operates together with:

- an extension of the approved mining footprint by approximately 698.5 ha to the west of current operations;
- the ability to transfer overburden to MTO to complete final landform;
- the closure of Wallaby Scrub Road;
- an option to develop an underpass beneath Putty Road for the second bridge crossing instead of the approved but yet to be constructed bridge crossing;
- minor changes to the design of the northern out-of-pit (NOOP) dam;
- exploration activities (ie drilling within the exploration lease and offset areas);
- the continued use of secondary access gates to the mine site and offsets for activities such as drilling, offset management, equipment shutdown pad access amongst other things;
- the maintenance of all access tracks with minor pruning and clearing in the offsets; and
- the sharing and selling of sand, gravel and other items excavated that would otherwise be waste.

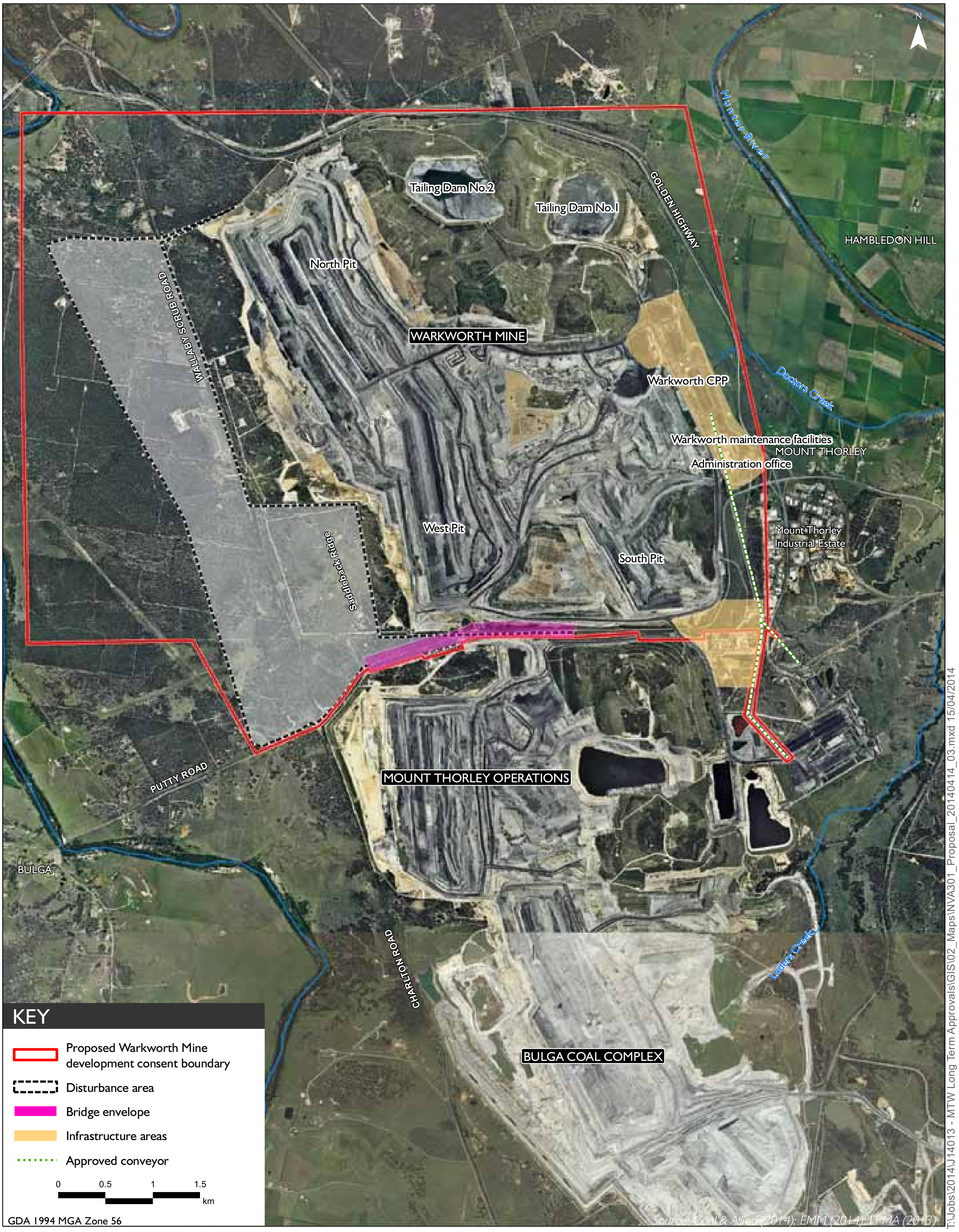
The proposal is shown in Figure 1.1.

1.3 Common noise levels

Table 1.1 gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels encountered on a daily basis are provided in Figure 1.2.

Table 1.1 Perceived change in noise

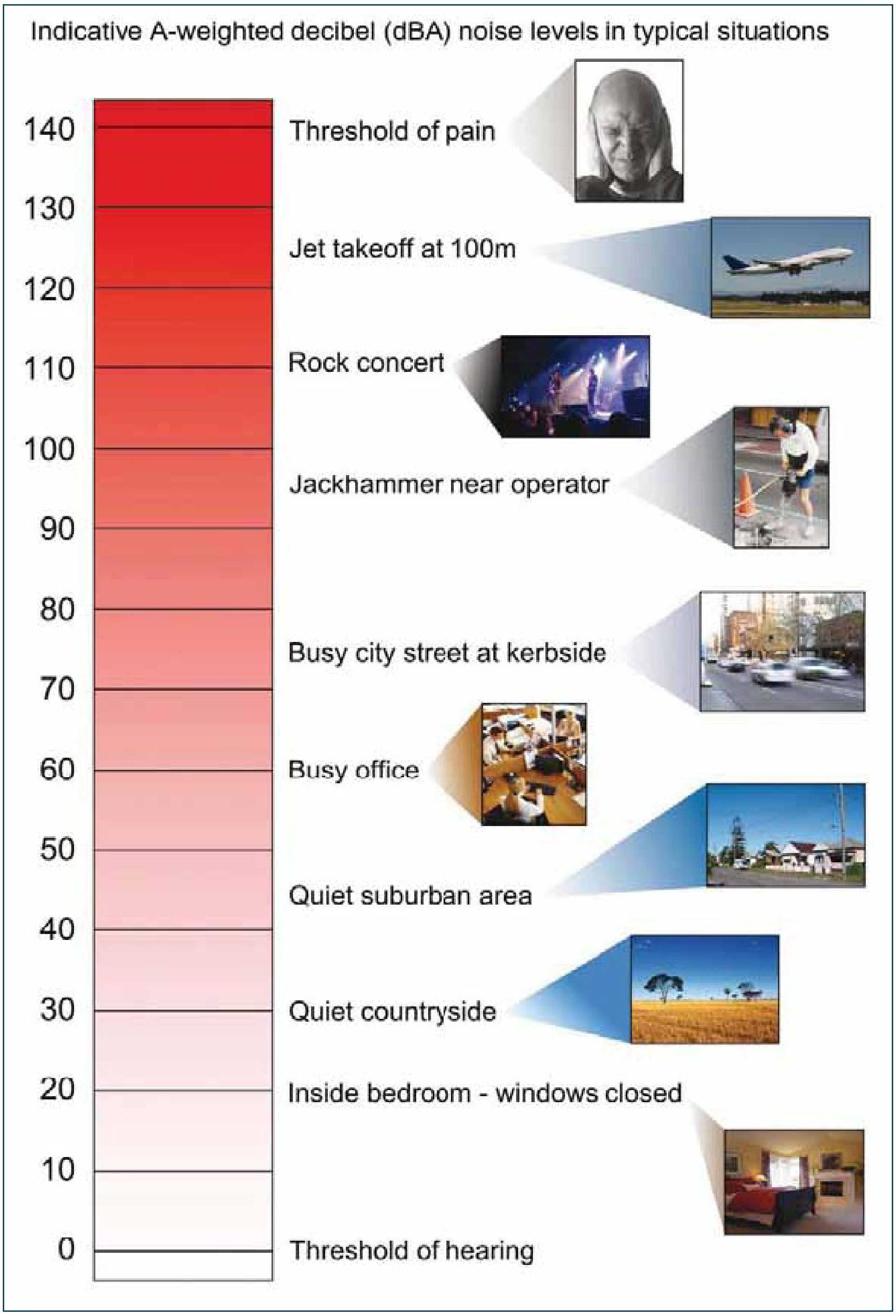
Change in sound level (dB)	Perceived change in noise
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times as loud (or quarter) as loud



Overview of the proposal

Warkworth Mine continuation
Noise and vibration assessment

Figure 1.1



Source: *Road Noise Policy (DECCW 2011)*

Figure 1.2 Common sources of noise with levels

2 Glossary

A number of technical terms are required for the discussion of noise and vibration. These are explained in Table 2.1.

Table 2.1 Glossary of acoustic terms

Abbreviation or term	Description
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L90 statistical noise levels.
Amenity criteria	The amenity criteria relate to all industrial noise. Where industrial noise approaches base amenity criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise.
ANZECC	Australian and New Zealand Environment Conservation Council
CNMP	Construction noise management plan
Coal & Allied	Coal & Allied Operations Limited
Day period[1]	Monday to Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB(A)	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
DGRs	Director-General's environmental assessment requirements
DP&E	Department of Planning and Environment (NSW government)
EA	Environmental assessment
EMM	EMGA Mitchell McLennan Pty Limited
EPA	NSW Environment Protection Authority
EP&A Act	Environmental and Planning Assessment Act 1979 (NSW)
Evening period[1]	Monday to Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays: 6.00 pm to 10.00 pm.
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy (NSW EPA 2000)
Intrusive criteria	The intrusive criteria refers to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in this report.
L_1	The noise level exceeded for 1% of the time.
L_{10}	The noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{90}	The noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{eq}	The energy average noise from a source. This is the equivalent continuous sound pressure level over a given period. The $L_{eq(15min)}$ descriptor refers to an L_{eq} noise level measured over a 15-minute period.
Linear peak	The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.
L_{max}	The maximum sound pressure level received during a measuring interval.
Night period[1]	Monday to Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NMP	Noise management plan
PSNL	The project-specific noise level (PSNL) are criteria for a particular industrial noise source or industry. The PSNL is the lower of either the intrusive criteria or amenity criteria.

Table 2.1 Glossary of acoustic terms

Abbreviation or term	Description
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
RING	Rail Infrastructure Noise Guideline
Sound power level (Lw)	A measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.
The proposal	Warkworth Continuation 2014
The Site	Area covered by application
Vibration	A motion that can be measured in terms of its displacement, velocity or acceleration. The common unit for velocity is millimetres per second (mm/s).

Note: 1. excludes road traffic noise where Day: 07.00 am to 10.00 pm; Night: 10.00 pm to 07.00 am.

3 Reasonable and feasible acoustic management

3.1 Overview of noise management system

The MTW Noise Management Plan (NMP) was developed in accordance with industry best practice with consideration given to the full available range of reasonable and feasible mitigation and their effectiveness in determining the measures to be implemented at the Site. The plan details a range of existing acoustic management and monitoring procedures which are managing the existing operations to comply with the conditions of the development consent. The management measures include those which are implemented on a continuous (standard) basis, as well as both proactive and reactive measures, categorised in accordance with the hierarchy of control for contingency planning to manage residual risks. The hierarchy of control is as follows:

- administrative controls;
- substitution controls;
- engineering; and
- elimination controls.

Together, this suite of management measures and processes comprise the MTW Noise Management System.

The effectiveness of the MTW Noise Management System has been tested on a number of occasions in recent years, including formal compliance audits, requests for Independent Review, ad-hoc supplementary monitoring programs, and departmental requests for information. MTW continues to demonstrate a position of predominant compliance with noise criteria, and a high level of adherence to the measures outlined in the NMP.

MTW continues to work with the Department to improve the NMP, demonstrating commitment to continuous improvement and driving industry best practice noise management. It is expected that the continued implementation and refinement of measures outlined in the NMP (as updated from time to time) will enable MTW to effectively manage any noise impacts associated with this proposal, and to ensure a high level of compliance is maintained throughout the life of the Project.

3.2 Administrative controls

The following administrative controls are implemented at MTW, including:

- Trigger Action Response Process (TARP);
- HME Sound Power Level (Lw) screening;
- handover report; and
- validation surveys of the real-time monitoring network.

Each of these measures is described below.

3.2.1 Trigger Action Response Process

The TARP is the key reactive noise control implemented at MTW, and involves the effective and timely response to elevated noise (trigger), irrespective of meteorological conditions.

Triggers are enacted in a number of ways, prompting commencement of reactive processes to validate, quantify and appropriately respond to noise conditions, including:

- receipt of a noise alarm from the real-time, directional noise monitoring network;
- identification of elevated noise through routine supplementary surveillance noise monitoring, undertaken by MTW personnel each night;
- notification of elevated noise through the routine (monthly) attended compliance monitoring regime undertaken by experienced and independent experts; and
- receipt of community complaint in relation to noise.

When a trigger is confirmed (noise levels which are approaching or exceeding the noise criteria in the vicinity of nearby private residences), an appropriate response is implemented to ensure the noise event is resolved within 75 minutes of identification. The response may include substitution or elimination measures, commensurate with the nature and severity of the noise event.

3.2.2 HME Sound Power Level (Lw) screening

Understanding of the sound profile of the mining fleet is critical to effective introduction of both proactive and reactive noise controls. To ensure this information is kept up-to-date and relevant, sound power level testing (sound screening) is undertaken on 33% of the attenuated heavy mining equipment (HME) fleet annually. In this way, 100% of attenuated equipment will be screened on a rolling three-year cycle. The results of sound screening will be used for the following:

- to inform MTW of equipment which is experiencing degradation in suppression equipment and requiring repair;
- to inform MTW of fleet types and units which can be preferentially deployed into or removed from noise risk areas; and
- to periodically update the predictive modelling interface (PMI) to increase model accuracy and usefulness (refer to Section 5.1).

When one piece of equipment measures >3 dB(L) against operational specifications, MTW maintenance staff will inspect and assign the piece of equipment to the appropriate maintenance schedule.

3.2.3 Nightshift environmental management report

The MTW operational personnel prepare and circulate a report following each night shift which describes the noise management activities undertaken including routine controls, minor changes and equipment shutdowns, if any, during the shift. Where noise enhancing weather conditions are predicted for the shift ahead these are described in the report. Along with the description of the conditions, potential management strategies are also detailed.

3.2.4 Validation surveys of the real-time monitoring network

To ensure that the real-time monitoring network adequately assesses and represents all receivers, validation surveys are undertaken on an as-needs basis, involving supplementary noise monitoring in the vicinity of the private residence concerned, and comparison with measured levels from the nearest real time monitor. Where a survey indicates a change may be required this is reviewed and actioned as appropriate to ensure monitoring systems and reactive triggers remain representative.

3.2.5 Substitution controls

Substitution controls are implemented in response to one or more triggers (described in 'administrative controls' above), and are utilised both proactively and reactively. Substitution measures involve the repositioning or replacement of equipment or reassignment of tasks when conditions require. For example, assignment of sound attenuated trucks to higher (noise) risk hauls during noise enhancing conditions ahead of shift, or reactively following a trigger.

3.3 Engineering measures

In conjunction with their suppliers, MTW have progressed with the attenuation of its fleet of haul trucks and other mining equipment. All new trucks purchased for use on the Site will be commissioned as noise suppressed (or attenuated) units. MTW currently operates a mixture of sound attenuated and non-sound attenuated machines and the existing fleet of trucks are being progressively fitted with suitable noise attenuation packages. Baseline testing has been completed and acoustic engineering is being applied to understand what sound power levels are achievable across the fleet. The attenuation program is being undertaken in a targeted manner, addressing the noisier pieces of equipment as a priority for the operations given the remaining development consent life.

Identification and rectification of defects to sound attenuation equipment is undertaken as required through the normal maintenance process where reasonable and feasible. MTW have also completed works to replace all in-pit reverse alarms with 'quacker' style reverse alarms on its mining fleet.

During 2012, engineering works were undertaken to address noise associated with shovel operations. Engineering controls were introduced including hydraulic snubber brakes, and fitting of self-greasing permalubes to the dipper door pins. Where additional reasonable and feasible opportunities for engineering controls are identified in the future, these will continue to be investigated and trialled as appropriate.

3.4 Elimination controls

Elimination controls are implemented in response to one or more triggers (described in 'administrative controls' above). Elimination controls, equipment or task shutdown, are implemented as a last resort where other controls have been inadequate.

4 Warkworth noise management system in action

4.1 Night shift Environmental Management Report

MTW operational personnel prepare and circulate a shift report for planning activities and to handover to the next shift.

The report describes the noise management activities undertaken including routine controls, minor changes and equipment shutdowns, if any, during the shift. Where noise enhancing conditions are predicted for the next shift these are described in the report. Along with the description of the conditions, potential management strategies are also detailed. An example of information contained within the handover report is shown in Figure 4.1.

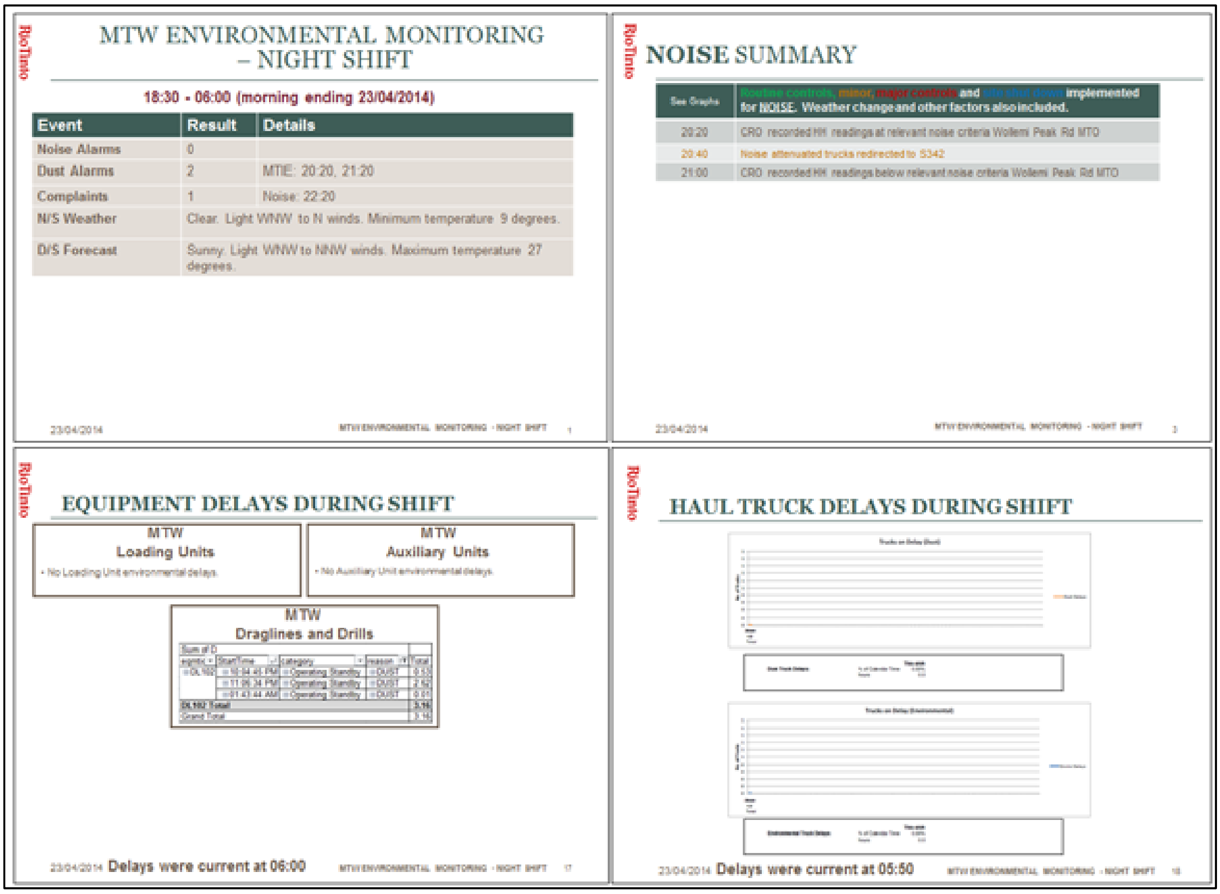


Figure 4.1 **Example information from the night shift environmental management report (night shift 22 April 2014)**

4.2 Real-time noise monitoring

Directional real-time noise monitoring is utilised to actively manage noise emissions from MTW on a continuous basis during night time operations. The real-time monitoring network comprises a number of monitors which have been strategically placed to adequately represent a wide range of private residences. Operational personnel have access to real-time data via the environmental intranet (also available on hand-held devices such as smart phones) and use a suite of tools to allow for swift resolution of any emerging issues during any shift including live audio streaming, dedicated pages for each monitoring location (an example is provided as Figure 4.2), and 'Noise roses' (a spatial representation of the directional assessment of measured noise, see Figure 4.3).

A real-time noise alarm system was introduced to MTW during 2011 which uses a set of rules to alert operational personnel to emerging noise issues in real-time. Numerous noise alarms have been acknowledged and responded to during night shift operations in 2014. Since the introduction of real-time noise alarms at Warkworth Mine in 2011, the monitoring network has expanded in the Bulga village area, now comprising four directional real-time monitors to ensure adequate representation of private residences in the area (see Figure 4.4).

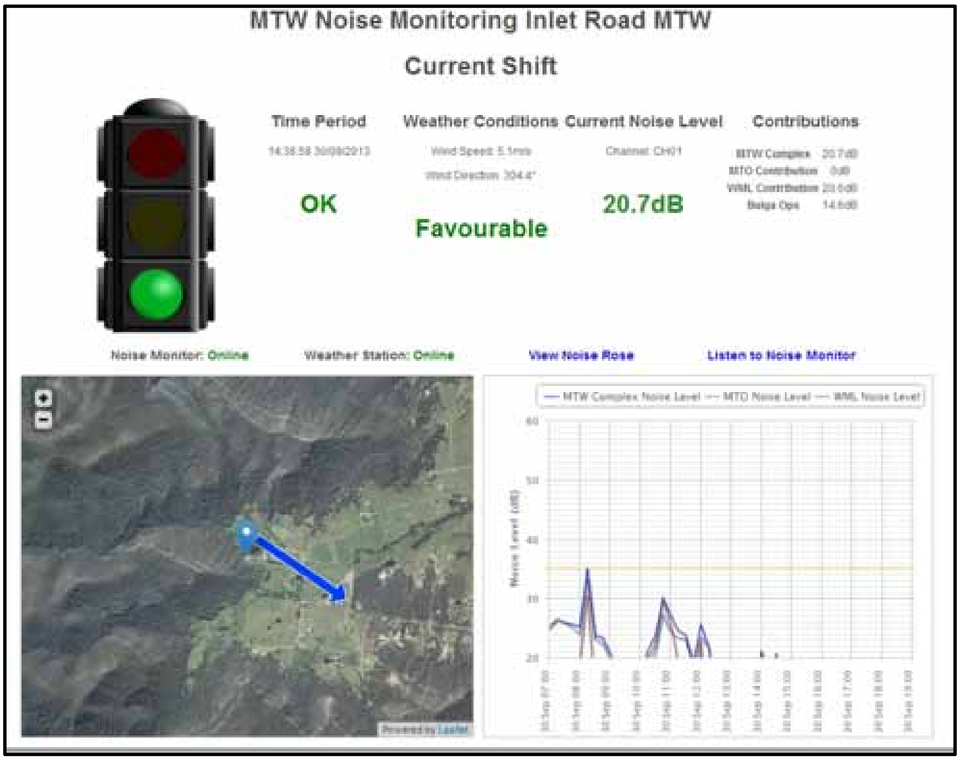


Figure 4.2 Noise management resource – trending noise levels at 'Inlet Road West' monitoring location

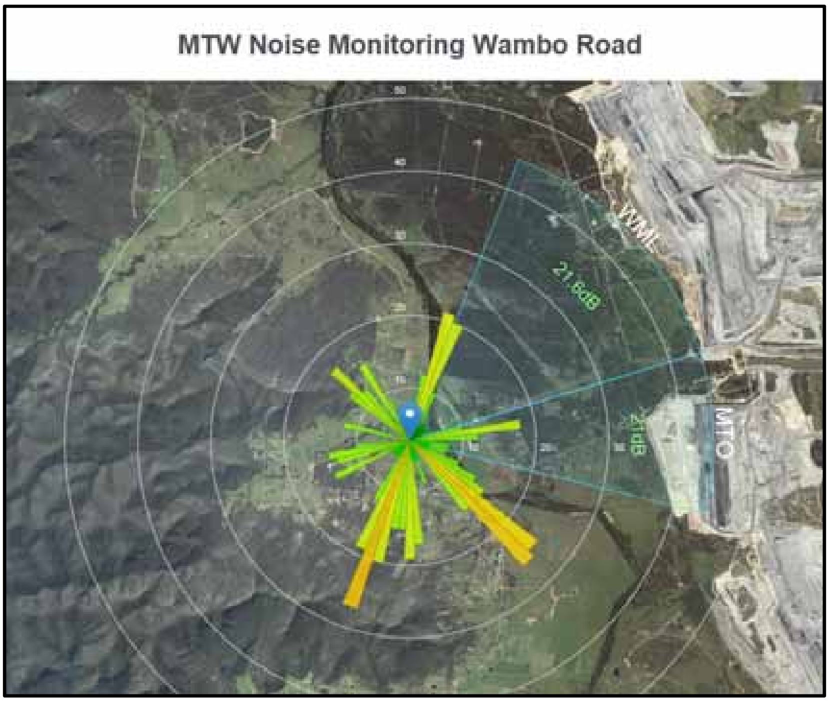


Figure 4.3 Noise rose – a spatial representation of directional noise assessment in real-time

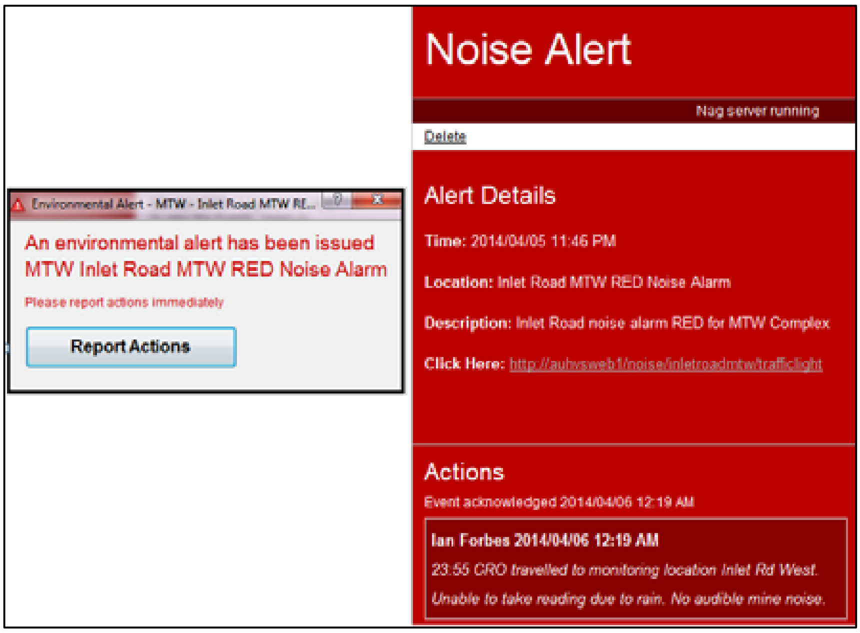
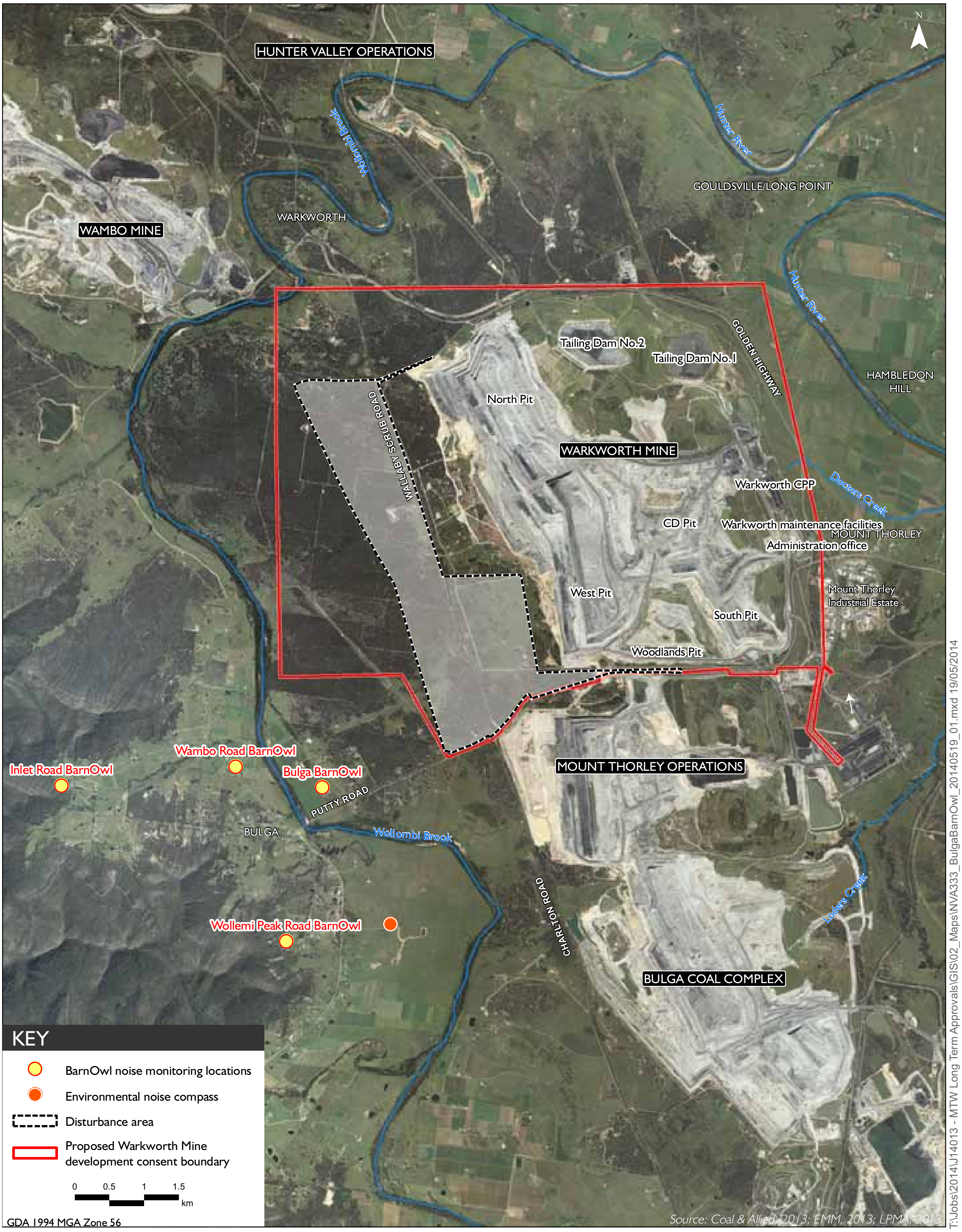


Figure 4.4 'Real-time' noise alarms in action at MTW



EMM
COAL & ALLIED

Directional real-time noise monitoring locations in the Bulga village community

Warkworth Mine continuation

Noise and vibration assessment

Figure 4.5

4.3 Supplementary attended noise monitoring

A programme of targeted supplementary attended noise monitoring is operated at MTW to support the real-time directional monitoring network and ensure the highest level of noise management is maintained. The supplementary programme is undertaken by MTW personnel and involves:

- undertaking routine inspections from both inside and outside the mine boundary;
- routine and as-required handheld noise assessments (undertaken in response to noise alarm and/or community complaint), comparing noise levels against consent noise limits; and
- validation monitoring following operational modifications to assess the adequacy of the modifications.

When a trigger is confirmed (noise levels which are approaching or exceeding the noise criteria in the vicinity of nearby private residences), an appropriate response is implemented to ensure the noise event is resolved within 75 minutes of identification. The response may include substitution of elimination measures, commensurate with the nature and severity of the noise event.

Supplementary noise monitoring undertaken in 2014 has, to-date, resulted in operational modifications (including equipment stoppage and, in some cases complete site shutdown) on numerous nights, resulting in over 8,000 hours of equipment stoppage.

A complete site shutdown (with the exception of dragline operations and some ancillary equipment activity) has been called on several occasions in 2014, in response to elevated noise measurements in the Bulga area. This significant level of operational disruption demonstrates MTW's clear commitment to minimising impacts and maintaining compliant operations.

Table 4.1 details MTW equipment stoppages due to noise year to date, by equipment type.

Table 4.1 MTW equipment stoppages

Equipment type	Equipment delay due to noise management (hours) January – April 2014
Drills	225
Dozers	764
Bladed equipment	41
Loaders	124
Shovels	748
Trucks	6,184

An analysis of supplementary attended monitoring data for the period 1 July 2013 to 28 April 2014 is shown in Table 4.2.

Table 4.2 Supplementary attended noise monitoring data – 1 July to 28 April 2014 (Warkworth Mine)[1]

Month	No of measurements	No. of measurements > trigger	No. of nights where measurements > trigger	% greater than trigger
July 2013	341	14	6	4.1
August 2013	306	25	11	8.2
September 2013	312	29	10	9.3
October 2013	294	26	8	8.8
November 2013	273	23	8	8.4
December 2013	358	35	14	9.8
January 2014	303	15	6	4.9
February 2014	337	44	10	13.1
March 2014	464	69	17	14.9
April 2014	314	36	9	11.5
Total	**3302**	**316**	**99**	**9.6**

Notes: 1. measurements taken under all meteorological conditions, including conditions under which the consent noise criteria do not apply.

Table 4.2 highlights that the majority of supplementary noise measurements do not indicate adverse noise conditions and thus do not trigger any operational modifications. The data also shows a noise assessment trigger may be enacted multiple times on one night and this would typically be in situations where an additional verification noise assessment is undertaken to determine the effectiveness of the control measures implemented and whether further operational modifications are required.

The following case studies are provided to demonstrate the effective implementation of the MTW Noise Management System in recent months.

4.3.1 Night shift 24 February 2014

Fifty-six pieces of equipment were stood down for a total of 181.7 equipment operating hours on the night of 24th February 2014 after elevated noise was detected through supplementary handheld monitoring at the 'Wambo Road' monitoring location. Real-time monitoring data supported the observations of the operator conducting the supplementary assessments. Operational modifications were immediately introduced, with follow-up monitoring undertaken to validate and verify the effectiveness of the modifications. Noise levels were verified as below the Warkworth Mine trigger limit 65 minutes following detection, compliant with the commitments made in the MTW NMP.

Meteorological conditions on the night assisted noise propagation toward Wambo Road (easterly and south easterly winds), however were such that the consent noise criteria did not apply (average wind speed of 3.8m/sec). Despite this, significant operational modifications were made to ensure noise remained below criteria so as to minimise impacts on surrounding residents. It should be noted that MTW did not receive any community complaints from Wambo Road residents on the night of 24th February 2014. A summary of noise management activities undertaken on the night is shown in Table 4.3.

Table 4.3 Summary of actions implemented on 24 February 2014

Time	Trigger / response / verification	Details
19:40	N/A	Supplementary monitoring undertaken at Wambo Road – noise levels significantly under Warkworth Mine trigger
21:20	Trigger	Supplementary monitoring undertaken at Wambo Road detects elevated noise from Warkworth Mine
21:25	Response	Drill 223 and Drill 230 shut down
21:30	Response	Excavator 393 and supporting equipment shut down.
21:35	Response	Drill 227 shut down
21:40	Verification	Supplementary monitoring undertaken – noise remains elevated.
21:50	Response	Excavator 313 and supporting equipment shut down
21:55	Verification	Supplementary monitoring undertaken – noise remains elevated
22:00	Trigger	Real time noise monitoring data supports supplementary monitoring observations
22:00	Response	Shovel 344 and supporting equipment shut down
22:10	Verification	Supplementary monitoring undertaken – noise remains elevated
22:15	Response	Excavator 310 and supporting equipment, Shovel 345 and supporting equipment shut down.
22:20	Response	Dozer 516 shut down
22:25	Verification	Supplementary monitoring undertaken confirms controls introduced are effective. Staged restart of some activity commences
23:10	Verification	Supplementary monitoring undertaken – confirms controls remain effective – additional equipment is returned to service.
23:30	Verification	Supplementary monitoring undertaken – confirms controls remain effective - no further action required.
01:10	Verification	Supplementary monitoring undertaken – confirms controls remain effective - no further action required.
02:00	Verification	Supplementary monitoring undertaken – confirms controls remain effective - no further action required.
03:25	Verification	Supplementary monitoring undertaken – confirms controls remain effective - no further action required.

Figure 4.6 provides a graphic of the noise roses from the Wambo Road monitor for the night of 24 February 2014. Haul truck delays for the same night are displayed in Figure 4.7.

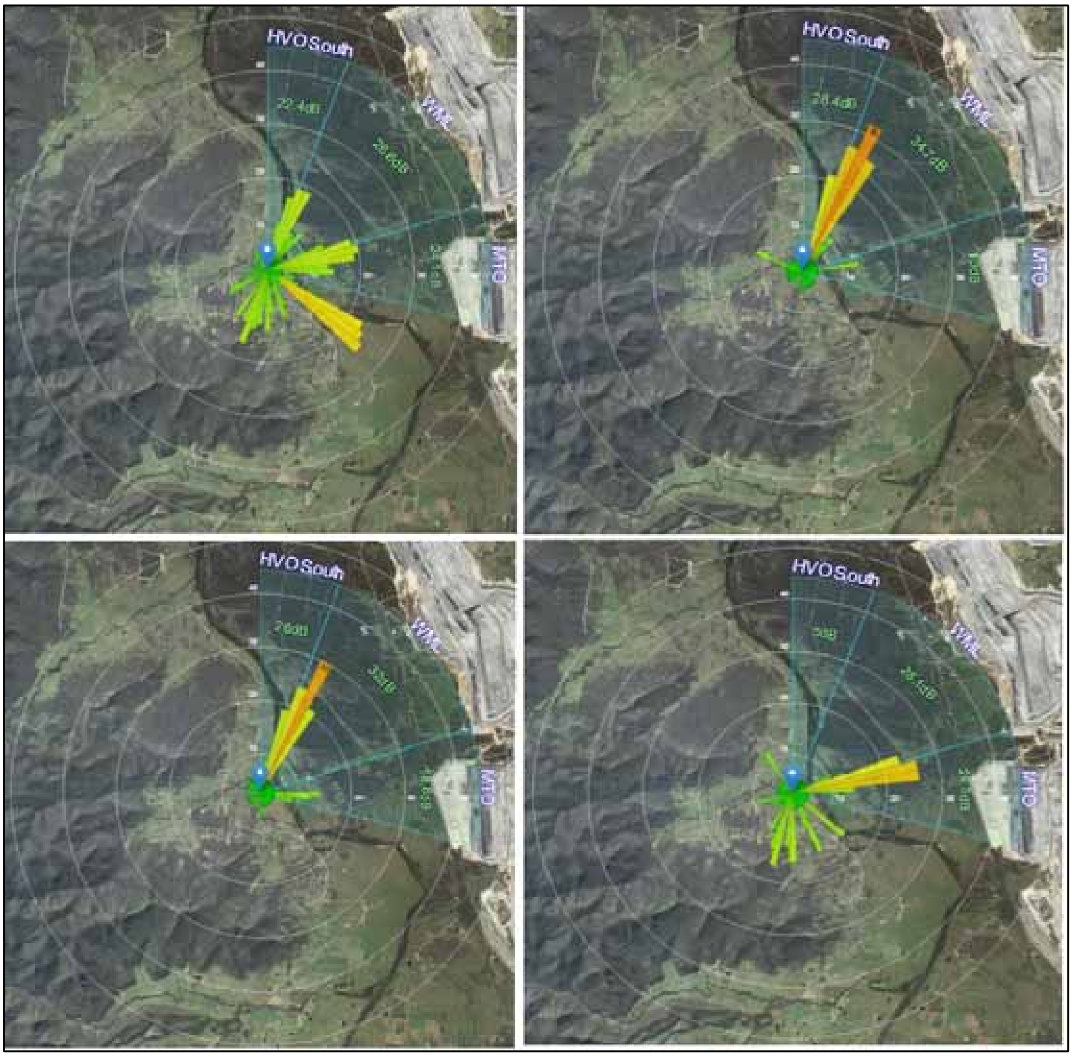


Figure 4.6 'Noise Rose' graphics from the Wambo Road real-time noise monitor on the night of 24th February 2014. Clockwise from left: 19:40, 21:30, 22:15, 22:50

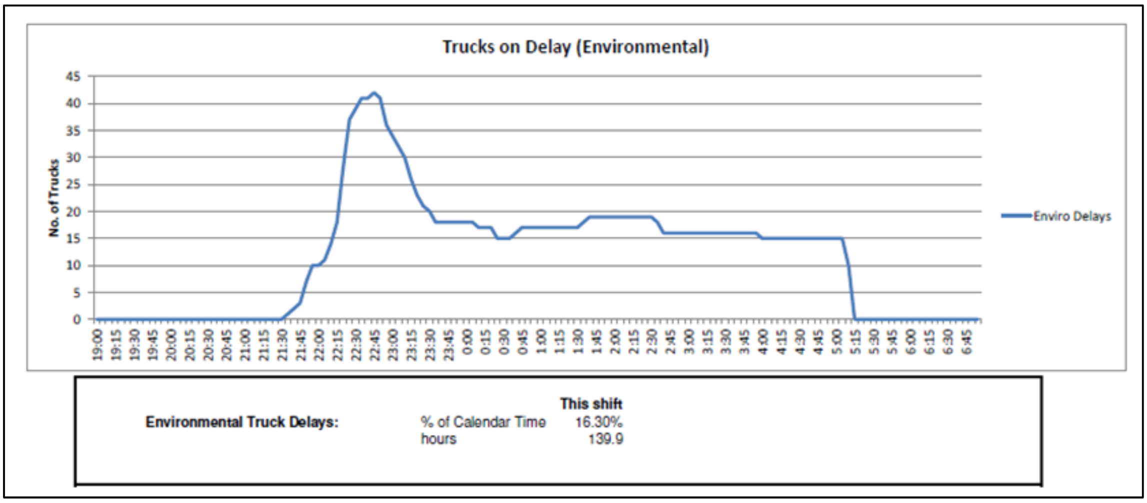


Figure 4.7 Haul truck delays (standby) due to noise on the night of 24th February 2014

4.3.2 Night shift 4 March 2014

Ninety-five pieces of equipment were stood down for a total of 209.6 equipment operating hours on the night of 4th March 2014 after elevated noise was detected through supplementary handheld monitoring at the 'Wollemi Peak Road' monitoring location. Real-time monitoring data supported the observations of the operator conducting the supplementary assessments. Operational modifications were immediately introduced, with follow-up monitoring undertaken to validate and verify the effectiveness of the modifications. Noise levels were verified as below the Warkworth Mine trigger limit 40 minutes following detection, compliant with the commitments made in the MTW NMP.

Similar to those witnessed on 24 February 2014, meteorological conditions on 4 March were noise enhancing toward Wollemi Peak Road during the period of elevated noise at Wollemi Peak Road (easterly and south-easterly winds). However, again, meteorological conditions were such that the consent noise criteria did not apply (winds >3m/sec for the majority of the period between 8:00pm and 10:00pm). Despite this, significant operational modifications were made to ensure noise remained below criteria so as to minimise impacts on surrounding residents as detailed in Table 4.4.

Table 4.4 Summary of actions implemented on 4 March 2014

Time	Trigger / response / verification	Details
19:40	N/A	Supplementary monitoring undertaken at Wollemi Peak Road – Warkworth Mine noted as inaudible
20:30	N/A	Supplementary monitoring undertaken at Wollemi Peak Road – Warkworth Mine noted as inaudible
20:43	Trigger	Complaint received from the Wollemi Peak Road area.
20:55	Trigger	Complaint received from the Wollemi Peak Road area.
21:15	Trigger	Supplementary monitoring undertaken at Wollemi Peak Road detects elevated noise from Warkworth Mine.
21:27	Trigger	Complaint received from the Wollemi Peak Road area
21:40	Response	Shovel 344 and supporting equipment shut down.
		Excavator 313 and supporting equipment shut down.
21:45	Verification	Supplementary monitoring undertaken at Wollemi Peak Road – noise remains elevated
22:05	Response	Site shutdown (with the exception of Draglines, Drills, and equipment handling reject material on the eastern side of the operation)
22:10	Verification	Supplementary monitoring undertaken at Wollemi Peak Road - confirms controls introduced are effective
22:30 to 01:20	Verification	Six supplementary monitoring events undertaken at Wollemi Peak Road - confirms controls remain effective

Figure 4.8 and Figure 4.9 provide noise roses and haul truck delays details respectively.

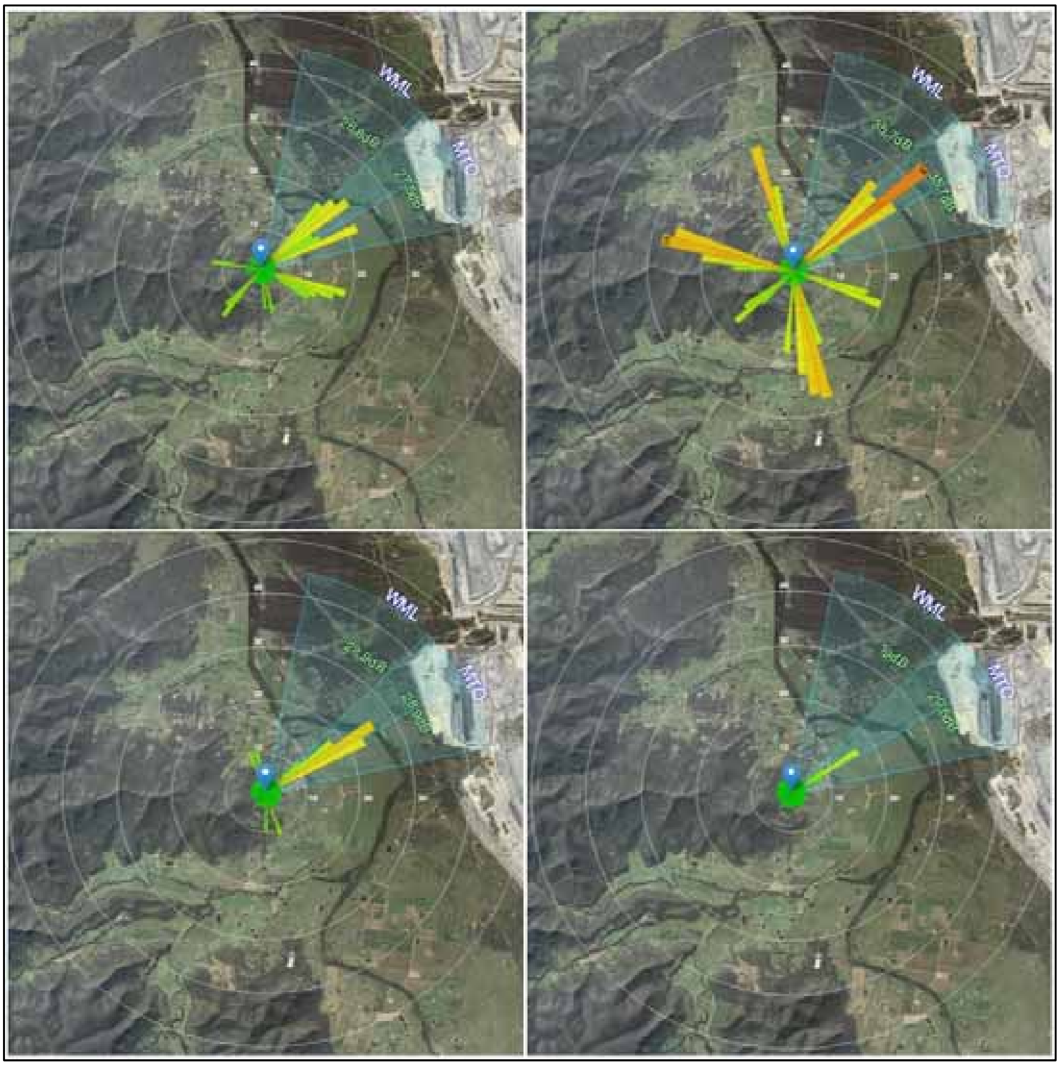


Figure 4.8 'Noise Rose' graphics from the Wollemi Peak Road real-time noise monitor on the night of 4th March 2014. Clockwise from left: 20:00, 21:15, 22:55, 00:50 (5th March)

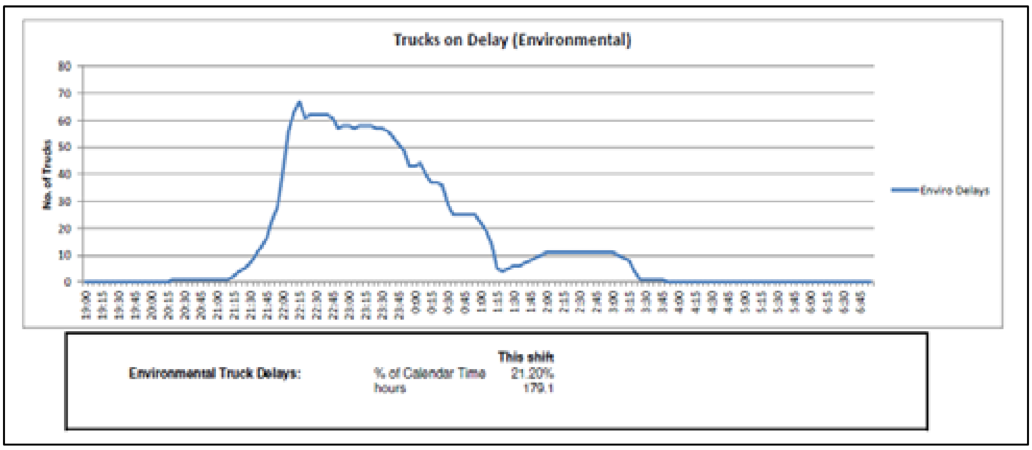


Figure 4.9 Haul truck delays (standby) due to noise on the night of 4th March 2014

4.3.3 Night shift 17 March 2014

Sixty-eight pieces of equipment were stood down for a total of 153.9 equipment operating hours on the night of 17th March 2014 after elevated noise was detected through supplementary handheld monitoring at the 'Wambo Road' monitoring location. Operational modifications were immediately introduced, with follow-up monitoring undertaken to validate and verify the effectiveness of the modifications. Noise levels were verified as below the Warkworth Mine trigger limit 45 minutes following detection, compliant with the commitments made in the MTW NMP. Real-time noise monitoring data was not available at the time due to a network malfunction.

Meteorological conditions on the night assisted noise propagation toward the Bulga village area (light winds, blowing from the south).

A summary of noise management activities undertaken is presented in Table 4.5.

Table 4.5 Summary of actions implemented on 17 March 2014

Time	Trigger / response / verification	Details
20:30	N/A	Supplementary monitoring undertaken at Wambo Road – Warkworth Mine noted as audible but well below trigger limit
21:30	N/A	Supplementary monitoring undertaken at Wambo Road – Warkworth Mine noted as audible but well below trigger limit
22:50	N/A	Supplementary monitoring undertaken at Wambo Road – Warkworth Mine noted as audible but well below trigger limit
00:10	Trigger	Supplementary monitoring undertaken at Wambo Road detects elevated noise from Warkworth Mine.
00:15	Response	Excavator 312 and supporting equipment shut down.
		Excavator 313 and supporting equipment shut down.
00:25	Verification	Supplementary monitoring undertaken at Wambo Road – noise remains elevated
00:30	Response	Shovel 344 and supporting equipment shut down
		Excavator 393 and supporting equipment shut down
		Front End Loader 649 and supporting equipment shut down
00:40	Verification	Supplementary monitoring undertaken at Wambo Road – noise remains elevated
00:40	Response	Shovel 345 and supporting equipment shut down
		Dozer 579 shut down
00:55	Response	Dozer 518 shut down
00:55	Verification	Supplementary monitoring undertaken at Wambo Road - confirms controls introduced are effective
		Dozer 519 shut down.
02:05 – 04:50	Verification	Nine supplementary monitoring events undertaken at Wambo Road – confirms controls remain effective

Figure 4.10 describes the haul truck delays for the night.

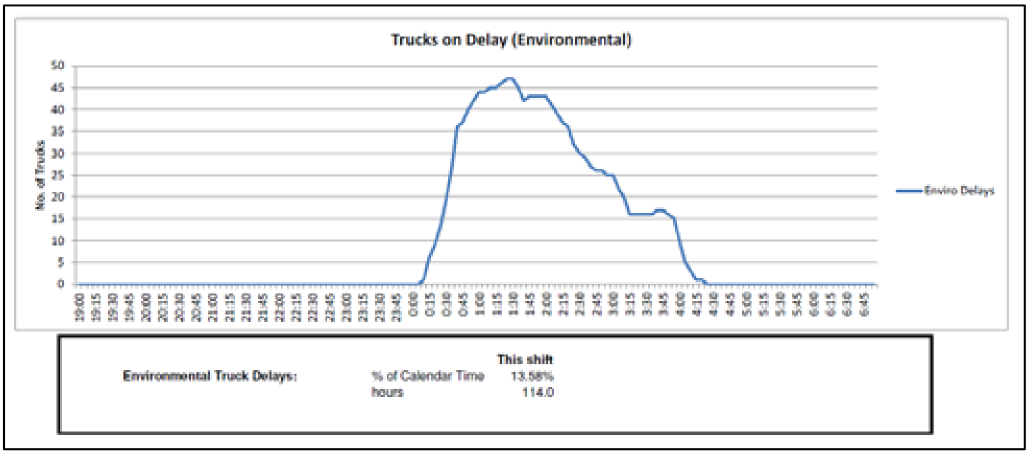


Figure 4.10 Haul truck delays (standby) due to noise on the night of 17th March 2014

5 Continuous improvement - acoustic management

Warkworth Mine is committed to reasonable and feasible continuous improvement and is currently working towards implementing a predictive modelling interface (PMI) and alternative real-time noise monitoring technology as described below.

5.1 Predictive Modelling Interface

MTW is in the process of developing a PMI which allows for proactive planning of mining operations and weather conditions as a leading measure for managing noise emissions. The PMI utilises predictive meteorological forecast data coupled with detailed mine plans and equipment sound power level information to predict noise levels at residences. The PMI is currently being refined and is expected to be fully integrated into day-to-day operations.

5.2 Development and installation of alternate real-time noise monitoring technologies

MTW is also in the process of investigating alternate noise monitoring technologies to assist with operational control. During 2012 MTW committed capital funding to build and install a first of class directional noise monitor, known as 'environmental noise compass' (ENC) in the Bulga village area. The ENC was installed late December 2013 and is currently collecting data. The ENC aims to accurately pinpoint and identify noise emissions from multiple sources in real-time, to a greater level of accuracy than existing directional noise monitoring technology. This technology is expected to provide additional noise management value to MTW and is considered a first in noise management in NSW. A picture of a typical unit is provided in Figure 5.1.

Figure 5.1 Typical image of the Environmental Noise Compass (ENC)

6 Compliance history

6.1 Noise

Compliance assessment monitoring for the Warkworth Mine has been undertaken in a number of forms during the period 2004 to 2014 including:

- routine compliance assessment (Global Acoustics) – 2004 to present and in more recent years, monitoring has included low frequency noise assessment;
- Long Point supplementary monitoring program (EMM) – June to October 2011; and
- independent review of noise impacts – Bulga (Sinclair Knight Merz) – December 2011 and January 2012.

An assessment of monitoring data (publically available via the Rio Tinto Coal Australia website www.riotintocoalaustralia.com.au) demonstrates predominant compliance with noise criteria has been achieved throughout the life of the mine. Non-compliant noise measurements account for a small percentage of the monitoring dataset at 0.37% (10 non-compliances measured from 2,689 individual assessments undertaken). These are shown in Table 6.1 and Table 6.2. These tables also demonstrate that there are no sustained exceedances.

Figure 6.1 spatially presents the non-compliances measured throughout the life of Warkworth Mine, further demonstrating that there are no sustained or recurring noise compliance risks associated with the continued operation of the Warkworth Mine.

Table 6.1 Summary of noise measurements for Warkworth Mine

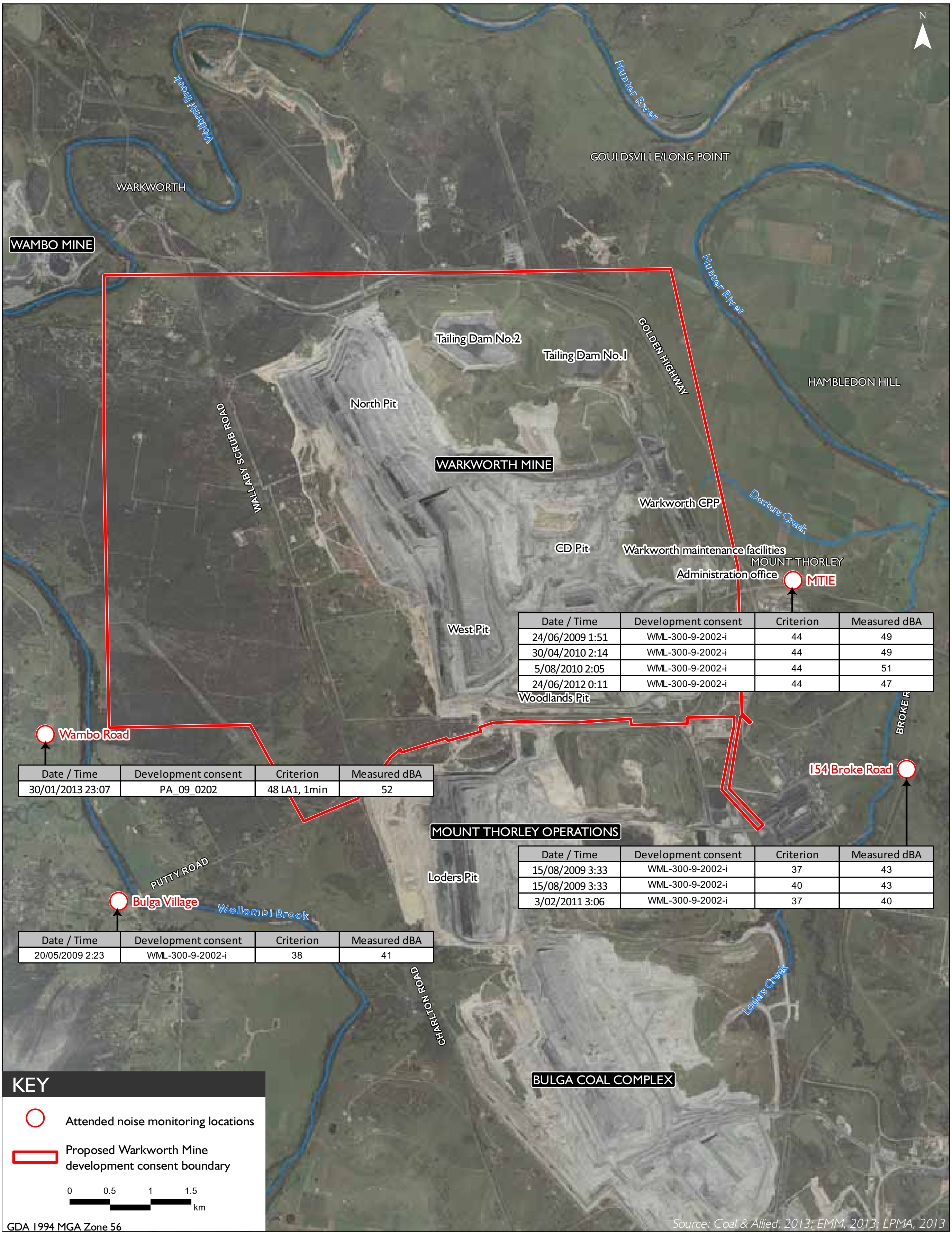
Total assessments (2004-2014 YTD)	2,689
Total number of exceedances (2004-2013 YTD)	24
Total number of non-compliances (2004-2013 YTD)	10
Percentage of non-compliant assessment (2004-2013 YTD)	0.37.

Note: 1. Exceedance refers to a measured result greater than the relevant consent limit, but within the 2 dB allowable tolerance listed in Chapter 11 of the INP.

Table 6.2 Yearly breakdown of noise measurements for Warkworth Mine

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total number of assessments	230	276	280	279	292	275	269	290	261	201	36
Total number of exceedances[1]	1	0	1	1	1	8	1	4	4	3	0
Total number of non-compliances	1	0	0	0	0	4	1	2	1	1	0
Non-compliant assessments (%)	0.43	0.00	0.00	0.00	0.00	1.45	0.37	0.69	0.38	1.14	0.00

Note: 1. Exceedance refers to a measured result greater than the relevant consent limit, but within the 2 dB allowable tolerance listed in Chapter 11 of the INP.



MTIE

Date / Time	Development consent	Criterion	Measured dBA
24/06/2009 1:51	WML-300-9-2002-i	44	49
30/04/2010 2:14	WML-300-9-2002-i	44	49
5/08/2010 2:05	WML-300-9-2002-i	44	51
24/06/2012 0:11	WML-300-9-2002-i	44	47

Wambo Road

Date / Time	Development consent	Criterion	Measured dBA
30/01/2013 23:07	PA_09_0202	48 LA1, 1min	52

154 Broke Road

Date / Time	Development consent	Criterion	Measured dBA
15/08/2009 3:33	WML-300-9-2002-i	37	43
15/08/2009 3:33	WML-300-9-2002-i	40	43
3/02/2011 3:06	WML-300-9-2002-i	37	40

Bulga Village

Date / Time	Development consent	Criterion	Measured dBA
20/05/2009 2:23	WML-300-9-2002-i	38	41

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Warkworth Mine non-compliance measurements - January 2004 to July 2013

Warkworth Mine continuation

Noise ad vibration assessment

Figure 6.1

When considering the impact of the Warkworth Mine on the area of Bulga village, the level of non-compliant measurements is relatively lower and accounts for 0.12% of the monitoring dataset (two non-compliances measured from 1,643 individual assessments undertaken). This is shown in Table 6.3 and Table 6.4. These tables also demonstrate that there are no sustained exceedances from Warkworth Mine.

Table 6.3 Summary of noise measurements at Bulga village for Warkworth Mine

Total assessments (2004-2013 YTD)	1,643
Total number of exceedances (2004-2013 YTD)[1]	8
Total number of non-compliances (2004-2013 YTD)	2
Percentage of non-compliant assessment (2004-2013 YTD)	0.12

Note: 1. Exceedance refers to a measured result greater than the relevant consent limit, but within the 2 dB allowable tolerance listed in Chapter 11 of the INP.

Table 6.4 Yearly breakdown of noise measurements at Bulga village for Warkworth Mine

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total number of assessments	136	160	160	160	168	160	160	166	211	140	22
Total number of exceedances[1]	0	0	0	0	0	2	0	1	2	3	0
Total number of non-compliances	0	0	0	0	0	1	0	0	0	1	0
Non-compliance assessments (%)	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.71	0.00

Note: 1. Exceedance refers to a measured result greater than the relevant consent limit, but within the 2 dB allowable tolerance listed in Chapter 11 of the INP.

6.2 Blasting

In 2013, 410 blast events were initiated at MTW during the reporting period. No non-compliances were recorded for Warkworth Mine blasts. One non-compliance was recorded against the 120 dB(L) airblast overpressure criteria on 27 August 2013 in Loders Pit of Mount Thorley Operations. The investigation into the blast event determined that the overpressure exceedance was caused by previously unmapped weathered ground in the area. The non-compliance was reported to the EPA and DP&E on the day of occurrence, and to affected landowners in the vicinity of the non-compliant measurement.

MTW complied with all other blasting related consent and licence conditions during the reporting period. A total of 38 complaints relating to blasts were received during 2013 compared to 69 complaints in 2012.

The blast monitoring system achieved a data capture rate of 99.9% during the reporting period (3271 of a possible 3280 measurements). There were seven compliance monitors used. For Warkworth Mine, 100% compliance was achieved for blast overpressure noise and ground vibration did not exceed the 0% allowable ground vibration criteria.

7 Properties surrounding the mine

A total of 221 privately owned assessment locations were identified within proximity of the mine and potentially exposed to noise from the proposal. These assessment locations are listed in Appendix A and illustrated in Figure 7.1 and Figure 7.2. The locations are numbered in accordance with the numbering system adopted in the EIS which is consistent with all supporting technical studies of the proposal. It should be noted that mine owned properties are not included in this list. The INP (page 58) defines a receiver as:

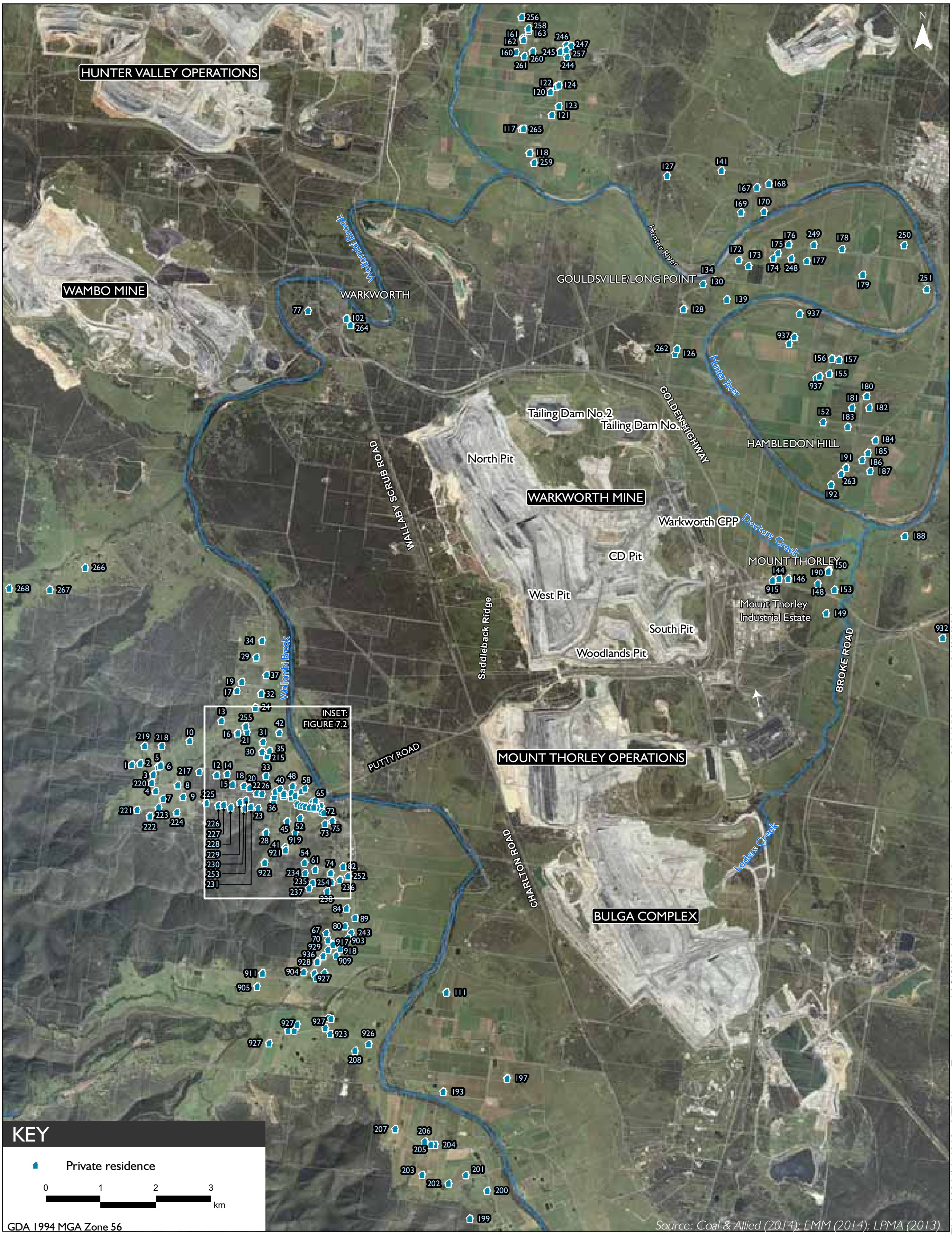
> *"The noise sensitive land use at which noise from a development can be heard."*

Such mine owned properties can be vacant or tenanted with mine staff or persons that have agreements with the mines relating to noise amenity or other emissions. Mine owned residential properties therefore are not considered 'noise sensitive' as defined in the INP. Further, the INP states:

> *"It will be used as a guide by Environment Protection Authority (EPA) officers for setting statutory limits in licences...."*

Such statutory limits have not in the past been set on non-private dwellings/properties by the EPA or NSW DP&E.

The locations of residences were identified by the applicant using land ownership registrations, aerial photographical images and, where possible, verification in the field limited to publicly accessible locations. It may be possible due to limitations of the mapping process that some properties have been missed, or others incorrectly identified as a residence when they are in fact a non-residing building on a privately owned lot (eg shed). Notwithstanding the assessment locations identified are considered representative of all residential locations and catchments surrounding the site.

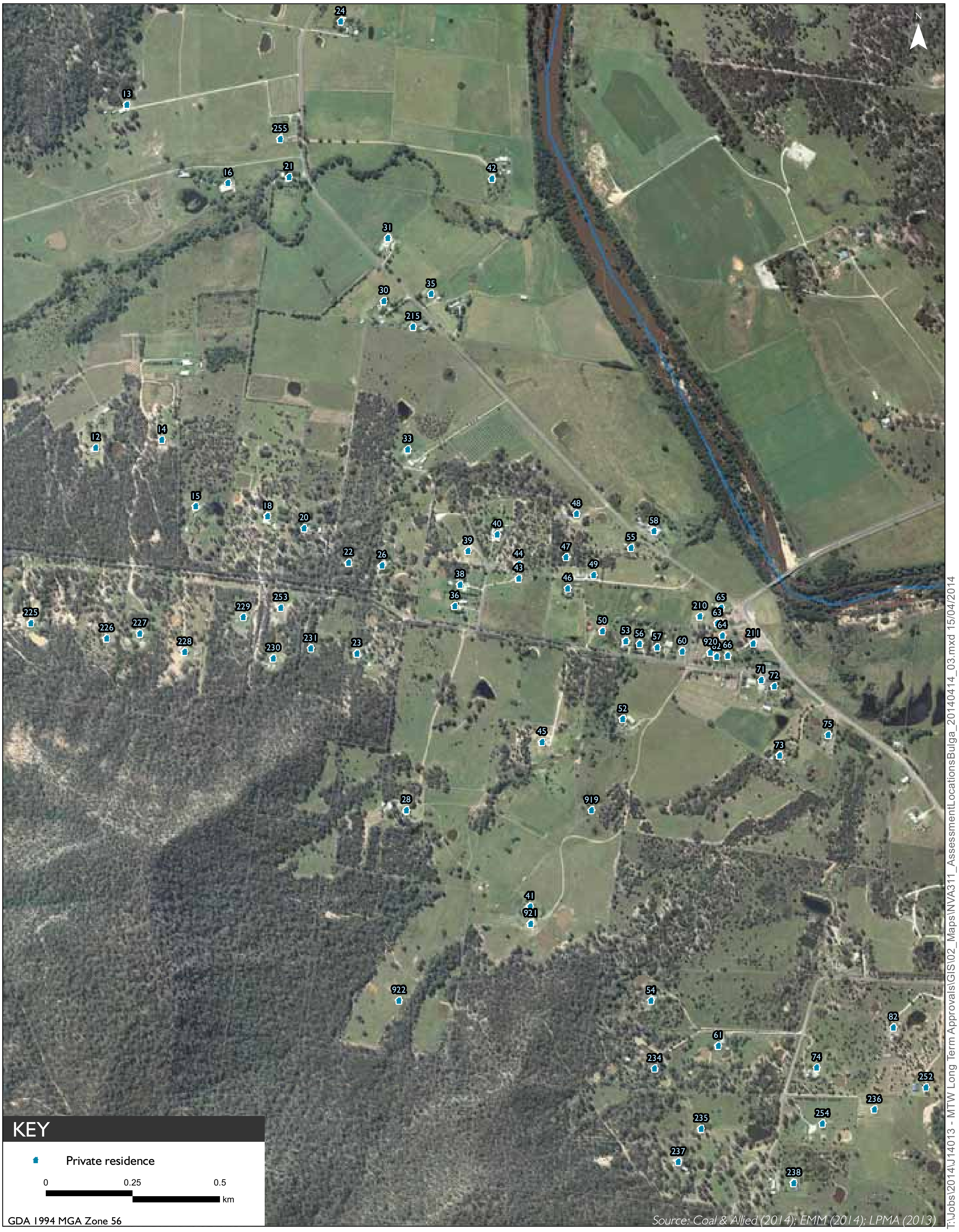


Assessment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure 7.1



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Assessment locations - Bulga

Warkworth Mine continuation
Noise and vibration assessment
Figure 7.2

8 Existing acoustic environment

8.1 Bulga background noise review

An extensive data gathering and analysis process was completed using six real time noise monitors in Bulga. The purpose of the monitoring was to quantify the background noise level for which the INP intrusiveness criteria should be set. For an impact assessment, the INP requires the assessment of noise levels that exclude influence on derived representative background noise levels from the site's existing operations. However, noise from other existing mines in the area are included in the background analysis as per the INP.

This was made possible by the use of noise loggers with directional filtering functionality, and for all locations the BarnOwl logger from SoundScience was used. The BarnOwl's directional L_{eq} data was used to filter influences on the total L_{90} (or background noise metric). That is, L_{eq} noise (of 34 dB(A) or greater) from the direction of Warkworth mine that could inflate total L_{90} to levels above 30 dB(A) (the INP's minimum threshold value) were removed from analysis.

The results of the long term background noise monitoring are summarised as rating background levels (RBL's) in accordance with the INP in Table 8.1 for all six locations A to F (refer to Figure 8.1). The data used in the exercise was collected between November 2012 and August 2013. RBL's are shown for day, evening and night assessment period as required by the INP. The assessment background levels (ABL's) determined in accordance with the INP that were used to derive the RBL data is provided in Appendix E. The quantity of data collected for the background noise survey is substantially greater than the INP's required minimum of seven days and therefore provides a much more comprehensive representation of the repeatable RBL value at each location.

Table 8.1 Representative background noise levels for Bulga (RBL as per INP)

Location	Period (Duration)	RBL, dB(A)		
		Day	Evening	Night
A. Wollemi Peak Rd	20/06/13 - 14/08/13 (3 months)	33	33	34
B. 367 Wambo Rd[1]	01/12/11 - 29/11/12 (11 months)	30	33	33
C. 128 Wambo Rd	29/11/12 - 31/07/13 (8 months)	33	37	33
D. 193 Inlet Rd[1]	01/12/11 - 28/05/12 (6 months)	30	32	30
E. 339 Inlet Rd[1]	18/03/13 - 30/06/13 (3.5 months)	30	30	30
F. Scout Hall (Putty Rd)	01/12/11 - 04/09/12 (10 months)	33	36	35

Notes: 1. Locations B, D and E data show RBL's at or below the INP minimum of 30 dB(A) for some assessment periods, and hence 30 dB(A) was adopted as per the INP across all three assessment periods.

2. The RBL is as defined in the INP, ie the median value of all ABL's. The ABL is also as per the INP, ie the lower 10^{th} percentile of L_{90} values.

Table 8.1 demonstrates relatively higher background noise at locations A, C and F. These locations are in relatively more exposed locations to the mines, Putty Road or the centre of Bulga than the other three locations (refer to Figure 8.1).

An analysis of the RBL's was completed for unfiltered data (ie whereby Warkworth Mine source direction was included) and it was found that RBL values are 1 dB to 3 dB higher at most locations for certain periods. For example, at the three locations exhibiting RBL's higher than the INP minimum of 30 dB(A), the unfiltered data shows the following RBL's:

- A. Wollemi Peak Rd – 34 dB(A) day and 35 dB(A) evening and night. That is, 1 dB, 2 dB and 1 dB higher for the day, evening and night respectively;

- C. 128 Wambo Rd – 33 dB(A) day, 37 dB(A) evening and 36 dB(A) night. That is, 3 dB higher at night; and

- F. Scout Hall (Putty Rd) – 33 dB(A) day, 37 dB(A) evening and 35 dB(A) night. That is, 1 dB higher during the evening.

Location C demonstrates the most change in RBL's for with and without Warkworth Mine noise, which is expected given this location is closest and most exposed to Warkworth Mine of the three locations A, C and F.

This demonstrates that removing Warkworth Mine from the analysis is material to the assessment of its impacts on the community.

The RBL data shows background noise levels are marginally higher during the evening or night at some locations as compared to their corresponding daytime values. This is likely a result of enhancement of neighbouring mine noise from influences of weather conditions. This is shown at five of the six locations monitored and therefore strongly supports a proposition that weather enhanced mine noise is likely during times when temperature inversion conditions exist, for example. This should be taken into consideration when reviewing the impact assessment of the proposal.

Notwithstanding higher background noise levels during the evening and night as compared to the daytime, the INP's application notes have been conservatively adopted to determine the final RBL for the six locations as follows:

- A. Wollemi Peak Rd –33 dB(A) day, evening and night;

- B. 367 Wambo Rd – 30 dB(A) day, evening and night;

- C. 128 Wambo Rd – 33 dB(A) day, evening and night;

- D. 193 Inlet Rd – 30 dB(A) day, evening and night;

- E. 339 Inlet Rd – 30 dB(A) day, evening and night; and

- F. Scout Hall (Putty Rd) – 33 dB(A) day, evening and night.

As shown above, three of the locations (B, D and E) have the INP's minimum threshold background value of 30 dB(A). These locations are relatively more removed from industrial sources (the mines), local road traffic and are further away from the central part of Bulga village, as compared to the other three locations.

The three locations where an RBL of 33 dB(A) is found, is consistent with the data in the Environmental Impact Statement for the Extension of Warkworth Coal Mine (August 2002) (Warkworth EIS 2002) for location N6 in that document, being the central area of Bulga village. Location F herein aligns approximately with location N6 in the 2002 study. Similarly, location N5 in the 2002 study aligns approximately with location B herein and represents the northern parts of Bulga on Wambo Road. These two sites demonstrate a consistent background noise level of 30 dB(A) in both studies.

As shown in Figure 8.1, the six locations are well dispersed across the Bulga area and therefore provide representative data for all residences in the area. Hence, this data was adopted for all Bulga residences based on a specific property's proximity to influencing noise sources in the environment (eg the mines to the east, Putty Road and the central part of Bulga village) as compared with one of the six monitoring locations' proximity to these sources.

The background noise levels assigned to each assessment location are illustrated in Figures 8.2 and 8.3. Where assessment locations are not in proximity to a noise logger and no data exists, the INP minimum of 30 dB(A) is conservatively assumed.

Also, given the differences in calculated RBL at locations D and F at Bulga, a transition of the RBL was developed along this orientation east to west. On the basis that mine noise was one of the main influences on background noise in the area, the transition was developed from demonstrated changes in predicted noise levels for MTO and Bulga mines (as published in their most recent assessments).

For example, predicted noise levels for the area near background monitoring location F (eg location 72) from the MTO noise assessment Appendix D (Table D.1), shows levels of up to 39 dB(A) in Year 3. Similarly, in the vicinity of background monitoring location D, the MTO report predicts levels of up to 36 dB(A) in Year 3 (eg locations 227 and 228). This 3 dB change in mine noise between the two monitoring locations F to D is demonstrated to be relatively evenly distributed when other assessment locations between F to D are mapped (refer Table D.1 of MTO noise assessment). From this, the resulting RBL values for all assessment locations between F to D were determined as displayed in Figure 8.2.

This interpolation of the RBL results in a relatively smooth transition in RBL values across this area and more fairly assigns corresponding criteria to adjoining neighbours. This approach minimises the situation often found where one property has a marked step increase in RBL, and therefore criteria than their immediate neighbour, or in other words the problematic 'line-in-the-sand' delineation of criteria which often results in different zones of impact (for example, one property is assigned treatment while their neighbour is not).

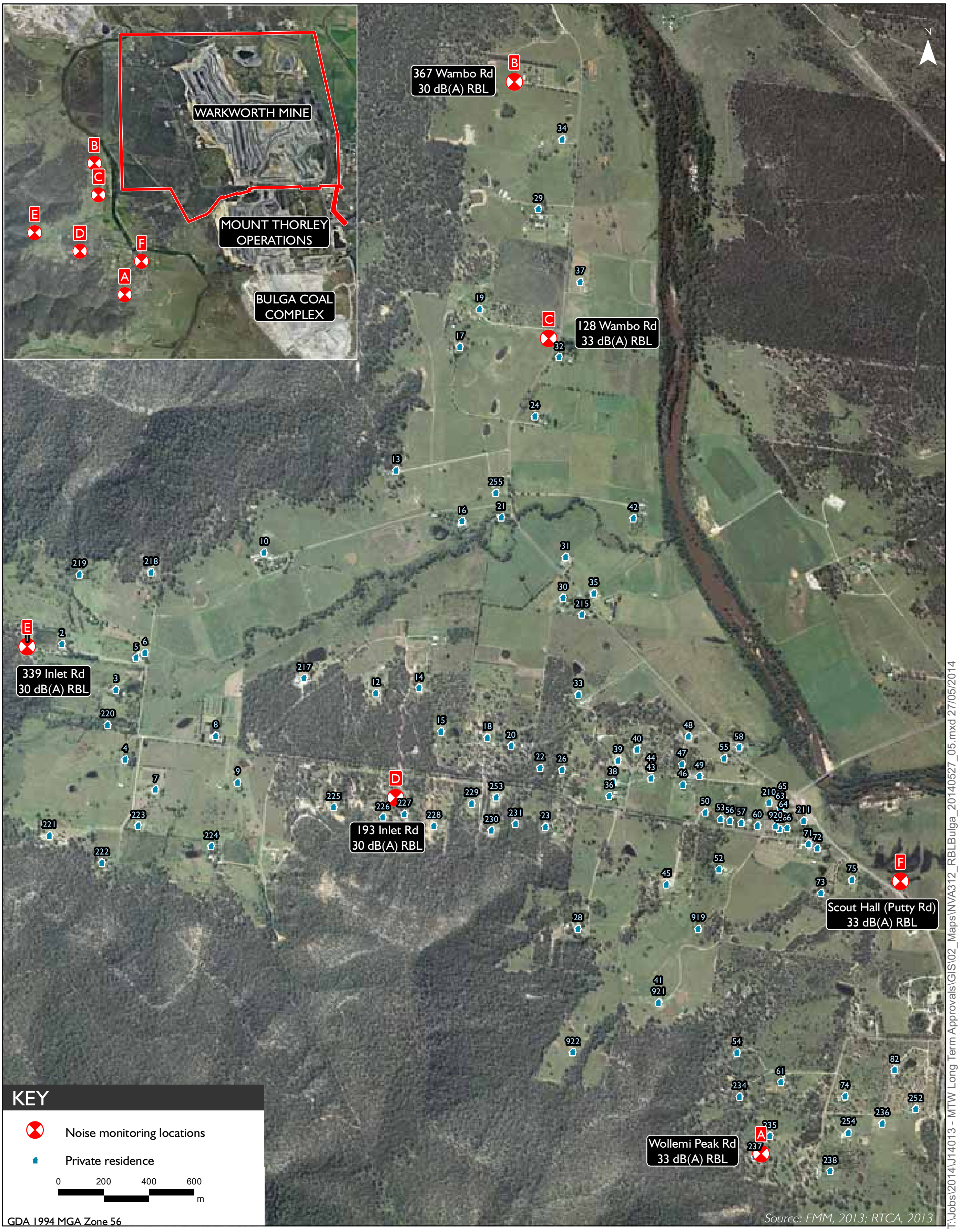
8.2 Background noise levels at other localities

The historic data contained in the Warkworth EIS 2002 includes RBL data as per the INP for Hambledon Hill, Gouldsville, Long Point Road and Warkworth village. The corresponding RBL values for these locations are as follows:

- Hambledon Hill (east of Warkworth Mine) – 30 dB(A) day, evening and night;
- Gouldsville Road (north east of Warkworth Mine) – 33 dB(A) day, evening and night;
- Long Point Road (further north east of Warkworth Mine) – 30 dB(A) day, evening and night; and
- Warkworth village (north west of Warkworth Mine) – 33 dB(A) day, evening and night.

For residences of Maison Dieu to the north of Warkworth Mine, in the absence of suitable long term monitoring data, background noise levels consistent with the INP's minimum threshold value of 30 dB(A) has been conservatively adopted. It is probable that background noise levels are higher due to Hunter Valley Operations South mine and other industry to the north of these residences.

The other group of residences considered are those located in relative proximity to the Mount Thorley Industrial area to the south east of Warkworth mine. Background or RBL data at these locations is not documented in any literature in the public domain. It is expected that these properties would be influenced by industrial noise from the nearby industrial estate, including the Mount Thorley coal loader and associated rail operations, as well as Mount Thorley mine. Further, some properties in this vicinity do not have operational noise limits in either Warkworth Mine or MTO's development consent. They do, however, have existing acquisition rights due to impacts from the mines. These are locations 144, 146 and 915 (915 is on the same lot as 144 and hence the same acquisition limit is adopted). Furthermore, existing acquisition consent noise limits for these properties differ for Warkworth Mine and MTO. For example, the Warkworth Mine development consent includes an acquisition limit of 44dB(A) for assessment location 144 while the MTO development consent modified in 2012 places location 144 in an 'acquisition on request' list. Hence, RBL values were not assigned to these locations and an assessment is completed against acquisition limits. Those properties in this area that do not have acquisition rights will be assessed conservatively as having the INP's minimum threshold RBL of 30 dB(A) for day, evening and night.

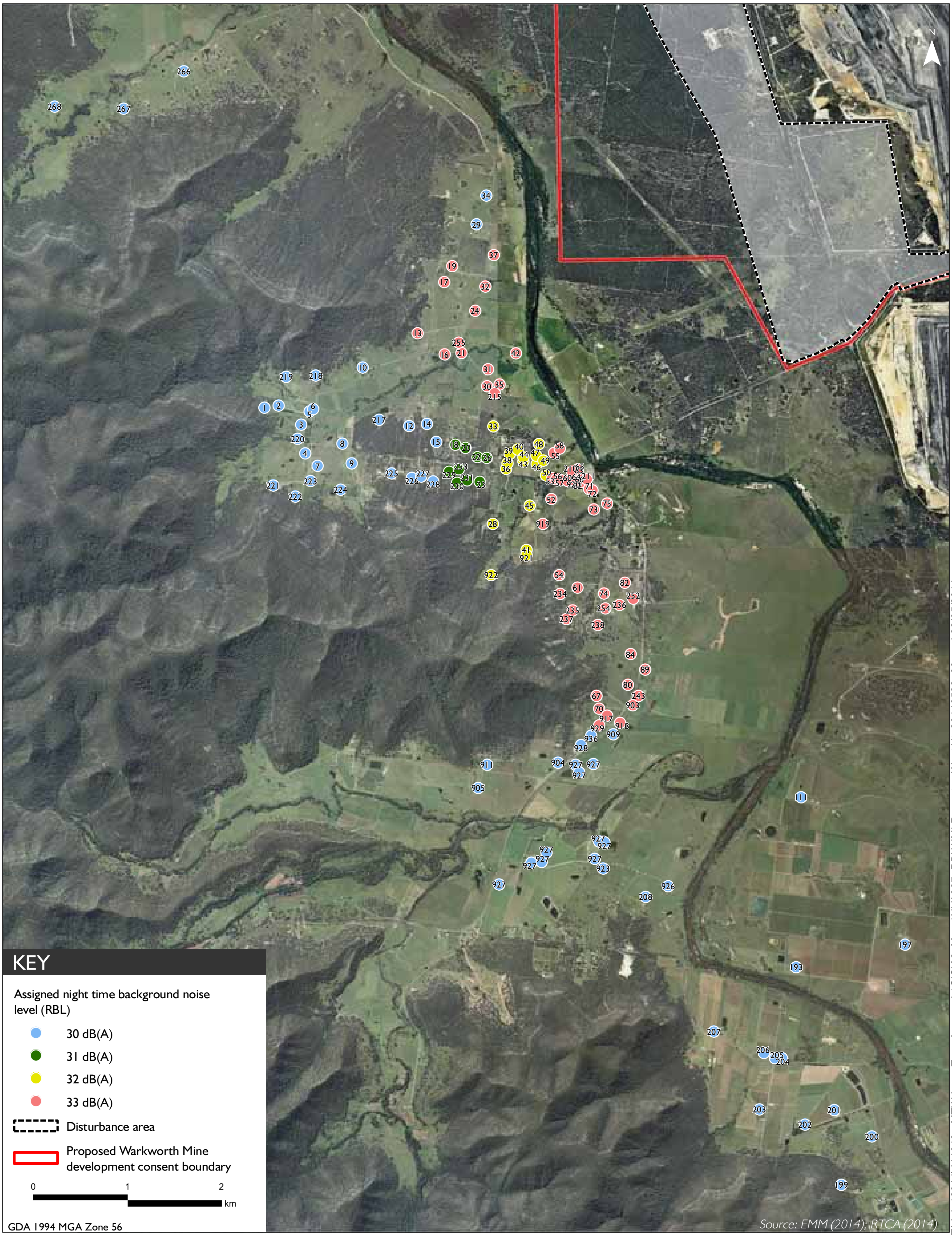


Long-term background noise monitoring locations in Bulga

Warkworth Mine continuation

Noise and vibration assessment

Figure 8.1



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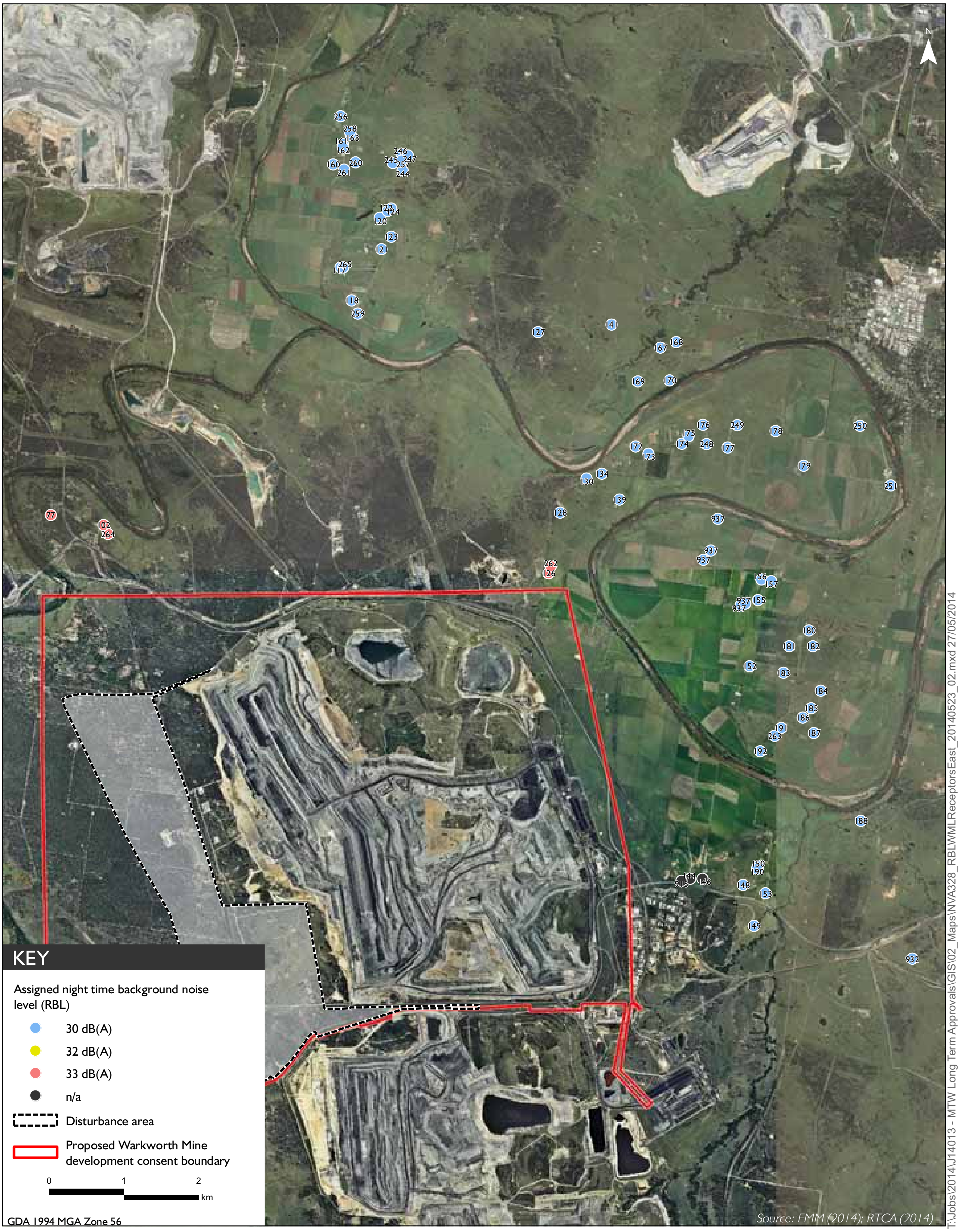
Assigned night time background noise levels - Western and southern assessment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure 8.2



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Assigned night time background noise levels - Eastern and northern assessment locations

Warkworth Continuation 2014

Environmental Impact Statement

Figure 10.4

8.3 Local weather patterns

A review was completed of meteorological data from the proponent's Automatic Weather Station (AWS) located at Charlton Ridge. The data was used in determining the above RBL values in accordance with the INP. The data was also statistically analysed to determine seasonal prevailing winds and any correlations with seasonal RBL values. These are noted in Table 8.2 and when reviewed alongside RBL data for example (as provided in Appendix E), the following trends are observed:

- Location A - The monitoring data available at the time was collected during the three winter months in 2013. During winter the winds are predominantly westerly, and therefore the data is considered to be less affected by mine noise than other times in the year. The winter period is also less likely to be affected by fauna noise (eg insects).

- Location B - There are 11 months of data for this location and hence the long term analysis provides an assessment across all seasons. It is apparent that summer months are influenced by insect noise as evident from the relative flatness and converging L_{90} and L_{eq} levels. The convergence of these noise metrics continues into autumn (eg March 2012), particularly during the night period. The data exhibited a noticeable increase in RBL's for the evening and night periods compared to daytime periods for the warmer months in the year.

- Location C - There are eight months of data analysed for this location, including summer, autumn and most of winter. The RBL values for January, February and March are relatively elevated as compared to other months. The data exhibited a noticeable increase in RBL's for the evening periods for the warmer months in the year. This was likely to be caused by insects and the like based on the relative flatness in the data during the summer months.

- Location D - As for other locations, it is probable that summer months present relatively elevated RBL's as compared to other seasons.

- Location E - Data was recorded during autumn and winter months where prevailing winds were predominantly westerly and hence likely to have kept mine noise at lower levels, resulting in the presented RBL's of 30 dB(A).

- Location F - The data exhibited a noticeable increase in RBL's for the evening and night periods for the warmer months in the year. The influences of seasonal weather and insects provide for a strong justification to assign representative RBL's for each site and period. However this was not the adopted approach and a conservative RBL adopted across all periods.

Table 8.2 Seasonal wind analysis

Season	Month	Comment on predominant winds
Summer	December	Predominantly easterly winds for D, E, N
	January	Predominantly easterly winds for D, E, N
	February	Predominantly easterly winds for D, E, N
Autumn	March	Predominantly easterly winds for D, E, N
	April	Drop in % of easterly winds; 55 % instead of >70%
	May	Westerly winds almost 50% of the time
Winter	June	Westerly winds >50% of the time
	July	Westerly winds >50% of the time
	August	Westerly winds nearly 80% of the time
Spring	September	Westerly winds almost 50% the time
	October	Increase in % of easterly winds; nearly 50% on average; 70% in evening
	November	Increase in % of easterly winds; nearly 50% on average; 88% in evening and 75% at night

Notes: D = Day, E = Evening, N = Night

9 Noise and vibration criteria

9.1 NSW Industrial Noise Policy

The overall aim of the NSW INP is to allow the need for industrial activity to be balanced with the desire for quiet in the community. One of its specific objectives is to establish noise criteria to protect the community from excessive intrusive noise and preserve amenity for specific land uses.

The INP discusses that within the community, there is a very large range of human reaction to noise, including those who are very sensitive to noise. This noise-sensitive sector of the population will react to intruding noises that are barely audible within the overall noise environment, or will have an expectation of very low environmental noise levels. On the other hand, there are those within the community who find living in noisy environments, such as near major industry, on main roads or under aircraft flight paths, an acceptable situation. The bulk of the population lies within these two spectrums, being unaffected by low levels of noise and being prepared to accept levels of noise commensurate with their surroundings.

The criteria in the INP have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time (refer Section 1.4.1 of the INP "Principles underpinning the noise criteria"). Provided the criteria in the INP are achieved, then it is unlikely that most people would consider the resultant noise levels excessive.

The INP sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB. The INP requires intrusive noise criterion to be measured over a 15 minute period.

The 15-minute period used for the intrusive noise criterion has been selected as a reasonable estimate of the period over which annoyance may occur. This time period has been used by the EPA for at least the past 14 years when the INP has been in force, and experience has shown that it is a reasonable approach to assessing intrusive noise impacts. Whereas the amenity criterion is measured over a longer time period (ie an entire 11-hour daytime, 4-hour evening or 9-hour night period) and aims to limit cumulative continuing increases in the ambient noise level within an area from industrial noise sources. In assessing the noise impact of industrial sources, both components must be taken into account for residential assessment locations, but, in most cases, only one will become the limiting criterion and form the project-specific noise levels (PSNL) for the industrial source.

9.1.1 Intrusiveness criterion

The intrusiveness criteria are derived in accordance with the INP (ie background plus 5 dB) and are listed in Table 9.3. As will be described later, these become the limiting or PSNL for the proposal.

9.1.2 Amenity criteria

The INP uses the amenity criteria to limit continuing increases in noise levels. It states "Meeting the acceptable noise levels in Table 2.1 will protect against noise impacts such as speech interference, community annoyance and, to some extent, sleep disturbance. These levels represent current best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia."

Most residences in surrounding areas potentially affected by this proposal would be categorised as rural or suburban according to the INP. However, two areas are considered as Urban/Industrial interface. The INP describes residential categories as follows:

Rural area

> "an acoustical environment that is dominated by natural sounds, having little or no road traffic..*";*

Suburban area

> "an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry";

Urban area

- dominated by 'urban hum' or industrial source noise;
- has through traffic with characteristically heavy and continuous traffic flows during peak periods;
- is near commercial districts or industrial districts;
- has any combination of the above, where 'urban hum' means the aggregate sound of many unidentifiable, mostly traffic-related sound sources; and

Urban/Industrial

> "an area defined as for 'urban' above that is in close proximity to industrial premises and that extends out to a point where the existing industrial noise from the source has fallen by 5 dB. Beyond this region the amenity criteria for the 'urban' category applies. This category may be used only for existing situations".

In the above context, the centre of Bulga is a 'suburban' area while most other assessment locations considered in this assessment reside in 'rural' areas. For this study, categorising residences as rural or suburban is inconsequential since the limiting night time amenity criterion is identical for both categories. Outside of the INP, it is acknowledged that feedback from Bulga residences describe their area as rural rather than suburban.

A relatively small number of residences adjoin the Mount Thorley industrial area and hence their amenity category is better described as urban/industrial interface according to the INP's definition. Similarly, the remaining two residences in Warkworth village are exposed to relatively high industrial noise from Wambo mine as will be demonstrated in the cumulative assessment later in this report. These two residential areas are therefore assessed as Urban/Industrial interface.

The amenity criterion for each of these categories is given in Table 9.1 (as per Table 2.1 of the INP).

One fundamental difference between the intrusiveness and amenity criteria is that the former is applicable over 15 minutes in any period, while the latter is assessed over the entire duration of the day (7 am – 6 pm), evening (6 pm – 10 pm) or night (10 pm – 7 am) periods.

Table 9.1 EPA residential amenity criteria

Indicative noise amenity area (Residence)	Time of day	Recommended L_{Aeq} noise level, dB(A)	
		Acceptable	Maximum
Rural	Day	50	55
	Evening	45	50
	Night	40	45
Suburban	Day	55	60
	Evening	45	50
	Night	40	45
Urban	Day	60	65
	Evening	50	55
	Night	45	50
Urban/Industrial interface	Day	65	70
	Evening	55	60
	Night	50	55

The INP approach to derivation of amenity noise levels is directly applicable for proposed developments new to an area with an existing level of industrial noise. Section 2.2.4 of the INP (Assessment in developing areas) clarifies that the acceptable amenity noise levels represent the ideal total level of noise from industry that should be met by a proposed development and any future developments. This section advocates where several developments are proposed, these are to be assessed as a group. It states:

> *This holistic approach allows project-specific noise levels to be set for a proposed industrial development, so that the total impact from all proposed and potential industrial developments does not cause amenity to deteriorate. In addition, this approach provides an equitable distribution in the burden of meeting the noise criteria.*

As the proposal relates to an existing site that has been present as long or longer than other mines in the area, it is not equitable to assume Warkworth Mine does not exist (ie and therefore a proposed project) while at the same time assuming other mines do exist. The appropriate method is to adopt a holistic approach as advocated by the INP, particularly given it is highly unlikely that any further developments will contribute to cumulative noise given geographic physical limitations.

The objective of the INP's holistic approach to amenity noise is to satisfy the recommended acceptable noise levels. The strictest of these is the night time acceptable amenity criterion of 40 dB(A), which has been adopted in this assessment for most residences and from all industrial noise sources as per the INP. This is a practical approach in the current situation given the reasons above but also because the neighbouring industrial sites (MTO and Bulga Coal Complex) are changing their noise contribution in the area as described in respective environmental assessments. The other instrument that supports this holistic approach is the non-discretionary Mining SEPP described in Section 9.2.

In deriving the amenity target for Warkworth Mine, the INP does not support and it is not appropriate to ignore Warkworth Mine's current contribution to the total existing industrial noise levels of the area.

Nonetheless, to illustrate the holistic method's appropriateness, we considered several example assessment locations to demonstrate whether the intrusive or amenity criteria is the more limiting when ignoring the presence of the existing Warkworth Mine operations (refer to Table 9.2). It is demonstrated that for all example assessment locations, the intrusiveness criteria is the more limiting and therefore becomes the adopted criteria (or PSNL) for the proposal. In one case (location 58) the two criteria have the same target level, but the intrusive value is the more limiting metric.

Table 9.2 EPA residential amenity versus intrusiveness criteria test cases

Assessment location	Existing industrial noise[1]	Amenity criteria			Intrusive criteria
(Area)	$L_{eq,9hr}$, dB(A)	ANL $L_{eq,9hr}$, dB(A)	Difference, dB(A)	Adjusted Criteria, $L_{eq,9hr}$, dB(A)[2]	$L_{eq,15min}$, dB(A)
15 (Bulga)	35	40	5	38	35
26 (Bulga)	36	40	4	38	36
44 (Bulga)	36	40	4	38	37
58 (Bulga)	36	40	4	38	38
77 (Warkworth village)	57	50	-7	40	35
128 (Gouldsville)	32	40	8	40	35
146 (Mount Thorley)	36	50	14	50	N/A
150 (Mount Thorley)	36	40	4	38	35

Notes: 1. In deriving 'existing' noise levels from MTO and Bulga mine, the latest noise assessments were adopted. This provides a more realistic quantification of the cumulative impacts when the proposal coincides with neighbouring contributions, which are changing relative to current levels. Existing Wambo mine noise adopted from 2003 EIS. Where locations do not match those listed, the closest neighbouring location was used. Hunter Valley Operations South monitoring results obtained from the 2003 EIS. An industry accepted approximation between $L_{eq,15min}$ and $L_{eq,9hr}$ of 3dB was adopted.

ANL = Acceptable Noise Level

2. Amenity criteria adjusted as per Table 2.2 of the INP

9.1.3 Summary of criteria approach

Irrespective of the RBL values assigned to specific assessment locations, the amenity criteria sets a noise 'ceiling' for all industrial sites to stop 'noise creep'. This is illustrated in Figure 9.1 using the night time amenity criteria of 40 dB(A) $L_{eq,9hour}$. This is an example only, but shows as each mine comes into existence (Mine 1 to Mine 3 in that order) it is possible that RBL values step up each time as does the corresponding intrusive criteria for each mine. However, this creep effect is at some point stopped by the amenity criteria ‘ceiling’ as shown because the INP requires that both the intrusiveness and amenity criteria are met.

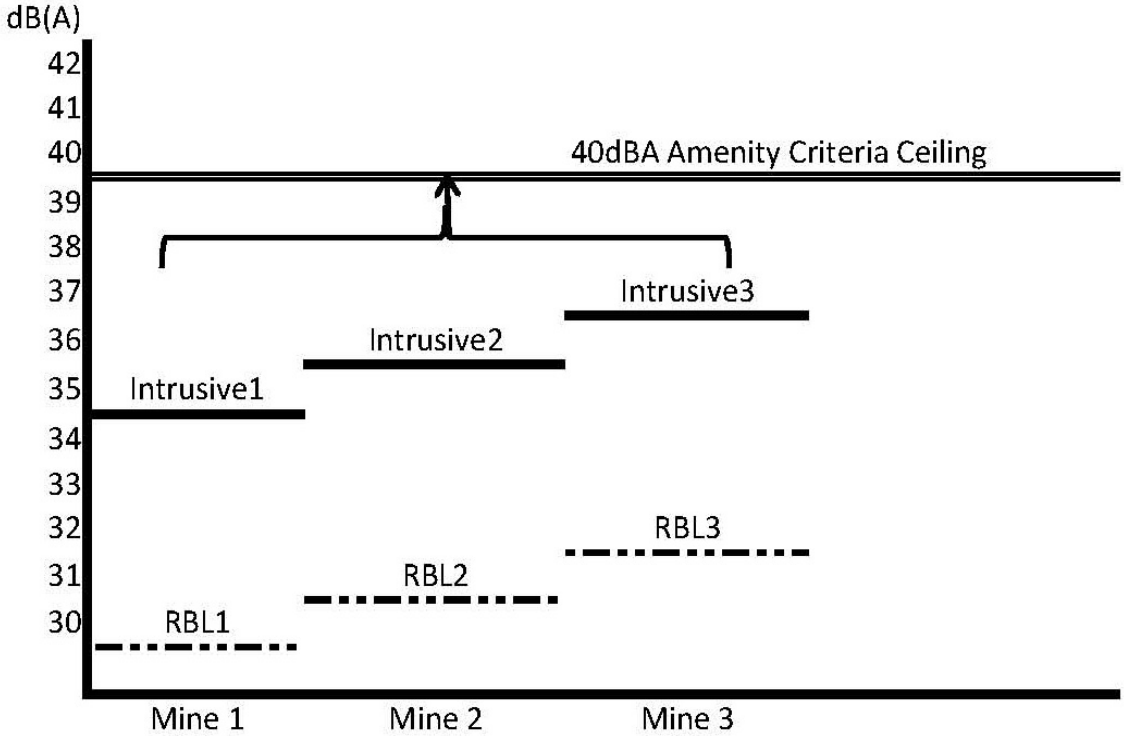


Figure 9.1 Amenity criteria to stop 'noise creep'

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

The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP) was recently amended and now includes clause 12AB Non-discretionary development standards for mining. The clauses relevant to this project are listed below.

Clause 12AB(1):

> The object of this clause is to identify development standards on particular matters relating to mining that, if complied with, prevents the consent authority from requiring more onerous standards for those matters (but that does not prevent the consent authority granting consent even though any such standard is not complied with).

Clause 12AB(3) Cumulative noise level:

> The development does not result in a cumulative amenity noise level greater than the acceptable noise levels, as determined in accordance with Table 2.1 of the Industrial Noise Policy, for residences that are private dwellings.

Other clauses of interest for this project are listed below.

Clause 12AB(5) Airblast overpressure:

> Airblast overpressure caused by the development does not exceed:
>
> (a) 120 dB (Lin Peak) at any time, and

(b) 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.

Clause 12AB(6) Ground vibration:

Ground vibration caused by the development does not exceed:

(a) 10 mm/sec (peak particle velocity) at any time, and

(b) 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.

The cumulative noise clause described in the Mining SEPP is fundamental to this study and is clear in its objective that the holistic approach to amenity is advocated as described earlier.

9.3 Operational noise assessment criteria

Operational noise assessment criteria for the proposal have been set considering the methods described in the NSW INP and the Bulga background noise monitoring review (prepared in accordance with the NSW INP as described in Section 8.1).

Table 9.3 provides the proposed assessment criteria or PSNL for the proposal.

Table 9.3 Noise assessment criteria, dB(A)

Locality	Assessment location	Rating Background Level (RBL)[1]	Intrusiveness criteria, PSNL (RBL+5dB), $L_{eq,15min}$ [2]	Derivation of RBL
Bulga	13, 16, 17, 19, 21, 24, 30-32, 35, 37, 42, 52-58, 60-67, 70-75, 80, 82, 84, 89, 210, 211, 215, 234-238, 243, 252, 254, 255, 903, 917-920, 929	33	38	Proximity similar to logger at A,C and F
	28, 33, 36, 38-41, 43-50, 921, 922	32	37	Background set using transition of noise levels from MTO and Bulga Coal Complex in this region (discussed in Section 8.1)
	18, 20, 22, 26, 23, 229, 230, 231, 253	31	36	Background set using transition of noise levels from MTO and Bulga Coal Complex in this region (discussed in Section 8.1)
	1-10, 12, 14, 15, 29, 34, 217, 218-228	30	35	Proximity similar to logger at B, D or E
	266-268, 904, 905, 909, 911, 927, 928, 936	30	35	RBL not available - assumed minimum
Gouldsville/	126, 262	33	38	RBL From 2002 EIS location N2
Long Point	128, 130, 134, 139, 172-179, 248, 249	30	35	RBL assumed from 2002 EIS location N3
	127, 141, 167-170, 250, 251	30	35	RBL not available - assumed minimum

Table 9.3 Noise assessment criteria, dB(A)

Locality	Assessment location	Rating Background Level (RBL)[1]	Intrusiveness criteria, PSNL (RBL+5dB), $L_{eq,15min}$ [2]	Derivation of RBL
Hambledon Hill/Wylies Flat	152, 155-157, 180-187, 191, 192, 263, 937	30	35	RBL from 2002 EIS location N6
Maison Dieu	117, 118, 120-124, 160-163, 244-247, 256-261, 265	30	35	From HVOS Coal Project EA 2008
Milbrodale	111, 193, 197, 199-208, 923, 926	30	35	RBL not available - assumed minimum
Mount Thorley	144[3], 146[3], 915[3]	n/a	n/a	RBL not available.
	148-150, 153, 188, 190, 932	30	35	RBL not available - assumed minimum
Warkworth	77, 102, 264	33	38	RBL assumed from 2002 EIS location N4

Notes: 1. Rating background level, or RBL, derived in accordance with the INP as described in Section 8.

2. Intrusiveness criteria is equal to the measured RBL + 5 dB.

3. RBL's without influence from the Site are not available and existing consent do not specify operational limits (only acquisition limits are provided in the existing consent). These locations have been previously identified as impacted by the Site.

9.4 Zones of impact

Section 1.4.8 of the INP describes zones of impact from industrial noise. It states "The various assessed levels of impact around an industrial noise source could be described as a zone of affectation, characterised by annoyance. Within this zone could lie a much smaller zone closer in to the source where impacts were greater and justified acquisition of residences. The border between the annoyance and acquisition zones would be represented by a noise level well above both background level and the EPA's criteria".

The commonly applied approach to zones of impact accepted by the NSW DP&E is provided below.

9.4.1 Noise management zone

The noise management zone is where modelled noise levels are above the PSNL but below the acquisition criteria (described later in Section 9.4.2). Within the management zone, receptors may experience noise levels up to 5 dB(A) above the PSNL. Depending on the degree of potential impact above the PSNL (1 to 5 dB), noise impacts in the noise management zone could range from minor (1 to 2 dB) to moderate (3 to 5 dB). For contemporary planning approvals for mining projects in the NSW, DP&E have prescribed the following actions in the conditions of approval:

- prompt response where issues of concern are raised by community;
- noise monitoring onsite and within the community at representative locations;
- consideration of on-site noise mitigation measures and plant maintenance procedures by the mine and where appropriate sound suppression components and preventative maintenance; and
- investigation of, and where practical and cost-effective, acoustical treatment/mitigation at receptors where levels are 3 to5 dB above PSNL (typically referred to as the 'mitigation zone').

The INP at Section 8.2 'Negotiation between proponent and regulator' states:

> Where proposed mitigation measures will not reduce noise levels to the project-specific noise levels, the proponent should seek to negotiate with the regulatory/consent authority to demonstrate that all feasible and reasonable mitigation measures have been applied. The regulatory/consent authority can choose to accept the level of impact proposed, or negotiate for a better level of control where this is considered achievable.
>
> Where, in the final analysis, the level of impact would still exceed the project-specific noise levels, the economic and social benefits flowing from the proposed development to the community should be evaluated against the undesirable noise impacts.
>
> Where it can be demonstrated by the proponent that the development offers net benefits, a regulatory consent authority may consider these as grounds for applying the achievable noise levels, rather than the project-specific noise levels, as the statutory compliance limit.

9.4.2 Noise affectation zone

The noise affectation zone applied by DP&E is where noise levels are more than 5 dB over the PSNL. Implementation of the following measures may be required:

- discussions with relevant property owners to assess concerns and provide solutions;
- implementation of acoustical mitigation at receptors; and
- negotiated agreements with property owners, or acquisition of the property by the proponent upon request by the property owner.

9.5 Cumulative noise

In addition to considering the individual impact of the proposal on residences, the INP also requires an assessment of the Proposal's contribution to the total, or cumulative noise received by any particular residence from all industrial operations.

The cumulative noise impacts resulting from the proposal are most appropriately assessed in the context of the amenity criteria listed in Table 9.1. The assessment of cumulative impacts is presented in Section 11. This approach is consistent with the INP's approach to the assessment of cumulative noise.

9.6 Sleep disturbance

The operational criteria described in Sections 9.1, which consider the average noise emission of a source over 15 minutes, are appropriate for assessing noise from steady-state sources, such as engine noise from mobile plant and other equipment. However, noise from sources such as reversing alarms or track plates is intermittent (rather than continuous) and, as such, needs to be assessed using the L_1 or L_{max} noise metrics. Such criteria is provided in the INP application notes which can be found on the EPA website.

The most important potential impact of intermittent noise to be considered is sleep disturbance of nearby residents. While the INP does not specify a criterion for assessing sleep disturbance, various studies including the EPA's *Road Noise Policy* (RNP) (DECCW 2011) indicate that levels below 50 to 55 dB(A) inside homes are unlikely to wake sleeping occupants. If bedroom windows are open, this corresponds to an external maximum noise level of approximately 60 to 65 dB(A) L_{max}. Similarly, the World Health Organisation (WHO 1999) suggest that levels below 45 dB(A) inside homes are unlikely to wake sleeping occupants. It is noted that the WHO criterion applies under the assumption that windows are closed.

However, the EPA's current position on sleep disturbance, is that maximum (L_{max}) noise from industrial sources should not exceed background (or RBL) plus 15 dB. Based on a night time RBL of between 30 dB(A) and 33 dB(A (refer to Section 8), this assessment has adopted an external sleep disturbance criterion of 45 dB(A) to 48 dB(A) L_{max} for residences, as applicable.

Where the sleep disturbance criterion is satisfied, sleep disturbance is unlikely. But where it is not met, a more detailed analysis is required. The detailed analysis should quantify the extent of impacts, including levels of exceedance above the criterion and the duration and the number of events that may occur.

9.7 Low frequency noise

Low frequency noise (LFN) has been raised as an issue by surrounding residences of Warkworth Mine in previous consultation undertaken as part of normal noise management activities and also as a part of the social impact assessment consultation being undertaken for this EIS. Warkworth Mine has listened to this feedback and to consider this issue EMM have completed three different methods of assessment for LFN as detailed below. These include the INP, 'Broner' and The Department of Environment Food and Rural Affairs (DEFRA) (UK) methods.

9.7.1 NSW Industrial Noise Policy

Section 4 of the INP provides guidelines for applying 'modifying factor' adjustments to account for LFN emissions. The INP states that where there is a difference of 15 decibels or more between the measured 'C' weighted (dBC) and measured 'A' weighted (dBA) levels, then a correction factor of 5 dB is applicable to the measured noise at the assessment location.

The INP's LFN criteria are being reviewed in light of challenges in practice at large distances from sources. For example, sounds that do not pose low frequency dominated spectra at close range, would by virtue of enough distance loss factors, inappropriately attract the INP penalty for low frequency as higher frequencies in their spectra are considerably more abated than the lower frequencies. The INP LFN criteria were originally intended for testing sources at relatively close range.

A letter prepared by the NSW Ombudsman (dated 22 January 2014) to DP&E relating to the subject site and the INP's approach to LFN, is attached in part as Appendix G. This document notes that: the DP&E (formerly DPI) and EPA (formerly OEH) agrees on the technical merits on the difficulty in applying the LFN modifying factor in rural areas; EPA have commissioned a comprehensive study on LFN as part of the revision of the INP; that EPA would not include conditions about LFN in an Environmental Protection Licence (EPL); and a review of the INP will be conducted with LFN being a priority issue.

The letter shows that the Environment Defenders Office (EDO) forwarded a complaint on behalf of the Bulga Milbrodale Progress Association Inc. (BMPA), about the DP&E's decision to refuse to apply LFN data in accordance with the Industrial Noise Policy (INP) and condition of consent for Mount Thorley and Warkworth coal mines, to the NSW Ombudsman.

The results of this complaint, were contained in the letter to DP&E. A copy of this was obtained under the Government Information (Public Access) Act 2009. An extract from this letter follows:

> *"As you are aware, Bryce Purches of this office had made inquiries with the DP&E and the NSW Office of Environment and Heritage (OEH). Mr Purches has recently left, and the file has been reallocated to me for assessment of the information received by those agencies.*

The Ombudsman is primarily concerned to ensure government agencies are fair and reasonable in their dealings. It is clear that opinions, even by experts, may differ. We are unwilling in such situations to question expert opinion, except in those rare cases where the opinion appears so unsupportable that it suggests something improper may have occurred. It is seldom appropriate for us to decide between differing technical views, nor do we have the resources to routinely obtain our own independent expert opinion.

To this end, we sought information from DPI and OEH about the review of the INP, and the application of LFN data to the operations of Mount Thorley Warkworth open cut mine in accordance with the conditions of consent DA 300-9-2002-1.

DPI has provided information and evidence to demonstrate that the (then) DECCW (OEH) had from 2010 made a commitment to revise the INP in relation to low frequency noise, and to review the INP as a whole. While progress on this has been slower than expected, our verbal interactions with OEH has confirmed that they anticipate a review will be completed later this year.

Assessment of LFN appears to be quite contentious, especially in rural settings. I do not propose to develop a view as to which position is most likely accurate, as I have explained above, we do not have that expertise, or the resources to seek that expertise.

It would appear to me, however, that the following points have been agreed by DP and OEH:

- *There may be technical merit as to the difficulty in applying the low frequency modifying factor in rural areas, subject to further study. OEH has commissioned a comprehensive study of LFN as a part of the INP review, titled Low Frequency Noise & Infrasound, still underway;*
- *That OEH would not include conditions about LFN in Environment Protection Licences; and*
- *A review of the INP would be conducted, and LFN would be a priority issue.*

When we receive complaints about compliance and enforcement, failure to take action alone is generally not sufficient grounds to justify an investigation by this office. We look closely at the facts of each case, including the agency's reasons for its decisions.

In this case, there appears to be appropriate consideration of professional advice from qualified staff and experts about LFN that casts doubt as to the practicality of strict enforcement of the condition of consent. Notwithstanding this, OEH has also acknowledged that any review of LFN in the INP will include consultation with NSW Health given the health issues said to be associated with LFN.

Noise monitoring continues to be a high priority issue, and a Noise Management Plan and Noise Monitoring Programme for the whole mining complex are in place. Further, DPI due to a Land and Environment Court decision.

For the reasons outlined above, it appears to me the information and evidence provided by the agencies is sufficient to satisfy me that the DPI has provided adequate reasons for its decision and has properly considered all relevant issues, and there is no other evidence of wrong conduct that requires intervention by this office.

I appreciate why you forwarded this matter to this office, and I acknowledge the importance of noise monitoring and the impacts of noise on the local community. BMPA should continue to engage with the agencies and the mine operators as is appropriate and participate in community consultation and engagement as opportunities arise."

The above confirms that the applicant currently undertakes regular LFN monitoring as part of the noise management regime for the Warkworth Mine.

9.7.2 'Broner' method

A paper by Dr Norm Broner, "*A Simple Outdoor Criterion for Assessment of Low Frequency Noise Emission*" published in Acoustics Australia Vol.39 April 2011, provides absolute level criteria for frequency noise. The paper presents the following targets external to a residence:

- for the daytime or when source operates intermittently (1-2 hours):
  - desirable 65 dBC L_{eq};
  - maximum 70 dBC L_{eq};
- for the night time or when the source operates continuously:
  - desirable 60 dBC L_{eq}; and
  - maximum 65 dBC L_{eq}.

This assessment will also review LFN against the Broner (2011) approach.

9.7.3 Department of Environment, Food and Rural Affairs (United Kingdom)

The Department of Environment Food and Rural Affairs (DEFRA) (UK) commissioned the University of Salford to prepare a detailed study on LFN in the community with the intent of formulating a practical LFN criterion to be used in the field by environmental health officers. The study, *Proposed criteria for the assessment of LFN disturbance* (Dr Moorhouse et al 2005), draws on several European LFN assessment methods to develop a frequency based reference criterion.

The process involves measuring the L_{eq}, L_{10} and L_{90} in third octave bands between 10 Hz and 160 Hz within an unoccupied room where the alleged LFN source has been observed. If the measured L_{eq} exceeds the levels in Table 9.4 in any third octave band, then this indicates the presence of a LFN source. This character of the noise should also be checked using an audio recording, where possible.

Table 9.4 DEFRA – proposed low frequency reference curve

Hz	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB, Leq	92	87	83	74	64	56	49	43	42	40	38	36	64

Notes: 1.The levels can be relaxed by 5 dB if: the source is present during the day only; or if the source is steady as demonstrated by: L10-L90 < 5 dB or the rate of change of sound pressure level (Fast time weighting) is less than 10 dB per second, where these parameters are evaluated in the third octave band which exceeds the reference curve values by the greatest margin.

The criterion applies to internal measured noise levels and therefore has fundamental limitations at the proposal stage, where external noise levels in single octave bands down to 31.5 Hz can be typically modelled and assessed. The application at the proposal stage would also rely on broad assumptions relating to the facade reduction provide by a given dwelling, which would vary greatly depending on the building materials dwelling to dwelling (eg light-weight versus brick veneer construction). Furthermore, room acoustic affects such as reverberation and room modal characteristics would present challenges at the assessment stage.

A test of internal LFN was completed at an unused dwelling to demonstrate the DEFRA approach and the results are described later in this report. Dr Moorhouse's paper provides a review of low frequency assessment standards and criteria in various European countries. Most methods reviewed in the document apply a reference curve similar to that proposed by DEFRA for use in the UK. This document also describes the method in German standard DIN45680 (1997) which uses preliminary measurement to review the dB(A) and dB(C) difference. If this difference is found to be greater than 20 dB, then further investigation using a nominated reference curve is to be undertaken. This preliminary measurement criterion is less stringent than the 15 dB threshold prescribed in the INP.

9.8 Blasting criteria

Recommended criteria for noise and vibration from blasting are provided in *Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC 1990) (the ANZECC guidelines) These criteria apply to minimise human annoyance and discomfort and were not developed to control possible structural damage. However, if ground vibration peak particle velocities comply with criteria for minimising human annoyance and discomfort, they would also be below levels that may cause structural damage to buildings.

This criteria is described below and is generally consistent with the current development consent conditions for the Site and with the Mining SEPP non-discretionary standards.

9.8.1 Noise overpressure

The ANZECC guidelines specify that air-blast overpressure should not exceed 115 dB(LinPeak) for more than 5 % of the total number of blasts over a period of 12 months. However, the maximum level should not exceed 120 dB (LinPeak) at any time. The dB (LinPeak) unit of sound measurement considers the low frequency sounds not audible to the human ear but can be 'felt'.

9.8.2 Ground vibration

Peak particle velocity (PPV) from ground vibration should not exceed 5 mm/s for more than 5% of the total number of blasts over a period of 12 months (ANZECC 1990). However, the maximum level should not exceed 10 mm/s at any time. The ANZECC guidelines also recommend that a level of 2 mm/s be considered as the long-term regulatory goal for the control of ground vibration.

9.8.3 Time and frequency of blasting

The ANZECC guidelines recognise that under some circumstances or at certain sites, blasting cannot always be restricted to general working hours (9 am to 5 pm Monday to Saturday) nor always comply with blast level limits. This is most often due to the enhancement of noise due to prevailing winds during blasting periods.

Coal & Allied has consulted rural communities surrounding their operations and has found that generally the community support flexibility in blast times. These communities are more sensitive to dust from blasting and would prefer blasting to be undertaken earlier or later in the day where wind conditions are more suitable and less likely to carry dust. The ANZECC guidelines state that blasting should not take place on Sundays or public holidays.

Condition 24 in Schedule 4 states:

> The Applicant shall only carry out blasting at the development between 7 am and 6 pm, Monday to Saturday, inclusive. No blasting is allowed on Sundays or public holidays, or at any other time without the written approval of the Director-General.

This will continue to be adhered to under the proposal. The ANZECC guidelines recommend blasting should be avoided, if practical, during periods of temperature inversions. These restrictions do not apply where the effects of blasting are not perceived at noise sensitive locations.

In addition to the above criteria, best practice procedures can, and are, used to effectively minimise noise impacts. These are detailed in the site's Environmental Management System (EMS) procedures as described in Sections 3 and 4 earlier.

9.8.4 Structural damage from blasting

Blast noise overpressure considerations include possible damage to some building elements such as windows if levels are relatively high. The Australian Standard, *AS2187.2 – 2006 Explosives - Storage and Use Part 2 Use of Explosives (Appendix J*), states that:

> From Australian and overseas research, damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133dBL.

For assessment of damage from blast ground vibration AS2187.2 – 2006 (Appendix J) provides frequency-based criteria, derived from *British Standard 7385-2* and *US Bureau of Mines Standard RI 8507*. Such criteria are less stringent than for human comfort levels of 5 mm/s described earlier.

A report by Bill Jordan & Associates (2009), *Edinglassie Homestead & Rous Lench – Blast Vibration Vulnerability*, concluded that a vibration limit of 10 mm/s peak component particle vibration velocity is appropriate for heritage buildings. The report concluded that blast vibration at this level would be safe and that the 10 mm/s limit was considered conservative.

9.9 Road traffic noise

As part of the proposal, the advancement of open cut mining to the west requires the closure of Wallaby Scrub Road prior to the indicative Year 3 mine plan. This closure will have the effect of diverting traffic to alternative routes via Golden Highway, Putty Road and Broke Road. The RNP provides traffic noise goals for such changes in conditions.

Assessment locations potentially affected by increased traffic volumes due to the detoured Wallaby Scrub Road traffic are near Golden Highway and Putty Road. These applicable sections of road are classified as freeways/arterial/sub-arterial as per the RNP. Therefore the proposal will be assessed as Existing' residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments'. The following daytime and night time criteria should be met according to the RNP:

- Daytime: 60 dB(A) $L_{eq,15hr}$
- Night time: 55 dB(A) $L_{eq,9hr}$

The RNP defines daytime as the period between 7 am to 10 pm and night time as the period between 10 pm to 7 am. These definitions differ from those outlined in the INP, which only relates to industrial noise sources on site.

The RNP policy recommends that traffic arising from the development should not lead to an increase in existing noise levels of more than 2dB, if the base criteria above are already exceeded. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria.

In addition to meeting the assessment criteria, any significant increase in total traffic noise at assessment locations must be considered. Assessment locations experiencing increases in total traffic noise levels above those presented in Table 9.5 should be considered for mitigation.

Table 9.5 Relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase - dB(A)	
		Daytime (7 am to 10 pm)	**Night time (10 pm to 7 am)**
Freeway/arterial/sub-arterial roads and transitways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{eq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{eq(9\text{-}hr)}$+ 12 dB (external)

10 Operational noise impact assessment

This section presents the results of modelled noise levels from the proposal inclusive of the effect of prevailing meteorological conditions recorded at the Site.

The INP requires the assessment of predicted noise levels against the PSNL's and where these are exceeded, identify all reasonable and feasible noise mitigation. The INP Section 7 "Mitigating noise from industrial sources" states there are three main strategies for noise control. These are controlling noise at the source, the transmission path and at the receiver. Initial modelling for unmitigated operations showed that mitigation measures were warranted. Hence, the modelling results herein adopt the following main mitigation strategies.

- Mitigation at the source: The applicant has currently attenuated 50% of the haul truck fleet, with the commitment to attenuate all trucks by the end of the 2016 calendar year. Attenuation packages to all dozers, excavators and drills is progressing and will also be complete by the end of 2016 calendar year. The cost of the attenuation program is in excess of $50M across MTW; and

- Operational management (mitigation at the source) : During adverse weather conditions identified 24 hours ahead of planned operations, a relatively small number of plant will be either relocated to in-pit areas or shut down so that total site noise satisfies criteria. These items are identified in the following sections. This method is common practice for current operations at the Site and is used elsewhere in the mining industry. This measure also results in a significant annual cost to the business associated with lost production.

Noise mitigation along the transmission path was also considered and was found to be ineffective for the residences of Bulga given the relatively flat open terrain between the Site and residences.

Finally, controlling noise at the receiver has been considered and properties have been identified where treatment to existing dwellings would be made available.

10.1 Noise modelling approach

To assess the potential for noise impacts on residences, a total of three indicative mine scenarios have been assessed over the 21 year life of the proposal. These three indicative mine plans reflect the worst-case operating scenarios in respect of the potential for impacts to surrounding residences. These indicative mine plans are referred to as Year 3, Year 9 and Year 14, each indicating the approximate time after the anticipated commencement date.

- Indicative Year 3 (nominally 2017) - early in the proposal timeframe when operations have started to encroach on Saddleback Ridge and necessitate the closure of Wallaby Scrub Road. At this stage, extraction at Warkworth Mine is at the currently approved upper limit of 18 Mtpa. It is also generally representative of current operations when residences to the east and north-east are potentially most affected by the proposal. Minimal construction activities are planned for the proposal. The most significant construction activities proposed include the Putty Road underpass and construction of the out-of-pit dam. Noise from these construction activities would be significantly less than that from mining operations and would therefore not contribute to the total overall received noise at surrounding assessment locations. Nonetheless, dam construction was modelled together with indicative Year 3 mining for completeness.

- Indicative Year 9 (nominally 2023) - approximately the half way point of the proposal timeframe and represents the stage when mining is predicted to have mined through Saddleback Ridge. Production at Warkworth Mine has peaked and is supported by the upgraded equipment fleet. For this reason, this stage in the operation is generally worst case for most assessment locations as will be demonstrated later.

- Indicative Year 14 (nominally 2028) - mining (at a sustained maximum production rate of 18 Mtpa) has extended to its western most point at, some 375 m further west than Year 9. Importantly however, by this time the plant is operating mostly below the highwall in relatively shielded areas at the western most parts of the mine. For this reason, noise during this stage is not worst case for Bulga residences. Other activities in this stage include establishment of final landform and rehabilitation areas to the east side of the Site. This will provide shielding to assessment locations east of the Site. Similarly, the footprint of the final year of the proposal operation (Year 21) will not extend any further west than Year 14. Between Year 14 and Year 21, the operation continues and mining deepens. Hence, Year 21 was not modelled as plant is shielded from assessment locations more than in any previous years.

Overburden will be emplaced at either Warkworth Mine or MTO to create an undulating final landform. Overburden transferred to MTO will also assist in filling the Loders Pit void.

During operations, alternative mine plans may be used to the indicative plans above, provided that the environmental impacts remain within the envelope as assessed in this EIS. The mining operations can therefore retain some flexibility within the constraints of the identified and assessed environmental envelope.

Each indicative mine plan also identifies the approximate location of mining equipment in these typical worst case operational scenarios.

Noise modelling was based on three-dimensional digitised ground contours for the surrounding land, mine pits and overburden emplacement areas for three stages of the proposal. The indicative mine plans represent worst case snapshots and equipment was placed at various locations and heights, representing realistic operating conditions in each of these indicative stages of the mine.

The noise model was configured to predict the total L_{eq} noise levels from mining operations based on the sound power levels presented in Table 10.2. These sound power levels are short term L_{eq} values of generally pass-by events and are therefore conservative representations of the INP's assessment metric, the $L_{eq,15minute}$. It should be noted that the model includes the entire spectral emissions for each individual plant item and therefore uses these spectra to predict received levels. This accounts for the linear characteristics of each source and not just the overall dB(A) level. The results presented assume all plant and equipment to be operating simultaneously and at full power. In practice, such an operating scenario would occur very infrequently. The noise predictions presented are therefore conservative.

The mine plans that form the basis of the assessment were optimised over many iterations of noise modelling for different operating scenarios. In arriving at the mine plans, alternative noise minimisation techniques were identified and applied. Some potential options, however, were rejected for a number of reasons. For example, reducing the height of night time overburden emplacement activities and acoustically treating the CPP were considered but found to provide minimal acoustic benefit (less than 1 dB(A)).

Noise mitigation along the transmission path such as a large noise bund was also considered and was found to be ineffective for the assessment locations in Bulga. The slope of the terrain between the mine and Wollemi Brook to the west would require a bund to be considerable in extent and height and would only provide minimal noise benefit to Bulga residences. Notwithstanding, if line of sight to residences could be obstructed, the benefit would be marginal during adverse weather conditions when it would be needed most. The impractical nature of such a bund includes the need for considerable land area to accommodate the bund's base and would need to be adjacent the Wollombi Brook in the proposed offset areas so as not to sterilise coal resources (see Chapter 23 of EIS).

Further plant relocation to in-pit areas or plant shutdowns to achieve PSNL at all assessment locations in Bulga (ie beyond those described previously) were also considered in the modelling and assessment process. However, these were found not to be reasonable for the Site. For example, the scenario required to achieve PNSL at all assessment locations in Bulga village resulted in one excavator, one dragline, 12 haul trucks, 12 dozers and two drills being relocated or shut down during adverse meteorological conditions. The resultant loss in production from this quantity of plant being disengaged, for the frequency and duration required due to the presence of adverse meteorological conditions, exceeds $100million (real NPV) over the life of the proposal.

10.2 Noise modelling parameters

The prediction of noise from the proposal's operations was undertaken using the Predictor software by Bruel & Kjaer. The software predicts total noise levels at residences from the concurrent operation of multiple noise sources. The model included consideration of factors such as the lateral and vertical location of plant, source-to-receiver distances, ground effects, atmospheric absorption, topography of the mine and surrounding area and meteorological conditions. This section outlines the base parameters used in the noise modelling.

In EMM's experience on many similar projects, the EPA, has encouraged site specific validation of noise predictions wherever possible to better represent potential impacts from industrial operations. The results of an extensive field validation exercise, part of and as documented in the 2002 and 2010 noise assessments, were adopted in the current prediction of noise levels for prevailing winds. Similar studies have been conducted and results of which published in technical journals (eg *Experimental Outdoor Sound Propagation' 13th International Congress on Sound & Vibration*, 2006 and *Experimental Outdoor Sound Propagation vs ENM* Australian and New Zealand Acoustic Society Conference, 2007). These studies concluded that the prediction of L_{eq} noise is consistently overestimated during weather enhanced conditions, a finding also consistent with a NSW Australian Acoustic Society presentation by Dr Robert Bullen in 2009 about such modelling software algorithms, particularly the Environmental Noise Model (ENM) algorithm.

10.2.1 Equipment noise levels

Table 10.1 describes the main noise sources associated with the proposal.

Table 10.1 Main noise sources of the proposal

Mining activity	Typical plant
Mine	Drills, shovels, front-end loaders, trucks, excavators, dozers, graders, draglines, cable reelers and generators for lighting sets.
Overburden emplacements, rejects emplacement and haul roads	Trucks, dozers, graders and generators for lighting sets.
Coal transportation	Trucks and graders on haul roads. CPP and conveyor.

Sound power levels for equipment used for in-pit earth-moving and overburden emplacement are listed in Table 10.2. These sound power levels are based on measurements at Site, and supplier in-service commitments for newly purchased or retro-fitted attenuated equipment. As described earlier, these are short term pass-by values and therefore a conservative representation of $L_{eq,15minute}$.

Table 10.2 Equipment sound power levels used in noise modelling – including attenuated equipment

Typical item	Representative $L_{eq,15minute}$ sound power level, dB(A)
#Haul truck	115
Water cart	116
#Drill	114
Shovel	117
#Dozer	115
Rubber tyre dozer	117
Dragline	119
Grader	108
Loader	116
#Excavator (3600)	119
#Excavator (5500)	117
Lighting plant (night only)	104
Infrastructure area:	
CPP	113
Reclaimer	111
Crusher/feed bin	105
#Conveyor (covered)	75 per linear metre
Conveyor (uncovered)	82 per linear metre

Notes: # Indicates attenuated plant.
The Proponent commits to all new trucks, dozers, drills and excavators purchased for use on the Site are commissioned as noise suppressed (or attenuated) units and the existing fleet of trucks, dozers, drills and excavators on site are progressively fitted with suitable noise attenuation packages to ensure that 100% of the fleet being used on site is attenuated by the end of 2016.

The applicant adopts a strict specification to suppliers when purchasing new plant or fitting attenuation packages to existing plant. This specification includes a dB(L) or linear target in addition to a dB(A) target as shown in Table 10.3.

It should be noted that in previous assessments for Warkworth Mine and other mines in the Hunter Valley, an attenuated haul truck sound power level of 113 dB(A) is referenced. Warkworth Mine has been engaging with their suppliers for many years now to confirm a technical pathway to achieve that sound power level. At the time of publishing this study, Warkworth Mine, in conjunction with its suppliers, have been successful in testing and operating sound suppressed haul trucks to a sound power level of 115 dB(A) in-service. Warkworth Mine have conservatively opted to model the haul trucks with a sound power level of 115 dB(A) for this EIS to represent a more accurate reflection of the noise emitted from the Site.

A supplier of the Site's haul trucks (Komatsu) has confirmed a technical path to reliably reach a 113 dB(A) sound power level in the future. This technology is not currently available and at present, this next phase package of attenuation is likely to be tested in the next 12 months. If this materialises, the predicted noise levels herein will reduce if it is determined that the package is reasonable and feasible to adopt.

Table 10.3 In-service target sound power levels

Plant	Lw, dB(L) (Primary target)	LwA, dB(A) (Reference only)
Haul Truck	123	115
Water Truck	125	116
Dragline	126	119
Shovel (electric)	124	117
Excavator	126	119
Loader	123	116
Grader	117	108
Track dozer (1st gear)	123	115
Rubber Tyred Dozer	121	117
Drill	121	114

10.2.2 Mining equipment schedule for Warkworth Mine

The typical equipment schedules for the three modelled indicative mining scenarios are presented in Table 10.4 and the modelled location of mining equipment is detailed in Appendix C. The figures in parenthesis (Table 10.4) represent the reduced fleet quantities initiated during worst case prevailing meteorological conditions. This was only needed for specific items as shown and for indicative Years 3 and 9 when emissions required management during adverse weather. As shown the fleet changes are relatively modest. To that end, further iterations were completed to determine how many more plant shutdowns would be required to achieve PSNL at all Bulga assessment locations and this was found to be impractical from an operational perspective.

Table 10.4 Modelled typical mining equipment schedule (Warkworth Mine only)

Equipment	Year 3[2]	Year 9[2]	Year 14
Haul truck	59 (56)	78(75)	78
Water cart	4	4	4
Drill	4	5(4)	5
Shovel	2	3	3
Dozer	17	20(18)	22
Rubber tyre dozer	2	3	3
Dragline	2	3	3
Grader	4	4	5
Loader	3 (2)	3	2
Excavator (5500)	2	2	2
Lighting plantplant[1]	20	23	25
Infrastructure area:			
CPP	1	1	1
Reclaimer	2	2	2
Crusher/Feed bin	2	2	2

Notes: *1. Lighting plant operates only during evening and night periods.*

2. The numbers in brackets () represent the reduced fleet numbers initiated during worst case prevailing conditions.

3. The listed plant are those proposed to operate within the Warkworth Mine site boundary and exclude plant within MTO's site boundary.

10.3 Predicted noise during calm weather

Operational noise levels to residences were determined for periods with no wind or temperature gradients, which are termed SI (Still Isothermal) or 'calm ‘conditions. Values for air temperature and relative humidity used in the noise modelling were 20°C and 70 per cent for day, and 10°C and 90 per cent for evening and night periods.

The $L_{eq,15min}$ noise levels at assessment locations resulting from mining operations during calm conditions for day, evening and night periods are presented in Appendix D. Comparison of predicted noise levels for day, evening and night periods for any particular year of mining indicates little difference. This is not unexpected as the equipment fleet is identical for both day and night scenarios with the exception that the latter includes lighting plant.

Notably, operational noise levels were predicted to comply with the INP's PSNL’s for all assessment locations during calm meteorological conditions for day, evening and night periods.

10.4 Predicted noise during ’prevailing’ meteorological conditions

The INP provides guidance on how noise due to varying meteorological conditions is to be assessed. The procedure is based on identifying and combining worst case meteorological conditions at the site (referred to as the ‘prevailing meteorology‘) and assessing the noise levels against the relevant limits.

During wind and temperature gradient conditions, noise levels at residences may increase or decrease compared with noise during calm conditions. This is due to refraction caused by the varying speed of sound with increasing height above ground. The level of noise received increases when the wind blows from source to assessment locations or under temperature inversion conditions, and conversely, decreases when the wind blows from receivers to source or under temperature lapse conditions.

Despite the increase in noise at properties caused by adverse winds, ambient noise also increases during such weather conditions (due to wind induced vegetation noise for example) and mine noise can be masked.

10.4.1 Assessment of potential for temperature inversions

The pasquil stability class represents the degree of mixing in the atmosphere, and can be used to gauge the presence and magnitude range of temperature inversions. Stability classes are categorised from Class A to Class G. Stability Class A applies under sunny conditions with light winds when dispersion is most rapid. Stability Class D applies under windy and/or overcast conditions when dispersion is moderately rapid and Stability Class F and G occur at night when winds are light and the sky is clear. Stability Classes B, C and E represent the presence of intermediate conditions. Temperature inversions may occur during Classes E, F and G. In particular, Class F generally represents a range of temperature gradients from 1.5ºC/100 m up to less than 4ºC/100 m.

Records of wind speed, wind direction and sigma-theta (σ - used to approximate pasquil stability classes) were acquired from the Coal & Allied Charlton Ridge AWS for the period 2007 to 2013, inclusive. The proposal’s air quality specialist confirmed this data as representative for the site and surrounds through a comparison of data from other neighbouring weather stations.

The stability class frequency for the area, as determined from the hourly weather data, is indicated in Table 10.5. The last column indicates that atmospheric stability class F/G occurs for only 8 per cent of the winter nights in the area. This is well below the INP's 30 per cent threshold where temperature inversions are considered to be a 'feature' of an area and therefore does not need to be included in a noise impact assessment. Nonetheless, the prediction of noise impacts in this assessment includes consideration of the effects of a 3.9ºC/100m temperature inversion consistent with the recommendations of the INP. This approach is appropriate given the well documented presence of temperature inversions in the broader Hunter Valley region.

Table 10.5 Atmospheric stability class frequency for Warkworth Mine

Stability Class	Percentage of occurrence (winter night)
A	8
B	5
C	18
D	49
E	12
F/G	8
Total	**100**

Notes: 1. This information is based on winter night analysis for years 2007 to 2013 inclusive as provided by Coal & Allied from the Charlton Ridge AWS.

10.4.2 Assessment of prevailing winds for the area

A detailed review of the vector components of the aforementioned hourly wind data (direction and speed) was undertaken in accordance with the INP. The results are summarised in Appendix C. The wind directions determined to be a feature of the area in accordance with the INP are summarised in Table 10.6. The cumulative total values indicate wind speed occurrence above the INP 30 per cent threshold, which triggers the requirement for assessment (Section 5.3 of the INP). This is determined by a cumulative arithmetic addition of percentage occurrence values (refer Appendix C). EMM's wind calculator adopted for the proposal provides results consistent with the EPA's wind calculator (as found on the EPA's website) for defining feature wind directions.

It is demonstrated that the assessable winds occur during the evening and night time, and these specific winds are considered a 'feature' of the area according to the INP.

For indicative Years 3 and 9 of proposed operations, when mining plant will operate on Saddleback Ridge, a drainage wind of 2m/s and a 3ºC/100m temperature inversion was included in the modelling. Previous noise impact assessments for the Site have also considered the likelihood of drainage winds from various local escarpments and from various opposing directions. One commonality is the flow or drainage of Wollombi Brook to the north-northwest. This was therefore the chosen direction of the modelled drainage wind. The resultant effect was the enhancement of mine noise propagation to assessment locations west of the mine due to a modelled combined wind and temperature inversion. Importantly, drainage is also a likely feature of the escarpment west of Bulga and therefore would result in favourable (westerly) wind conditions at times for the properties of Bulga.

Table 10.6 Assessed INP meteorological conditions

Scenario	Wind direction	Wind speed (m/s)
Day periods		
1	Calm	0
Evening period		
1	Calm	0
2	E	2.3
3	ESE	2.7
4	SE	2.6
5	SSE	2.5
6	S	2.5
7	SSW	2.3
8	SW	1.9
9	WSW	1.9
Night periods		
1	Calm	0
2	E	2.1
3	ESE	2.5
4	SE	2.7
5	SSE	2.7
6	S	2.6
7	SSW	2.3
8	SW	1.8
9	WSW	1.6
10[1]	SSE + 3 Deg Temp Inv	2.0

Notes: 1. Wind condition applies only to noise modelling for Year 3 and 9.

10.5 Predicted noise levels

The wind conditions in Table 10.6 were used in the modelled predictions of mining noise levels. The predictions of mining noise during periods of 'prevailing meteorology‘ are presented in Appendix D. The results presented in Appendix D are derived from considering the effect of only INP-assessable meteorological conditions (Table 10.6) and not all possible wind conditions that may be experienced at site.

These results are also presented in the form of coloured markers for Years 3, 9 & 14 (Figure 10.1, Figure 10.2 and Figure 10.3 respectively) which categorically represent predicted noise levels at assessment locations with respect to PSNL’s. Assessment locations which meet PSNL’s are indicated with a black marker for the respective indicative mining year. Assessment locations with a green, blue or orange marker represent predicted minor (1 to 2 dB(A)), moderate (3 to 5 dB(A)) or significant (greater than 5 dB(A)) noise level exceedances (respectively) of the PSNL for the respective mining year. These data incorporate all ’prevailing‘ INP weather conditions (ie calm, INP winds and temperature inversions) for day, evening and night operations, as appropriate.

Figure 10.4 and Figure 10.5 present coloured markers based on the worst case noise level predicted at each assessment location across the three indicative mining years (ie outer envelope or worst case for all years). For clarity, the markers are presented separately for assessment locations west and east of the site.

Operational noise levels during calm weather were predicted to comply with the PSNLs at all assessment locations. Noise during ‘prevailing meteorological conditions’ is below or at the EPA’s PSNL’s (refer to Table 9.3) at 118 assessment locations out of the 221 assessed. Conversely, noise during 'prevailing meteorological conditions' are predicted to exceed the PSNL at 103 assessment locations, and in four cases, the exceedance is in the significant range.

A summary of these noise level exceedances are provided in Table 10.7 for Bulga assessment locations and southern areas. The four locations predicted to experience moderate noise level exceedances are relatively more exposed to prevailing winds (easterly) and on elevated areas than their neighbours. These locations adopt the INP's minimum RBL and therefore minimum criteria. The one Bulga assessment location (34) with predicted levels (up to 41 dB(A)) in the significant range is located in the northern most area of Bulga on Wambo Road and it too has been assessed using the INP's minimum RBL and corresponding criteria.

Table 10.7 Summary of PSNL exceedances - Bulga and southern assessment locations

Extent of noise exceedance	Number of affected properties			
	Indicative Year 3	Indicative Year 9	Indicative Year 14	All years
Marginal (1-2dB(A))	9	54	58	60
Moderate (3-5 dB(A))	2	5	1	5
Significant (greater than 5 dB(A))	0	1	1	1

Notes: 1.The 'All years' column lists the assessment location by worst of marginal, moderate and significant and therefore does not double count or double assign a location in these three categories.

Table 10.8 summarises the exceedances for all other locations generally to the east of the mine, but includes Warkworth village and Maison Dieu locations to the north west and north. The existing impacts are shown in parenthesis, where known. The predicted noise presents significant exceedances of criteria (refer to Table 9.3) at three assessment locations. These are locations 77, 102 and 264 located in Warkworth village. Of these, location 77 is identified within the current zone of affectation of a neighbouring mine’s development consent. The second property (102) is not a residence (local hall and therefore residential criteria do not apply) and the third is a newly identified location (264), that by virtue of extrapolating predictions from assessment location 77, would also be within Wambo Mine's acquisition zone had it been previously assessed.

Table 10.8 Summary of PSNL exceedances - East and northern assessment locations (including Warkworth village)

Extent of noise exceedance	Number of affected properties			
	Indicative Year 3	Indicative Year 9	Indicative Year 14	All years (Existing)
Marginal (1-2dB(A))	18	19	19	21[2]
Moderate (3-5 dB(A))	15	10	11	13[2]
Significant (greater than 5 dB(A))	1	2	3	3 (3)[3]

Notes: 1.The 'All years' column lists the assessment location by worst of marginal, moderate and significant and therefore does not double count or double assign a location in these three categories.

2. Six of these properties have had mitigation installed on dwellings.

3. One of the three locations is a non-residence (Warkworth Hall).

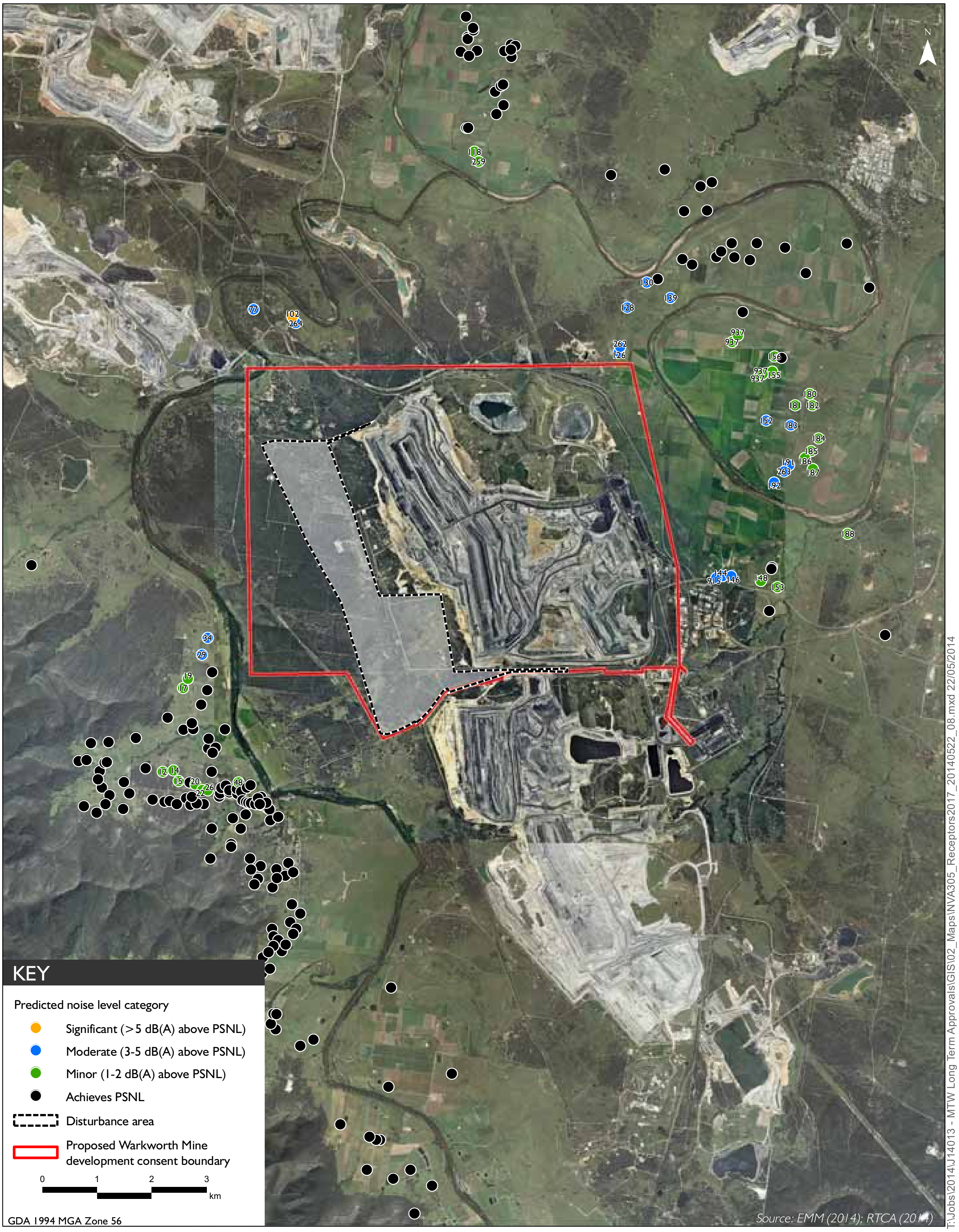
10.5.1 Existing versus proposal noise level comparison

To provide some illustration of the likely changes in noise levels due to the proposal, one east and one west assessment location have been selected. The comparison of existing and the proposal for similar weather conditions are shown below. Note that the proposal level is from the worst case year of that assessment location and accounts for attenuated plant as described herein. The 'existing' noise level is sourced from EMM's 2010 *Mount Thorley Warkworth Operations Modification - Proposed Warkworth Extension Acoustic Assessment report* (April 2010). The Year 2 modelled unmitigated level is adopted from that study in each case.

- Assessment location 58 for example (west, in Bulga):
  - Existing = 37 dB(A)
  - Proposal = 38 dB(A)
- Assessment location 146 (east, in Mount Thorley):
  - Existing = 47 dB(A)
  - Proposal = 42 dB(A)

The above demonstrates that maximum benefit from attenuation of plant will be afforded to assessment locations to the east of the mine, with a predicted noise reduction of 5 dB. At the same time, the noise reduction at source from attenuation of plant almost completely negate any increases in noise due to the westward advancing nature of the proposal, including the removal of Saddleback Ridge, for Bulga residences to the west.

The removal of Saddleback Ridge is accounted for in modelled and predicted noise levels for the proposal in indicative Years 3 and 9. A review of predicted noise levels at assessment locations west of the proposed 2014 disturbance area for these mining years shows that noise levels generally increase by 1 to 2dB(A).

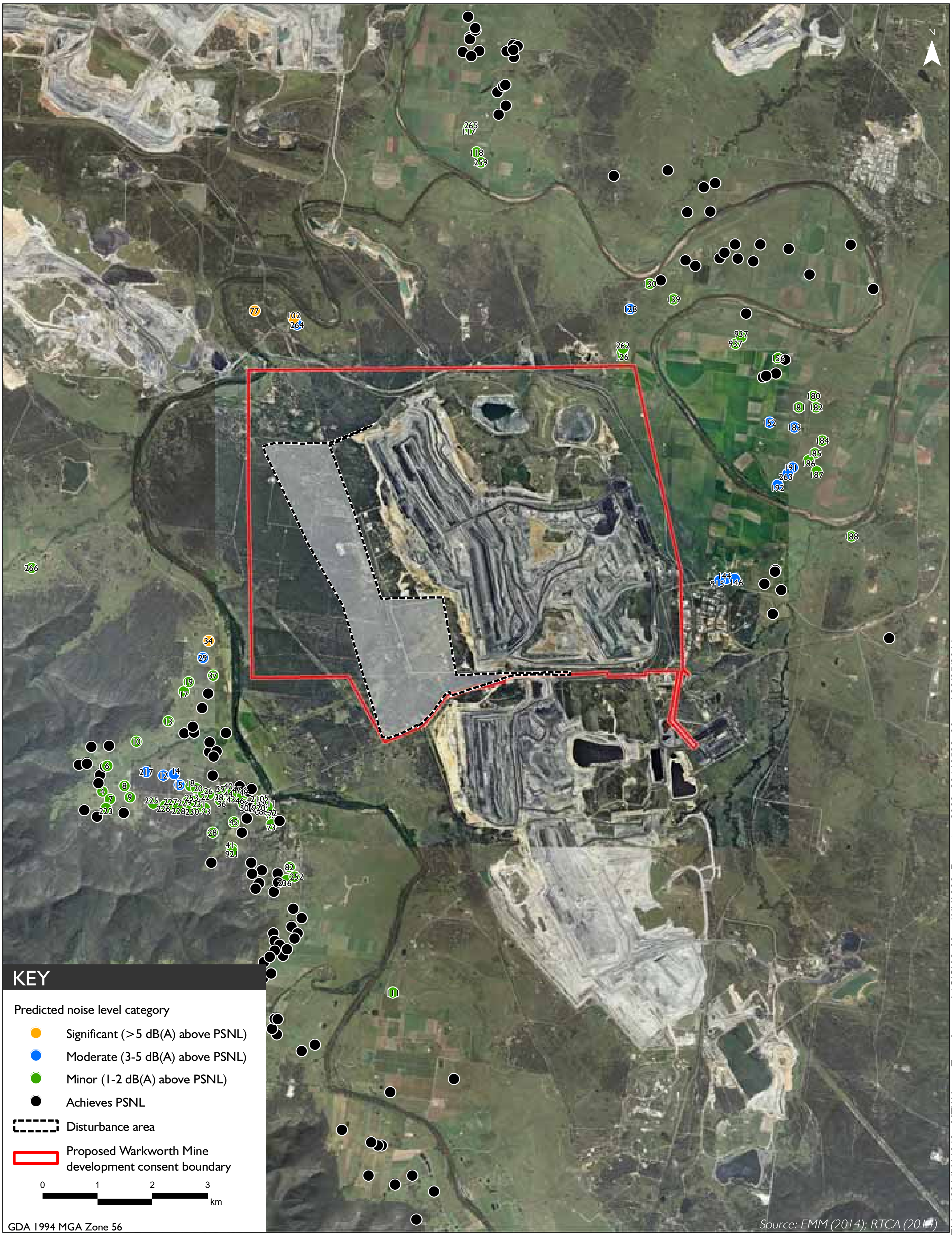


Year 3 worst case day, evening and night operational noise levels, INP weather (Leq,15min dB(A))

Warkworth Mine continuation

Noise and vibration assessment

Figure 10.1



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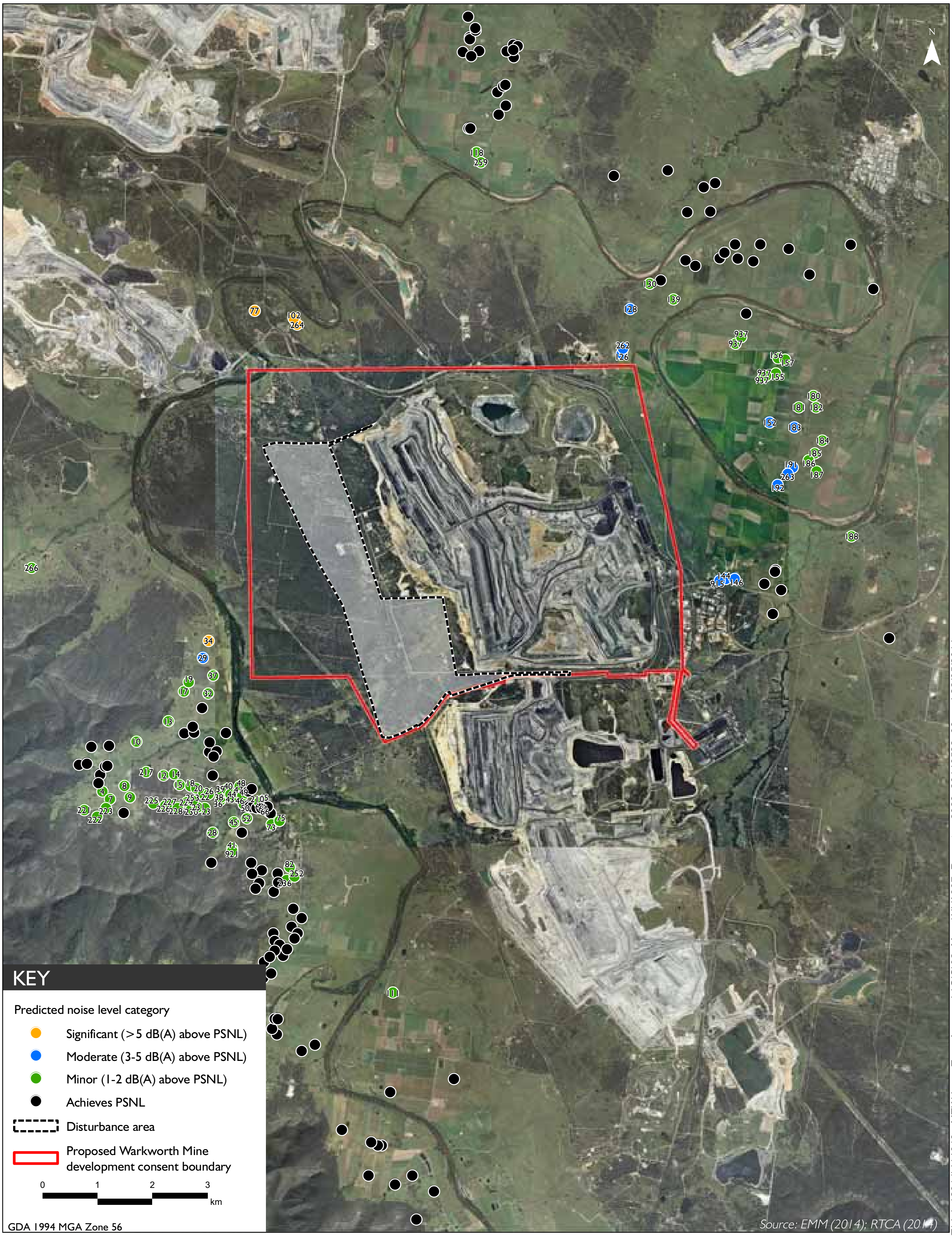
Year 9 worst case day, evening and night operational noise levels, INP weather (Leq,15min dB(A))

Warkworth Mine continuation
Noise and vibration assessment

Figure 10.2



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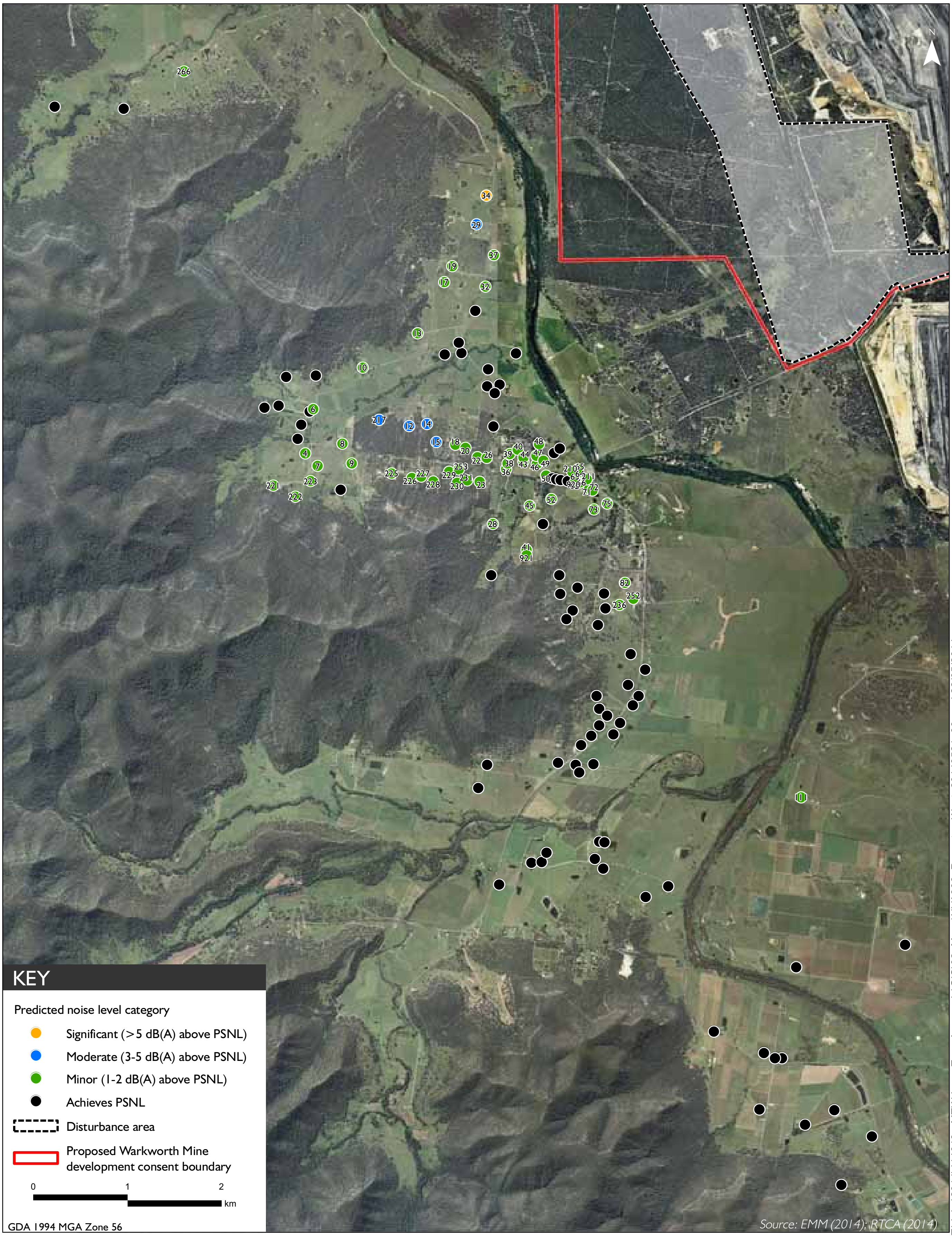
Year 14 worst case day, evening and night operational noise levels, INP weather (Leq,15min dB(A))

Warkworth Mine continuation

Noise and vibration assessment

Figure 10.3

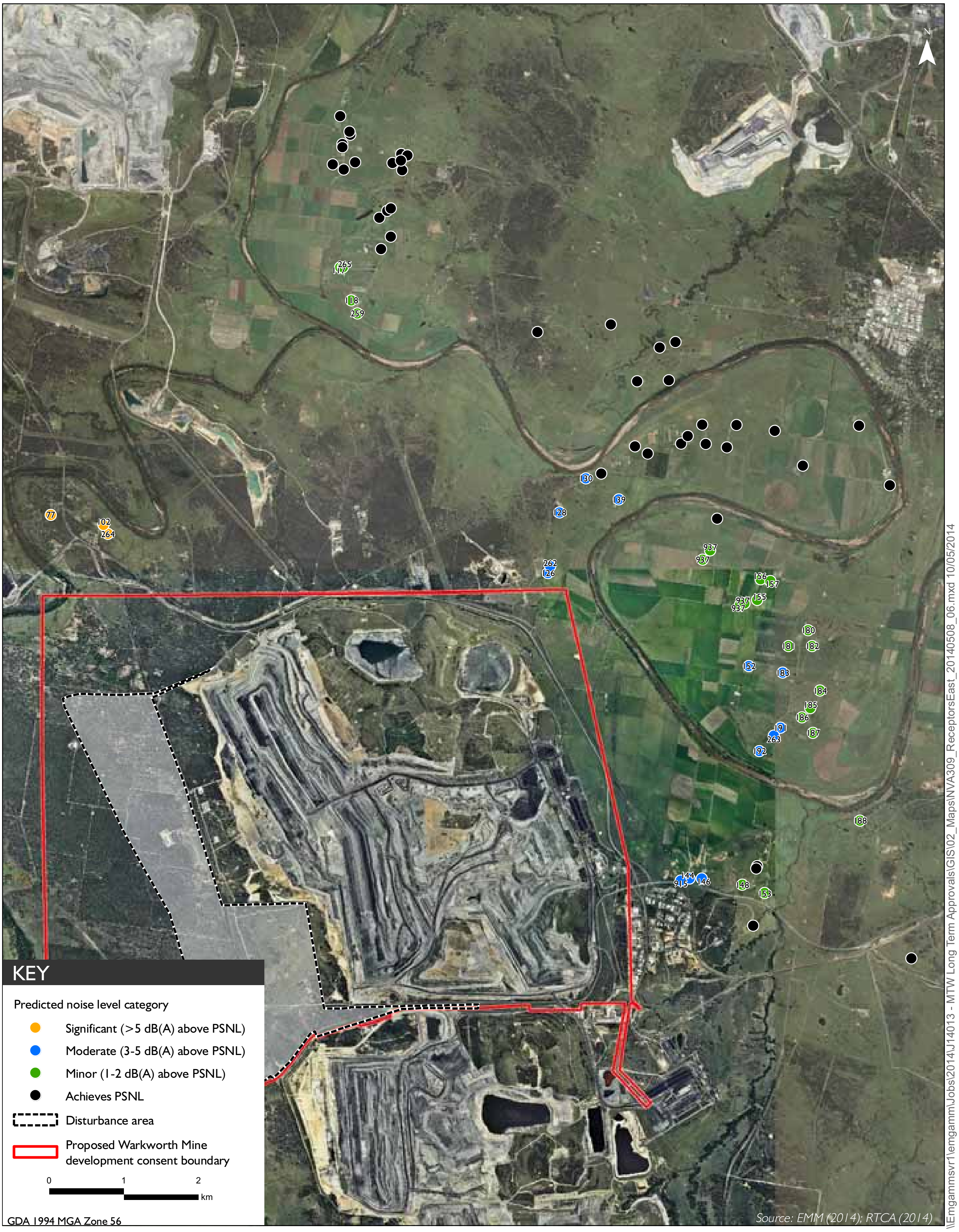


All years worst case day, evening and night operational noise levels, INP weather (Leq,15min dB(A)) – Western assessment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure 10.4



All years worst case day, evening and night operational noise levels, INP weather (Leq,15min dB(A)) – Eastern assessment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure 10.5

For example, assessment location 14 is southwest of the proposed 2014 disturbance area with Saddleback Ridge directly between the mining activity and this assessment location. Assessment location 14 is approximately 4.3km from mining activity in Year 9 when Saddleback Ridge has been removed. This assessment location has predicted noise levels of 36dB(A) in Year 3 and 38dB(A) in Year 9, a predicted increase of 2dB(A). Further north is assessment location 266, where Saddleback Ridge is not directly between mining activity and the assessment location. This assessment location is northwest of the proposed 2014 disturbance area and approximately 5.4km from mining activity in Year 9 (ie when Saddleback Ridge has been removed). This assessment location is predicted to experience noise levels of 35dB(A) in Year 3 and 37dB(A) in Year 9, a predicted increase of 2dB(A), which is the same increase predicted for assessment location 14. Therefore, it is considered that the removal of Saddleback Ridge is not a material contributor to the minor increase in noise predictions.

The change in noise from current and approved operations is expected to be marginal for western assessment locations, while a material reduction is predicted for eastern assessment locations as attenuation of plant progresses. The proposed noise suppression and fleet management will mean the advancement westward will not result in a material increases to noise levels.

10.6 Residual level of impact (INP Section 8.2.1)

Section 8.2.1 of the INP lists issues to be considered if predicted noise levels exceed the PSNLs after reasonable and feasible mitigation has been applied. Table 10.9 provides an assessment of residual noise impacts (presented in Table 10.7 and Table 10.8) from the proposal.

Table 10.9 Residual level of impact

INP factors for consideration	Justification of the proposal
1. Characteristics of the area and receivers likely to be affected	The majority of the local area surrounding the proposal is characterised by mining and associated infrastructure and agricultural land, mainly pasture, with moderate sized stands of native woodland retained along the steeper hillsides and ridgelines and in patches along creek lines. The applicant owns a substantial area of land surrounding the Site. Warkworth Mine has been in operation since 1981 and the originally approved mine has been modified several times. Immediately to the south of Warkworth Mine is MTO, commissioned in 1981. The integrated operation of MTW has been ongoing since 2004. The Bulga Coal Complex, which is adjacent to the south of MTW, was commissioned in the 1980s. Wambo Mine and Hunter Valley Operations South to the north of MTW were commenced in 1969 and 1971 respectively. The noise and vibration study predicted noise levels at 221 privately owned assessment locations surrounding the mine. The predicted noise levels are during worst case INP prevailing meteorological conditions and for the majority of the time actual noise levels are likely to be less than those predicted. This is demonstrated in the noise level probability distribution chart shown in Section 10.7. Of the 221 assessment locations, a total of 103 assessment locations are predicted with noise levels above PSNLs over the life of the mine. Of the 103 assessment locations, 81 are predicted with minor noise level exceedances (1-2 dB(A) above PSNL), 18 are predicted with moderate noise level exceedances (3-5 dB(A) above PSNL) and four (three residential and the Warkworth Hall) are predicted with significant noise level exceedances (greater than 5 dB(A) above PSNL). Assessment locations with predicted moderate and significant noise level exceedances account for less than 10% of the total assessment locations considered. Further, one of the three assessment locations (77) predicted with a significant noise level exceedance has previously been identified in an acquisition zone of a neighbouring mine.

Table 10.9 Residual level of impact

INP factors for consideration	Justification of the proposal
	A total of 139 assessment locations within Bulga and surrounds have been considered. Of these, 60 are predicted with minor noise level exceedance, five are predicted with a moderate noise level exceedance and one is predicted with a significant noise level exceedance, over the life of the mine. Assessment locations in Bulga with predicted moderate or significant noise level exceedances account for approximately 4% of the total assessment locations considered in Bulga. The change in noise from current and approved operations is expected to be marginal for western assessment locations, while a material reduction is predicted for eastern assessment locations as attenuation of mobile plant progresses. The proposed noise suppression and fleet management will mean the advancement westward will not result in a material increases to noise levels. A cumulative noise assessment in accordance with the INP and Mining SEPP demonstrates criteria will be satisfied for the all western locations with the exception of those already impacted by other mining operations. There is a very large range of human reaction to noise, including those who are very sensitive to noise. This noise-sensitive sector of the population will react to intruding noises that are barely audible within the overall noise environment, or will have an expectation of very low environmental noise levels. On the other hand, there are those within the community who find living in noisy environments, such as near major industry, on main roads or under aircraft flight paths, an acceptable situation. The bulk of the population lies within these two spectrums, being unaffected by low levels of noise and being prepared to accept levels of noise commensurate with their surroundings.
2. Characteristics of the proposal and its noise or vibrations —	Warkworth Mine is an existing and well established mine in the Hunter Valley. The proposal seeks a continuation of all aspects of Warkworth Mine as it presently operates together with an extension of the approved mining footprint by approximately 697.5 ha to the west of current operations. WML currently invests significantly in the noise management on the mine and will continue to do so under the proposal. For example, attenuation of all major plant will exceed $50M across MTW and will be completed by the end of 2016. RTCA has committed to managing noise levels to within 1-2 dB above PSNL at approximately 90% of properties. Managing noise to this level is reasonable and feasible for the Site. Managing noise to PSNLs at all locations was tested and found not to be reasonable or feasible for the Site. The resultant loss in production exceeds $100million (real NPV) over the life of the proposal. The assessment has identified that noise levels predicted above PSNLs will only occur during worst case prevailing metrological conditions. It has been demonstrated that with continued management of the mine, such as by limiting some plant and equipment operation during adverse meteorological conditions, and implementing equipment fleet with best practice noise suppression, that INP PSNLs can be met for the majority of assessment locations. The noise modelling adopts area specific validation and therefore provides added confidence in the accuracy of predictions. Extensive monitoring to measure compliance would be continued under the proposal. The economic assessment for the proposal has identified that the direct economic benefit that can be attributed to Warkworth Mine is around $1,384 million in net present value (NPV) terms. The economic flow-on effects from WML amount to: • for NSW, around $346 million in additional income (in NPV terms), additional annual employment of 191 full-time equivalent workers, and a contribution to NSW gross state product (GSP) of around $407 million; • for the Mid and Upper Hunter region, around $204 million in additional income in NPV terms, and additional annual employment of 198 full-time equivalent workers; and • for the Singleton LGA, around $75 million in additional income in NPV terms, and additional annual employment of 57 full-time equivalent workers.

Table 10.9 Residual level of impact

INP factors for consideration	Justification of the proposal
3. The feasibility of additional mitigation or management measures: - Alternative sites or routes for the development - The technical and economic feasibility of alternative noise controls or management procedures	Warkworth Mine is an existing and well established mine in the Hunter Valley and relocation is not reasonable or feasible. The applicant has considered a range of noise management and mitigation measures for the proposal. Those that are considered reasonable and feasible have been included in this assessment. These include a significant investment in providing best practice noise suppression to their equipment fleet (see details in section 10.2.1) and limiting some plant and equipment operation during worst case meteorological conditions. These measures in combination with the established real-time noise monitoring and management system will assist in keeping noise levels to within or below 1-2 dB of PSNL for approximately 90% of the assessment locations considered - this is a reasonable and feasible outcome for the viability of the proposal.
4. Equity issues in relation to: - The costs borne by a few for the benefit of others - The long-term cumulative increase in noise levels - The opportunity to compensate effectively those affected	The applicant will be investing significantly in noise management and mitigation over the life of the proposal which will be of significant benefit to the surrounding communities. The cumulative noise assessment in Section 11 demonstrates that with reasonable and feasible mitigation and management in place that the INP recommended acceptable Amenity noise limits can be achieved for the life of the mine. The applicant will appropriately compensate all assessment locations identified with moderate or significant noise level exceedance as negotiated with DP&E and the community.

10.7 Percentage occurrence of noise levels

The level of mine noise at a given assessment location varies and is dependent upon many factors including prevailing weather conditions. It is prudent to gain an understanding of this variation rather than relying on a single predicted noise level for one set of weather conditions as presented earlier.

The noise model predicts noise levels under various combinations of wind speed and direction and vertical temperature gradient. Hence, the proportion of time during which certain noise levels will be experienced can be inferred from the percentage occurrence of the various combinations of wind speed, wind direction and stability class.

The effect of a representative set of meteorological conditions on the level of noise received at assessment locations 14 and 152 is presented for the indicative Year 9 night operating scenario (representative worst case year). These assessment locations represent areas west (Bulga) and east of the mine (Hambledon Hill) respectively. The result is shown for a worst case season and period of day and differs for each receiver.

The analysis of meteorological effects involved calculating noise to each assessment location under the influence of each of 198 meteorological conditions based on a combination of wind speed, wind direction and temperature gradient, and combining these in proportion to the probability of their occurrence. These conditions are derived by adopting sixteen wind directions, six temperature gradients and two 10 m elevation wind speed ranges (ie 16 x 6 x 2 = 192). In addition, six calm weather conditions (defined by winds less than 0.5m/s and six stability classes) where included in the calculations. The meteorological data used for this exercise is the same as that used for the preceding predictions (ie 2007 to 2013 hourly data from Coal & Allied's Charlton Ridge AWS).

This analysis results in a noise probability distribution for assessment location 14 and 152 as shown in Figure 10.6.

A reasonable indicator of noise impact is associated with an industrial noise level present for at least 10 per cent of the time. This is consistent with the intent of the INP (ie to protect 90 per cent of the community 90 per cent of the time).

The 10 per cent exceedance noise level from Figure 10.6 is 35 dB(A) and 36 dB(A) for assessment locations 14 and 152 respectively. These levels compare to the above single set weather condition predictions (see Appendix D) of up to 38 dB(A) and 39 dB (A) for assessment locations 14 and 152 respectively. This demonstrates a difference between the two methods of 3 dB, with the INP-based prediction being marginally conservative for both assessment locations.

Other observations of note include that mine noise at assessment location 14 (in Bulga) are at or below 35 dB (A) for 90 per cent of the time. Similarly, for assessment location 152, 35 dB(A) is achieved for 85 per cent of the time. The PSNL for both these locations is 35 dB(A). The analysis also implies that the higher INP-based predictions of up to 39 dB(A) will occur very infrequently.

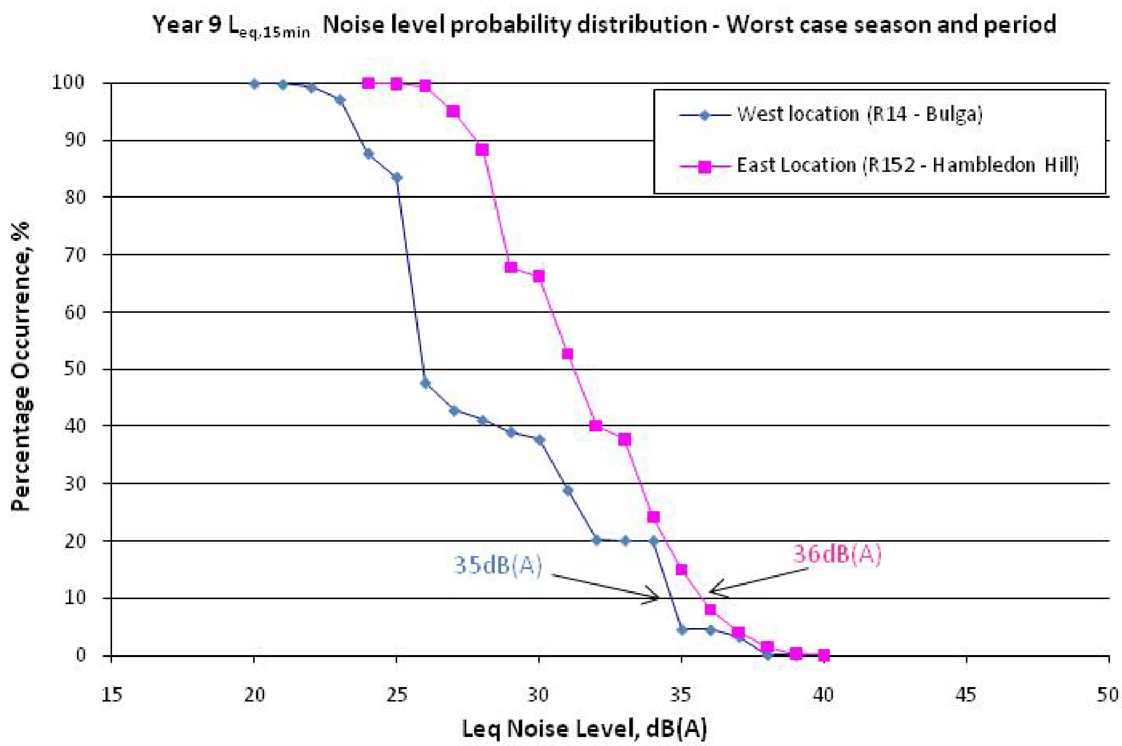


Figure 10.6 Year 9 $L_{eq,15min}$ noise level probability distribution - worst case season and period

10.8 Assessment of potential sleep disturbance

As described in Chapter 9, sleep within residences may be disturbed by intermittent noises such as shovel gates banging, bulldozer track plates and heavy vehicle reversing alarms. Typical noise levels from the loudest of these events are presented in Table 10.10.

Table 10.10 Maximum noise from intermittent sources

Noise source	Measured L_{max} noise level, dB(A)
Haul truck pass-by at high revs	125
Shovel gate banging	120
Bulldozer with reversing alarm	115

Table 10.10 indicates that the highest maximum noise levels expected at residences would likely result from haul trucks. The maximum sound power level of unmitigated haul trucks has previously been measured to be typically 125dB(A) L_{max}. Maximum noise levels at each residence were calculated under assessable worst case weather for the three indicative years of operations.

Table 10.11 provides the maximum predicted L_{max} noise levels from the proposal under adverse meteorology at select representative assessment locations based on the typical equipment locations used for mining operations. Predictions were based on a single event, rather than the simultaneous operation of a number of plant items because of the low probability of more than one peak noise event occurring concurrently. The criteria used to assess sleep disturbance are based on the INP's requirement for the maximum L_{max} level of 'background noise level plus 15 dB'. This results in sleep disturbance criteria of 45 to 48 dB(A) L_{max} depending on the individual assessment location's background noise levels.

Table 10.11 indicates that predicted noise levels under prevailing weather conditions are within the EPA's conservative sleep disturbance criterion at all representative assessment locations.

Table 10.11 Predicted maximum noise levels from site under prevailing meteorology

Property no.	External L_{max} noise level from on-site plant, dB(A)			L_{max} criterion, dB(A)
	Year 3	Year 9	Year 14	
1	32[1]	34[1]	34[1]	45
34	41[1]	41[1]	41[1]	45
42	37[1]	36[1]	38[1]	48
58	37[1]	38[1]	38[1]	48
72	38[1]	39[1]	38[1]	48
75	38[1]	38[1]	39[1]	48
118	36[1]	37[1]	36[1]	45
126	42	42	44	45
144	43	43	43[1]	45
147	42[1]	41	42	45
148	39	39	39	45
237	35[1]	38[1]	38[1]	45

Notes: 1. The L_{eq} operational noise level prediction from Appendix D has been adopted where it is higher than the predicted L_{max} noise level. This is because it is theoretically impossible to measure an L_{eq} greater than the L_{max}. However, the prediction method adopts the maximum noise level from a single source which can result in an L_{max} prediction less than the overall L_{eq} result, which includes all noise sources.

10.9 Low frequency noise

10.9.1 Review of external noise monitoring data

The applicant currently undertakes regular LFN monitoring as part of the noise management regime for Warkworth Mine as outlined in Section 3 and 4. Monitoring data from the 2013 calendar year was reviewed in detail (total of 46 measurements) to provide a current representation of potential LFN impacts from the mine. This method is preferred and considered more comprehensive than an alternate theoretical noise modelling approach, as it provides a 'real-world' representation of noise levels received in the surrounding communities.

The data was reviewed and assessed using the INP and Broner assessment methods as outlined in Section 9.7 and is provided in Table 10.12. The review has been limited to data samples where a mining noise contribution was observed from Warkworth Mine only.

Table 10.12 Review of LFN monitoring data - 2013

Monitoring location	Total measured noise levels (inc. Warkworth Mine noise), dB		INP assessment[2], dB	'Broner' criteria, dBC	Comment on audible noise sources
	L_{Aeq}	L_{Ceq}	L_{Ceq}- L_{Aeq}		
Bulga village	31	50	**19**	60	Warkworth Mine
Bulga village	41	54	13	60	Warkworth Mine
Gouldsville Road	48	56	8	60	Warkworth Mine
Inlet Road West (Bulga)	35	54	**19**	60	Warkworth Mine
Long Point	33	55	**22**	60	Warkworth Mine
Long Point	36	59	**23**	60	Warkworth Mine
Long Point	31	50	**19**	60	Warkworth Mine
Mount Thorley Industrial Estate	55	**61**	6	60	Warkworth Mine, road traffic and dogs
Mount Thorley Industrial Estate	50	**62**	12	60	Warkworth Mine, road traffic and dogs
Mount Thorley Industrial Estate	61	**65**	4	60	Warkworth Mine, road traffic and dogs
Wambo Road	42	55	13	60	Warkworth Mine
		INP criteria	**15**		

Notes: 1. Values are shown in bold if they exceed the INP or 'Broner' low frequency assessment criteria.

2. As per Sections 9.7.1, the INP low frequency assessment method is exceeded if the difference is greater than or equal to 15 dB.

3. Source is Global Acoustics reports (various) - EMM has not verified the raw data.

Measurements that exceed the 'Broner' criteria where Warkworth Mine noise was observed are at the Mount Thorley Industrial Estate (MTIE) where road traffic noise contribution was also observed to be a likely contributor to the elevated L_{Ceq} noise level. At all other locations the 'Broner' criteria is achieved.

The INP assessment criterion has been exceeded at Bulga Village (one measurement), Inlet Road West (one measurement) and Long Point (three measurements). However, the overall dB(C) value is below the 'Broner' criteria in each case. As described in Section 9.7.1 (and Appendix G), the INP LFN criteria in its current form is not suitable for rural areas and is under review.

10.9.2 Review of representative internal noise levels – DEFRA curve assessment

External and internal noise monitoring was undertaken at a mine owned residence on Putty Road during the night-time on 17 April 2014 to quantify representative internal mine levels and to apply the DEFRA reference curve to highlight any potential for internal LFN impacts.

The dwelling selected is located at 1916 Putty Road (E 315215, N 6386292) approximately 3 km west of MTO. The dwelling construction was relatively lightweight with external timber cladding and internal villaboard/plasterboard lining. The house is raised on brick footings with a timber floor and joist construction. Standard glazing (4 to 6 mm) in aluminium frames was observed. Overall, the building construction is typical of a light-weight rural dwelling, providing relatively low impedance to LFN, and therefore provides a conservative test case for this exercise.

Measurements were taken in two rooms, one representative of a living and dining room and the other representative of a bedroom. Three measurement positions were selected in the living and dining room and two in the bedroom. The schematic in Figure 10.7 shows the approximate measurement positions.

Figure 10.7 Dwelling schematic and internal noise measurement positions

The sound level meters used were set to record third octave band spectral noise level data continuously in one minute intervals over a period of approximately two hours. Calibration was checked before and after and the meters were found to be within an acceptable tolerance (+/- 0.5 dB(A)). A mine noise contribution was clearly audible externally throughout the measurement period.

i External noise levels

The level of mining noise externally was approximated from measured levels between the third octave frequency range of 10 Hz to 800Hz inclusive (ie low pass). The external low pass noise level was found to be in the range of 59 dB(L) to 64 dB(L), 54 dB(C) to 58 dB(C) and 40 dB(A) to 44 dB(A). The average of the external noise levels is presented in Figure 10.8. It was also found that corresponding dB(C) minus dB(A) readings did not exceed 14 dB throughout the two hours of monitoring. Other noise sources included occasional traffic on Putty Road and natural noise sources such as insect's.

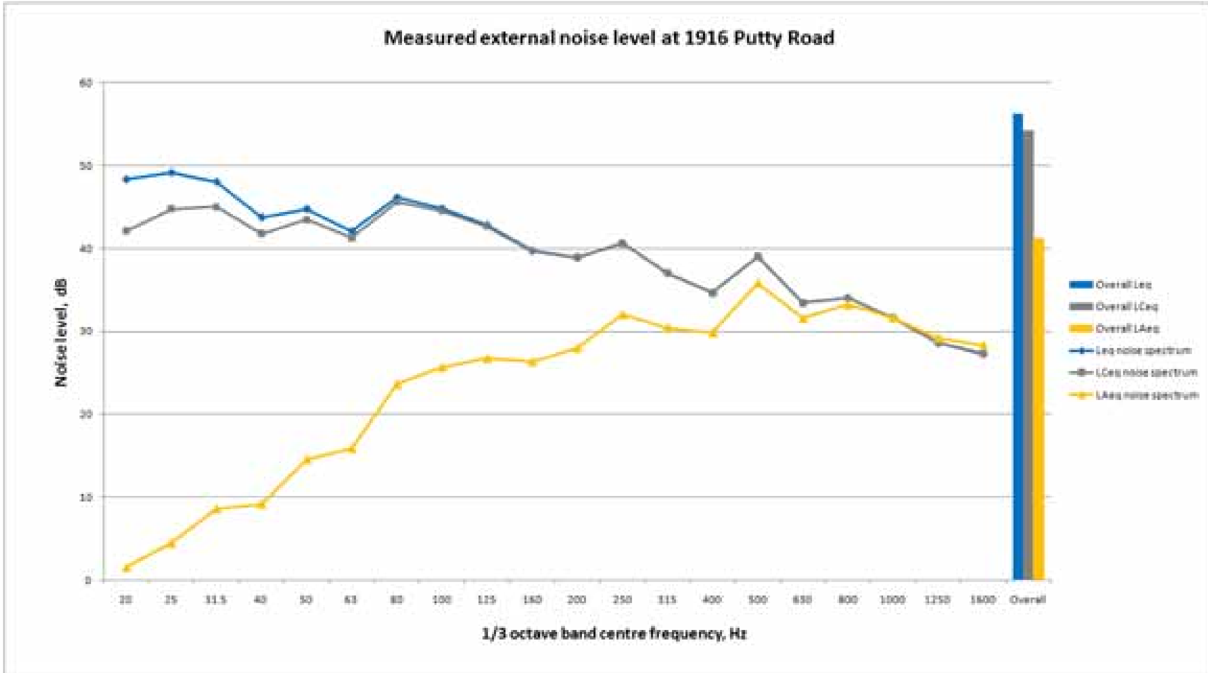


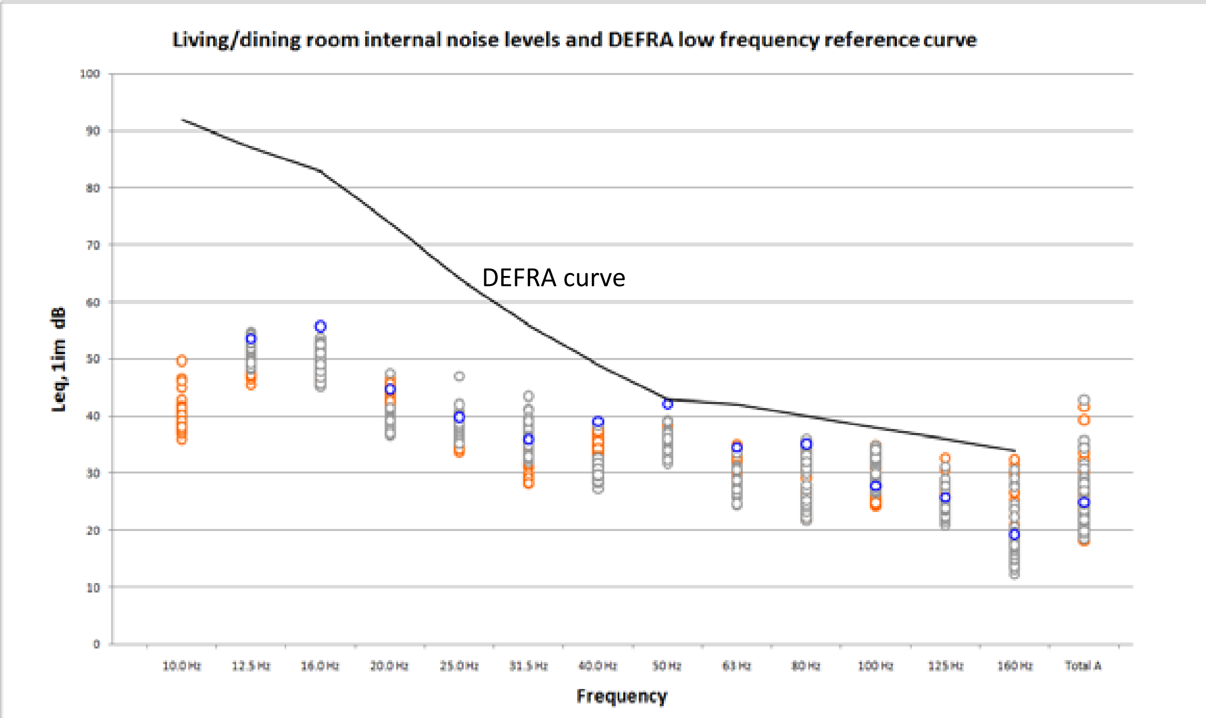
Figure 10.8 External noise levels at 1916 Putty Road

ii Internal noise levels

Whilst mining noise was audible, measurable and consistent outside this dwelling, internally mining noise was not audible in any areas or rooms. The dwelling where measurements were completed (1916 Putty Road) is relatively closer to MTO than Bulga village. To simulate noise levels at the closest private assessment locations in Bulga, the recorded internal noise levels were corrected by subtracting 3 dB to represent the loss in noise energy. This correction was calculated using MTO indicative Year 3 noise model, as the noise contribution from MTO operations was observed to be dominant externally during the measurement period.

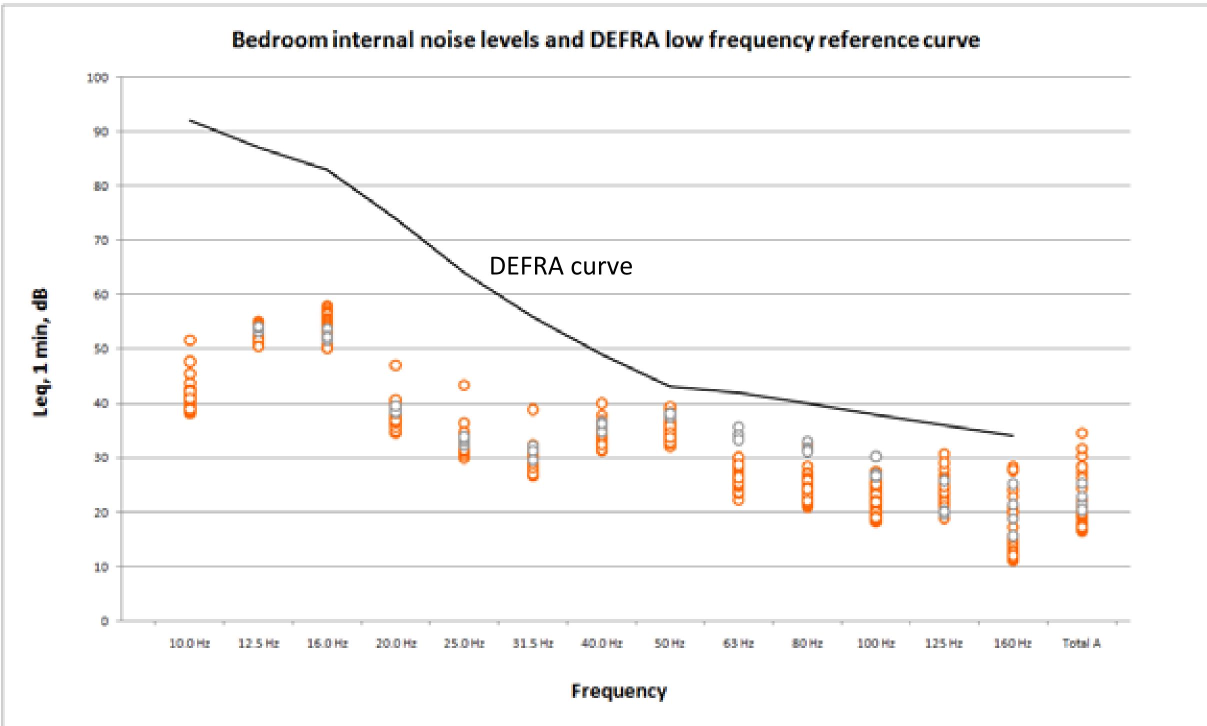
The results from the noise monitoring plotted against the DEFRA LFN reference curve are provided in Figure 10.9 and Figure 10.10 for the living/dining and bedroom, respectively. The charts exclude samples where extraneous noise was observed. A total of 88 one minute samples in the living/ dining room and 51 in the bedroom were captured.

It is clear from the charts that noise levels recorded in the living/dining and bedroom are below the DEFRA LFN reference curve for all measurements.



Note: *orange marker represents position 1, grey marker represents position 2 and blue marker represents position 3.*

Figure 10.9 Internal LFN monitoring results (living/dining room)



Note: *orange marker represents position 1 and grey marker represents position 2.*

Figure 10.10 Internal LFN monitoring results (bedroom)

10.10 Other activities

10.10.1 Construction

Minimal construction activities are planned for the proposal. The most significant construction activities proposed include the Putty Road underpass and construction of the out of pit dam. These activities would be undertaken concurrently with mining and most likely during daytime hours only. Noise from these construction activities would be significantly less than that from mining operations and would therefore not contribute to the total overall received noise at surrounding residences. Nonetheless, dam construction was modelled together with indicative Year 3 mining for completeness.

10.10.2 Rail traffic

The proposal will not result in any net increase in rail traffic above currently approved rail activities servicing Warkworth Mine. Coal production rate increases for Warkworth Mine and MTO are managed as part of the integrated MTW operation. This will essentially result in a balance of coal rail traffic operations, with no net change anticipated.

The proposal will not result in any net increase in rail traffic over and above currently approved rail activities servicing the integrated MTW operation. This is because the maximum approved output from MTW will not be increased for the proposal.

11 Cumulative noise

This section provides an assessment of cumulative noise from all industrial sites to assess an area's amenity against the Mining SEPP's non-discretionary standards which adopt the INP's ANLs. The amenity criteria provide the over-arching goal that if achieved will mean a residence's amenity is not compromised.

The ambient noise at assessment locations in the vicinity of the proposal is also influenced by adjoining industrial premises, for example, Wambo Mine, Hunter Valley Operations South Mine, MTO, Bulga Coal Complex, and to some extent Redbank Power Station.

The level of noise at residences from each of these surrounding industries was referenced from the following documents:

- an EIS for the expansion of Wambo Mine (Resource Strategies 2003);
- an Environmental Assessment Report for Hunter Valley Operations South Coal Project (ERM 2008);
- the EIS prepared for Mount Thorley Operations 2014 being exhibited concurrently with this proposal and corresponding noise assessment (EMM 2014); and
- the EIS for the Bulga Coal Complex optimisation project (Umwelt 2013).

Most of these assessments predict noise levels at residences under both calm and adverse weather conditions. To assess cumulative impacts, the L_{eq} noise levels predicted by this assessment were combined with the L_{eq} noise levels from relevant mining stages of each of the aforementioned assessments. For Redbank power station, EMM's attended noise measurements completed during a study in 2010 were adopted and are limited to assessment locations in Gouldsville and Long Point Road.

The cumulative impacts can be predicted for any given mining year, using the conservative approach of combining worst case adverse weather condition noise predictions from each of the mines. In some cases, this is a highly conservative strategy for at least the scenario that for some assessment locations, meteorological conditions required to produce worst case noise levels from one mine will generally be different and are, in some cases, in opposition. For example, while westerly winds will serve to increase noise to residences in Warkworth village from Wambo Mine, they will also serve to decrease noise from the proposal.

In light of this, the assessment of cumulative noise impacts was undertaken on the basis of considering the following:

1. For assessment locations west of the proposal:
    a) adverse weather predictions from Wambo Mine and Redbank power station were combined with calm predictions from all other mines. This simulates north westerly wind situations; and
    b) calm predictions from Wambo Mine where combined with adverse weather predictions from all other sites. This simulates easterly or south easterly winds and therefore worst case for these assessment locations.

2. For assessment locations east and north of the proposal:

   a) adverse weather predictions from Bulga Optimisation Project (BOP) where combined with calm predictions from all other mines. This simulates a southerly wind situation; and

   b) adverse predictions from all mines where combined with calm predictions from Hunter Valley Operations. This simulates a conservative worst case situation for these assessment locations.

Table 11.1 summarises the cumulative noise levels at residences surrounding the proposal. As for the sleep disturbance assessment, a subset of representative assessment locations has been used to assess cumulative noise impacts. The results are presented as a range of noise levels in accordance with the approach described above.

The first number in the range relates to scenario (a) above, while the second number of the range relates to scenario (b). Also presented (in parentheses) within Table 11.1 is the respective percentage contribution to the total cumulative noise level from the Site. To estimate $L_{eq,period}$ noise levels from each site, the published $L_{eq,15min}$ predictions were adjusted by subtracting 3dB to account for changes in operations and weather conditions between a “prevailing” worst case 15-minute and an average nine hour night period. This adjustment is conservative based on our experience in the field for this and other sites.

The results show that the INP's (and Mining SEPP) acceptable night time criteria are satisfied at most locations. The exception is location 77 in Warkworth village north west of the Site (dominated by Wambo Mine operations worst case predictions). This assessment location is already entitled to acquisition rights upon request from a neighbouring mine. Given the magnitude of exceedance at location 77, and being representative of Warkworth village, through extrapolation the amenity criterion is likely to be exceeded at neighbouring locations 102 (the hall) and 264, due to Wambo mine.

It is demonstrated that the non-discretionary Mining SEPP is satisfied for Bulga residences and, therefore, the area's amenity is not compromised as it meets the INP's ANL.

This outcome is based on noise from the proposal being assessed during indicative worst case operating years and, therefore, the contribution to the cumulative noise environment is not expected to increase beyond indicative Year 14. Further, predicted noise levels from Bulga Mine as referenced from the Bulga Optimisation Project (Umwelt 2013) demonstrates that noise levels are expected to decrease over time. For example, assessment location 266 in Bulga (as per the BOP numbering system) shows upper predicted noise levels of 36, 35, 34, 33 and 29 dB(A) for mining years 1, 3, 6, 13 and 16, respectively. The noise levels in Bulga from MTO also decrease throughout the mine life, with all active mining and emplacement activity ceasing by Year 14. For example predicted noise levels from MTO at assessment location 58 in Bulga are 39, 35 and 27 dB(A) for mining years 3, 9 and 14, respectively. Given the preceding it is therefore clear that the predicted cumulative noise levels presented in Table 10.9 represent worst case cumulative noise levels for the life of the proposal.

Further, the amenity, which relates to cumulative noise from all industry, cannot worsen for this area because it is highly unlikely that new large scale industry will be able to physically exist in a position that could push amenity levels any higher for Bulga residences.

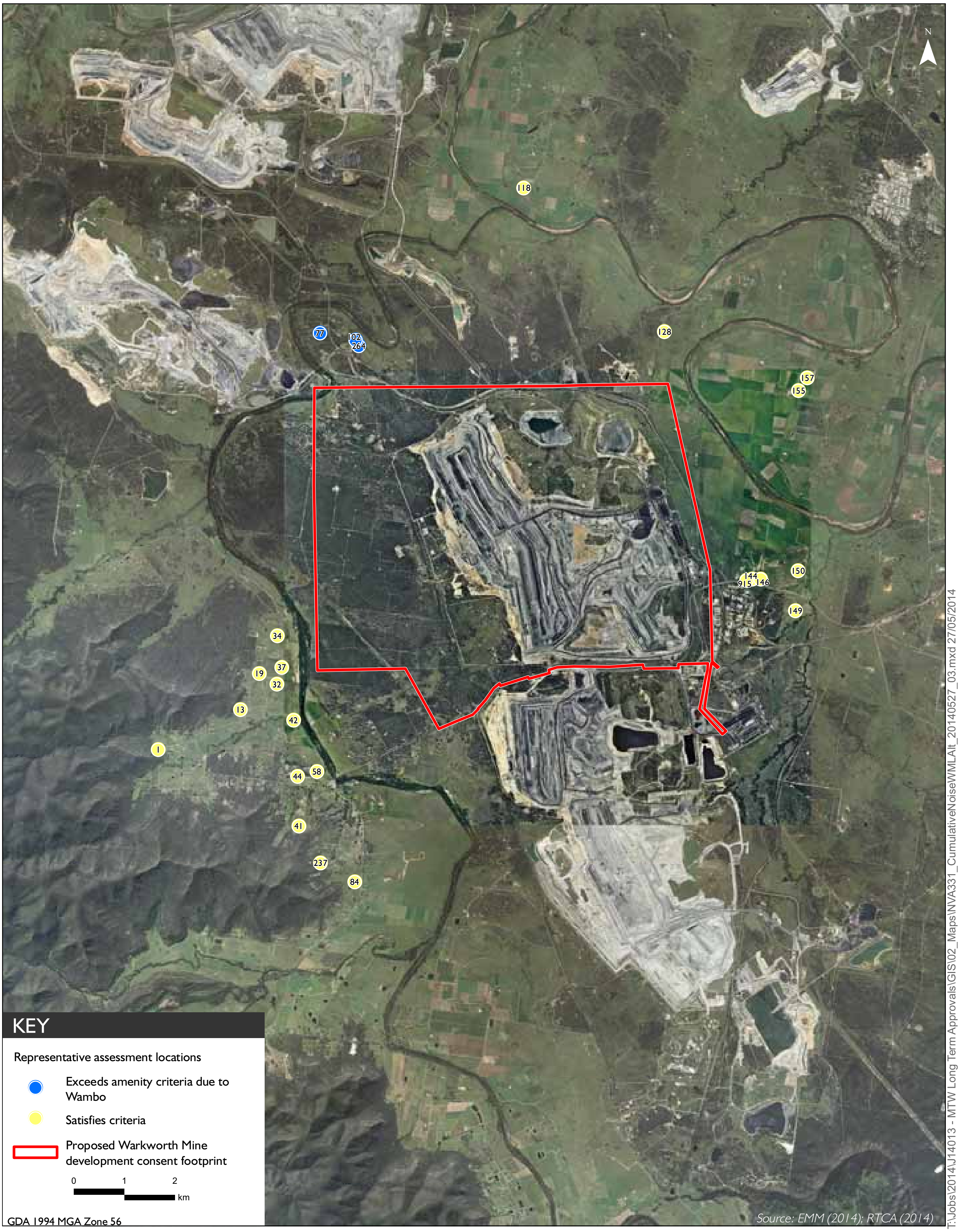
Refer to Figure 7.1 for assessment locations and to Figure 11.1 for predicted amenity noise criteria exceedances.

Table 11.1 Cumulative noise at properties, dB(A) $L_{eq,period}$

Property no.	Warkworth mine indicative operating years			INP Acceptable Amenity criteria
	Year 3	Year 9	Year 14	
1	26 (33%) - 33 (43%)	25 (46%) - 32 (74%)	23 (74%) - 32 (92%)	40
13	34 (15%) - 38 (46%)	35 (25%) - 38 (70%)	35 (28%) - 36 (87%)	40
19	34 (21%) - 39 (58%)	34 (36%) - 38 (71%)	34 (38%) - 37 (87%)	40
32	32 (29%) - 38 (53%)	33 (41%) - 37 (58%)	33 (43%) - 36 (87%)	40
34	34 (36%) - 38 (72%)	34 (37%) - 40 (83%)	35 (43%) - 38 (92%)	40
37	34 (26%) - 38 (62%)	34 (34%) - 38 (64%)	34 (33%) - 37 (88%)	40
41	29 (36%) - 37 (36%)	29 (58%) - 37 (57%)	27 (90%) - 36 (86%)	40
42	32 (26%) - 38 (40%)	32 (35%) - 37 (44%)	31 (37%) - 36 (86%)	40
44	32 (23%) - 38 (41%)	33 (36%) - 38 (60%)	32 (43%) - 36 (87%)	40
58	32 (24%) - 38 (42%)	33 (37%) - 38 (56%)	32 (43%) - 36 (84%)	40
77	**53** (0%) - **57** (2%)	**53** (0%) - **57** (3%)	**53** (0%) - **57** (2%)	**50**[2]
84	29 (27%) - 37 (30%)	28 (56%) - 37 (49%)	25 (82%) - 33 (70%)	40
118	29 (22%) - 35 (71%)	28 (19%) - 35 (78%)	28 (8%) - 34 (77%)	40
128	34 (53%) - 39 (77%)	34 (52%) - 37 (68%)	33 (48%) - 37 (76%)	40
146	33 (56%) - 41 (66%)	32 (44%) - 40 (56%)	31 (43%) - 40 (73%)	50[2]
149	34 (3%) - 39 (2%)	35 (3%) - 39 (3%)	31 (4%) - 38 (2%)	40
150	34 (5%) - 37 (3%)	34 (5%) - 36 (7%)	30 (6%) - 35 (3%)	40
155	32 (26%) - 36 (56%)	32 (21%) - 35 (53%)	31 (22%) - 35 (62%)	40
157	32 (22%) - 36 (54%)	32 (24%) - 35 (50%)	31 (23%) - 35 (62%)	40
237	29 (23%) - 38 (22%)	29 (54%) - 37 (53%)	27 (88%) - 36 (83%)	40

Notes: *1. Numbers in bold indicates levels above EPA's night Amenity Criterion.*

2. The urban/industrial interface ANL has been adopted for these locations.



Cumulative noise assessment

Warkworth Mine continuation

Noise and vibration assessment

Figure 11.1

12 Blasting noise and vibration impact assessment

The proposed 2014 disturbance area is generally consistent with the disturbance area proposed under the Warkworth Extension 2010 Project. Blasting impacts are not materially different when considering off-site noise and vibration from blasting. Hence the following sections rely on the assessment undertaken in 2010.

12.1 General blast impacts

The blast design is actively managed by the operation, and hence corresponding airblast overpressure and ground vibration will be minimised. MTW's existing blast management procedures will be used to ensure appropriate charge masses are used for blasting. Other mitigation options include reducing bench heights and the use of electronic detonators to provide more accurate timing of blasts. Typically, blasting occurs once per day, however it is not uncommon for two blasts to be undertaken in one day at larger mines. Blasts can occur regularly on consecutive days throughout the majority of the year.

The charge masses (or maximum instantaneous charge MIC) needed to achieve human annoyance based criteria are presented in Table 12.1. This provides a guide to assist blast designers with their assessment of potential impacts at the specified distances from assessment locations. The predictions were derived from formulae in the Blastronics Pty Limited publication for monitoring data collected at similar mines (Blastronics 1994). The formulae used are:

- Blast overpressure (95 per cent) in dBL = 172.8-23.7*LOG(D/(MIC^1/3)) (1)
- Blast vibration (95 per cent) in mm/s = 1667*(D/(SQRT(MIC^-1.45)) (2)

Where D is the blast to assessment location separation distance in metres and MIC is the maximum instantaneous charge in kg.

Adopting the mass charges in Table 12.1 for corresponding separation distances to residences will ensure current blast consent limits will be achieved. The typical MIC used for blasting in mines is up to 1,500kg and 3,000kg for coal and overburden blasts respectively. Table 12.1 demonstrates that ground vibration limits will be achieved during all types of blasts for separation distances of over 3km. Within 3 km, blasts will be designed to achieve the appropriate limits and in all cases will be monitored. Appropriate management of blasts will be needed to ensure blast noise overpressure limits are satisfied.

Table 12.1 Blasting assessment

Distance to property, m	MIC_{8ms} to satisfy ANZECC 95 % overpressure limit of 115 dB(Lin), kg	MIC_{8ms} to satisfy ANZECC 95% Ground vibration limit of 5 mm/s (ppv), kg
900	NA	268
1,500	163	745
2,000	386	1,324
2,500	753	2,069
3,000	1,302	2,980

12.2 Sensitive structures

The potential impact of blasting on structures is another area that was considered in the assessment. Notwithstanding the closest structures being MTW offices, workshops and other site structures, the focus of this assessment was on Bulga Bridge and St Phillip's Church in Warkworth Village.

The Bulga Bridge is a relatively robust structure that carries light and heavy vehicle traffic, which would generate significant levels of vibration on the bridge.

Blasting will be at its closest to both the Bulga Bridge and to St Phillip's Church during indicative Year 14 of mining. The separation distance from the indicative Year 14 blast areas to both these structures will be at least 2500m.

Based on Bill & Jordon 2009 a conservative limit of 10mm/s peak particle component vibration velocity would be conservative for heritage type structures. Adopting this limit for the bridge is therefore considered additionally conservative.

To achieve this limit at the bridge and church from blasting at 2,500 m away, Blastronics formulae suggest a MIC of up to 5,400 kg can be used. This should only be used as a guide to blast designers, and be confirmed through monitoring. The largest blast masses typically used at MTW are for overburden material which only range up to 3,000 kg MIC. Hence, impacts on these structures are considered highly unlikely and would allow for normal blasting practices to continue.

12.3 Effects on animals

Very little evidence is available in literature on the direct impacts that blast noise has on livestock or animals in general. Blast noise is not a new or newly introduce source for the area and, therefore, it is expected that livestock and other animals are accustomed to such sources of noise. For the proposal, it is clear that the current level of noise from blasting is not going to increase significantly at locations assessed. A similar level of minimal change is therefore expected for locations where livestock or animals inhabit. These include the national parkland areas west of Bulga and surrounding grazing land. Impacts to animals are therefore expected to be minimal.

13 Road traffic noise impact assessment

Modelling of traffic noise impacts resulting from the proposed closure of Wallaby Scrub Road in indicative Year 3 of mining was undertaken using the industry accepted UK Calculation of Road Traffic Noise (CoRTN) algorithm. Traffic information used for the assessment was derived from the proposal's traffic and transport study (EMM, 2014). As well as classification, speed rating and per cent heavy vehicle data for the road network surrounding Warkworth Mine, the assessment provided day and night peak hour traffic volumes for the following scenarios:

- Indicative Year 3 with no mine extension and no road network changes (the "'Do Nothing' scenario); and
- Indicative Year 3 with the mine extension and Wallaby Scrub Road closed.

The privately owned assessment locations potentially most affected by the closure of Wallaby Scrub Road will be locations 144 and 915, approximately 75 m from Putty Road (Golden Highway) between Broke Road and Mount Thorley respectively. These residences are the closest to the Putty Road (Golden Highway) where traffic changes will be most pronounced due to the proposal. Refer to Figure 13.1 for assessment locations and the proposed detour route.

The total combined L_{eq} noise level received from all surrounding roads was determined based on factors such as its distance and angle-of-view to those roads, and the worst case daily traffic volumes and percentage of heavy vehicles conveyed on those roads.

The following parameters were used in the modelling of the potential traffic noise impact resulting from the closure of Wallaby Scrub Road:

- Façade correction applied at assessment location: +2.5dB;
- Height of assessment location above ground (locally): 1.5m; and
- Road Surface Material: Dense-Graded Asphalt.

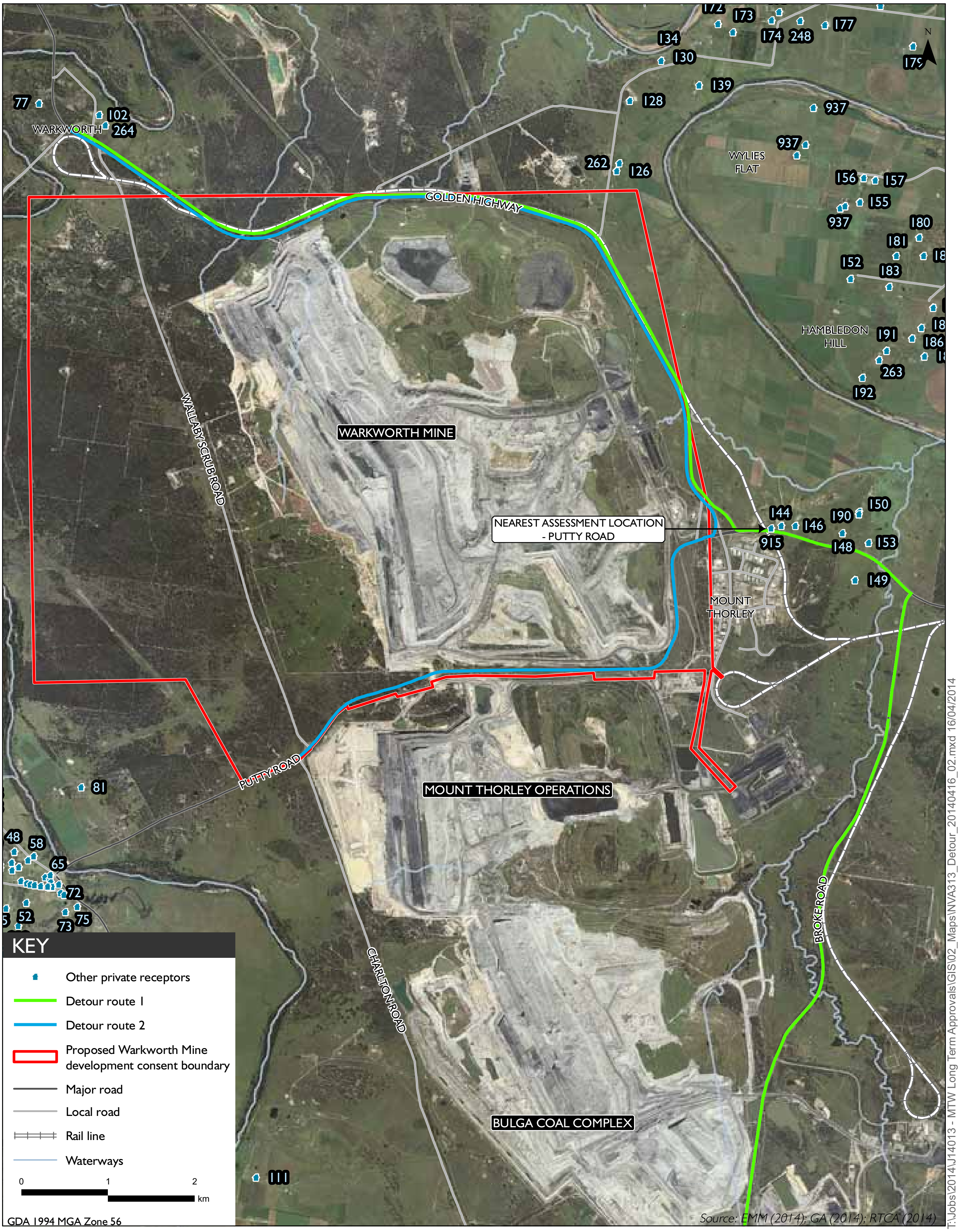
The current daily traffic movements on this road section are 8,847 vehicles. This is predicted to increase by 609 vehicles in indicative Year 3 which equates to a 6.9 per cent increase in traffic volumes.

The assessment of traffic noise impacts potentially resulting from the closure of Wallaby Scrub Road were assessed against the RNP criteria presented in Section 9.9. The results of noise modelling of the two road traffic scenarios presented above are summarised in Table 13.1.

The results presented in Table 13.1 indicate that the RNP day and night criteria are met for both scenarios. The relative change in noise level is also marginal (0.3 dB) for assessment locations 144 and 915. It should be noted that dwellings at this property have previously been mitigated using architectural treatment.

Table 13.1 Predicted $L_{eq,1hour}$ road traffic noise levels, dB(A)

Assessment location	Indicative Year 3 'do nothing'		Indicative Year 3 Wallaby Scrub Rd Closed		Increase in noise[1]	
	Day	Night	Day	Night	Day	Night
144/915	59	51	59	51	0	0.3
Criteria	**60**	**55**	**60**	**55**	**n/a**	**n/a**



Wallaby Scrub Road traffic detour routes and nearest assessment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure 13.1

14 Other noise management and mitigation considerations

Consideration was given to restricting overburden emplacement heights during night time.

Current operational controls at the mine include management of day to day activities to real time and predictive monitoring of prevailing meteorological conditions. Where prevailing conditions are unsuitable, emplacement at specific locations, regardless of height, is suspended.

The applicant considered a range of different design scenarios for night time overburden emplacement with permutations of emplacement height and equipment used. The noise modelling results demonstrated that restricting the height of emplacement activities would not result in material benefit to assessment locations.

That is, a blanket restriction to emplacement location without regard to prevailing meteorological conditions had the effect of limiting the ability of the operation to respond to prevailing conditions. Analysis of lower elevation night time overburden emplacement identified additional spatial constraints as well as negative impacts on productivity, particularly as the overburden inventories reduce over the life of the proposal. To mitigate these negative operational effects, the night time overburden emplacement scenarios considered different and more efficient equipment operating at higher levels during the day, whilst lower emplacement areas would be rolled over at night as the main strip progresses. Similar to other scenarios, these results indicated that additional dust would be generated during these activities and would increase the total dust emissions generated from the operation. Notwithstanding that Warkworth Mine currently implements active operational control for emplacement areas in response to actual and predicted meteorological conditions to meet prescribed criteria, the option of establishing a consistent night time emplacement solution across the Site was discounted for the reasons outlined above.

Another consideration included earth mounds to shield Bulga residences from mining operations. Due to the slope of the terrain between the mine and Bulga residences, mounding would need to be considerable in extent and height to be of any benefit. Notwithstanding, if line of sight to residences could be obstructed, the benefit would be marginal during adverse weather conditions when it would be needed most. The impractical nature of such a mound includes the need for considerable land area to accommodate the mound's base and would need to be along the Wollombi Brook. This land area near the brook is not available. Furthermore, the mining operations at their western most extent are well shielded by the depth of the pit in latter stages and additional surface mounding would not provide any further noise benefits.

Further considerations included a ramp up in daytime operations to counter production losses if reduced night operations were employed. This measure would require purchase of several plant items (eg shovel and fleet of trucks) which would then be required to be parked up during the night time. This is not a practical or reasonable and feasible measure.

15 NSW Land and Environment Court judgement

The NSW Land and Environment Court handed down its findings on the Warkworth Extension Project in a judgement in April 2013 following an appeal from the Bulga Milbrodale Progress Association Inc. One of the key matters raised in the L&E Court was noise. The broad areas relating to noise the judgement focussed on are as follows:

1. combining Warkworth mine and Mount Thorley Operations into one assessment;
2. representative background noise for Bulga;
3. sleep disturbance impacts;
4. low frequency noise (LFN);
5. cumulative noise (amenity); and
6. existing mining noise levels already unacceptable (suggesting, therefore, any new mining proposals should not be allowed).

Each of the above matters has been addressed in more detail in this report. A summary for each is provided below and further detail can be found in the references provided:

1. The current approach does not combine Warkworth Mine and MTO. The two mines are assessed separately in this EIS;
2. An extensive background noise analysis has been completed for Bulga residences and is documented in Section 8. Six long term monitoring sites across Bulga were used capturing, in some cases, several months of data. The data reflects consistency with historic (2002) data showing background levels of 30 dB(A) to 33 dB(A);
3. Sleep disturbance is addressed in Sections 9.6 and 10.8;
4. LFN is addressed in Sections 9.7 and 10.9;
5. Cumulative noise is addressed in Sections 9.5 and 11. It is demonstrated that the non-discretionary Mining SEPP is satisfied for Bulga residences and means the area's amenity is not compromised as it meets the INP's ANL. Further, the amenity, which relates to cumulative noise from all industry, cannot worsen for this area because it is highly unlikely that no new large scale industry will be able to physically exist in a position that could push amenity levels any higher for Bulga residences; and
6. A comprehensive data set of Warkworth Mine's performance with respect to compliance is provided in Section 6. Further the mine's current and on-going management is described in Sections 3 to 5. It should also be noted that the attenuation to plant is currently at 50 per cent of trucks, and partly commenced on other items, and a commitment to have all major plant attenuated by the end of 2016 will mean an improvement to off-site noise levels on the current situation. As per Item 4, it is demonstrated that the ANL would be satisfied with the proposal.

16 INP Checklist

The INP provides nine steps for noise management at Section 1.4 'Applying the policy'. For reference, these steps are provided in Table 16.1 with references within this report as to where these steps have been addressed.

Table 16.1 INP Checklist

INP step	Reference section in this document
1 Determining the project specific noise levels for intrusiveness and amenity that are relevant to the site or the area (Section 2).	Section 9
2. Measuring and determining existing background and ambient noise levels, using the method relevant to the expected level of impact (as outlined in Section 3).	Section 8
3. Where the proposed development is expected to produce annoying noise characteristics, adjustments are to be applied to the noise levels produced by the development in question (as outlined in Section 4).	Section 9.7 and 10.9
4. Predicting or measuring the noise levels produced by the development in question, having regard to meteorological effects (such as wind, temperature inversions) (see Section 5).	Section 10
5. Comparing the predicted or measured noise level with the project-specific noise levels and assessing impacts (Section 6).	Section 10.5, 10.6 and Appendix D
6. Considering feasible and reasonable noise mitigation strategies where the project specific noise levels are exceeded (Section 7).	Sections 3 to 6, 10.2.1, 10.6, and 14
7. Negotiation between the regulatory/consent authority and the proponent and between the community and the proponent to evaluate the economic, social and environmental costs and benefits from the proposed development against the noise impacts (Section 8).	Refer EIS Chapters 7 'Stakeholder engagement', and Chapter 24 'Justification and conclusion'. Several meetings have been held between the applicant and the regulator in relation to noise, social and economic implications of the proposal.
8. The regulatory/consent authority sets statutory compliance levels that reflect the achievable and agreed noise limits for the development (Section 9).	To be completed by consent authority at the completion of the approval process.
9. Monitoring of environmental noise levels from the development to determine compliance with the consent/licence conditions (Section 11).	To be completed post approval for the proposal. Monitoring data for the current operations is provided in Section 6.

17 Conclusion

This study considers the potential for noise impacts to residences from the proposal, including:

- background noise level analysis in accordance with the INP;
- establishing PSNLs in accordance with the INP;
- detailed three-dimensional noise modelling and predictions;
- assessment against PSNLs;
- assessment of potential sleep disturbance;
- assessment of LFN (external and internal);
- assessment of blasting;
- assessment of road traffic noise;
- best practice sound suppression on all major plant at an estimated capital cost exceeding $50M across MTW;
- operational controls to manage off site noise to PSNL where reasonable and feasible to do so; and
- description of comprehensive management procedures adopted by the Site.

Furthermore, a peer review by Wilkinson Murray Pty Ltd was completed and a summary letter of their review is provided in Appendix F.

The assessment of the potential for noise impacts on 221 residences over the life of the proposal includes predictions of emissions based on an equipment fleet with best practice sound suppression on all major plant. Further, Warkworth Mine is in final stages of developing a pre-emptive real time noise modelling interface (a first in the NSW mining industry) and is using best practice real time noise monitoring and management techniques. This constitutes all reasonable and feasible mitigation has and would be adopted as part of the proposal.

One of the study's aims was to demonstrate the effectiveness of managing off site noise to within the INP's requirements, and as described below, this has largely been achieved.

Operational noise at residences was predicted under varying meteorological conditions prevalent at the Site including calm, winds and temperature gradient conditions. Modelling has been validated in the past against monitoring results with strong correlations found.

The study developed a fairer approach to background noise level assignment for Bulga residences using long-term monitoring locations and transition of RBL's between these locations.

The assessment concluded that operational noise would comply with the Mining SEPP non-discretionary standards at all locations not already significantly impacted by mining noise. It was also found that operational noise will comply with the INP's operational criteria for all assessment locations during 'calm' weather conditions for day, evening and night periods.

Predictions during adverse weather indicated that operational noise levels from the proposal would likely present significant noise level exceedances at four assessment locations, three of which are located to the north west of the Site in Warkworth village. Of these properties, one location (location 77) has previously been identified within a zone of acquisition of a neighbouring mine (Wambo). The second property (102) is not a residence (Warkworth Hall) and the third is a newly identified location (264), that through extrapolation of noise, would also be within Wambo's acquisition zone had it been previously assessed. A significant exceedance is predicted for one assessment location in Bulga.

The change in noise from current and approved operations is expected to be marginal for western assessment locations, while a material reduction is predicted for eastern assessment locations as attenuation of plant progresses. The proposed noise suppression and fleet management will mean the advancement westward will not result in a material increase to noise levels.

The cumulative noise assessment demonstrates adherence to the INP's amenity criteria and the non-discretionary Mining SEPP at all properties with the exception of those previously identified as impacted by other mining operations.

It is demonstrated that the non-discretionary Mining SEPP is satisfied for Bulga residences. This means the area's amenity is not compromised as it meets the INP's ANL. Further, the amenity, which relates to cumulative noise from all industry, cannot worsen for this area because no new large scale industry will be able to physically exist in a position that could push amenity levels any higher for Bulga residences. This means that while some assessment locations will be 1 or 2dB above PSNLs, for example, this means these assessment locations can remain habitable whilst still being subject to a noise level commensurate with a rural amenity residential area as defined in the INP.

This assessment also concludes that noise impacts are within appropriate criteria for:

- operational blasting activities; and
- increased traffic volumes on public roads due to the detoured traffic resulting from the closure of Wallaby Scrub Road.

References

Bill Jordan & Associates (2009), Edinglassie Homestead & Rous Lench – Blast Vibration Vulnerability

British Standard 7385-2 and US Bureau of Mines Standard RI 8507 (2006)

Bulga Optimisation (Umwelt 2013); Project Environmental Impact Statement

International Organisation for Standardisation (1999); DIN 4150 Part 3 – Structural Vibration: Effects of Vibration Structures

Deutsche Norm (1999); DIN 4150 Structural Vibration Part 3: Effects of Vibration on Structures

Blastronics Pty Limited (1994); Drill & Blast Study, Mount Pleasant, prepared for Coal & Allied

Dr Norm Broner (2011); A Simple Outdoor Criterion for Assessment of Low Frequency Noise Emission Acoustics Australia Vol.39

Dr Moorhouse (2005); Proposed criteria for the assessment of low frequency noise disturbance Bill Jordan & Associates (2009); Edinglassie Homestead & Rous Lench – Blast Vibration Vulnerability

EMM (2010); Mount Thorley Warkworth Operations Modification - Proposed Warkworth Extension Acoustic Assessment report

Experimental Outdoor Sound Propagation' 13th International Congress on Sound & Vibration, (2006) and Experimental Outdoor Sound Propagation vs ENM Australian and New Zealand Acoustic Society Conference (2006)

Environment Protection Authority (2011); Road Noise Policy

Environment Protection Authority (2000); NSW Industrial Noise Policy

Australian and New Zealand Environment and Conservation Council (ANZECC) (1990); Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration

The Australian Standard, AS2187.2 (2006); Explosives - Storage and Use Part 2 Use of Explosives (Appendix J)

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

Resource Strategies (2002); Wambo Development Project, Environmental Impact Statement

Appendix A

Assessment locations

Table A.1 Properties included in the noise assessment

Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Bulga	1	310903	6386238
Bulga	2	311055	6386261
Bulga	3	311295	6386059
Bulga	4	311336	6385751
Bulga	5	311384	6386200
Bulga	6	311422	6386223
Bulga	7	311470	6385618
Bulga	8	311735	6385855
Bulga	9	311832	6385649
Bulga	10	311950	6386665
Bulga	12	312442	6386044
Bulga	13	312532	6387028
Bulga	14	312632	6386066
Bulga	15	312729	6385875
Bulga	16	312822	6386804
Bulga	17	312814	6387573
Bulga	18	312935	6385847
Bulga	19	312900	6387741
Bulga	20	313041	6385812
Bulga	21	312998	6386821
Bulga	22	313169	6385713
Bulga	23	313193	6385453
Bulga	24	313145	6387267
Bulga	26	313266	6385706
Bulga	28	313335	6385003
Bulga	29	313160	6388183
Bulga	30	313270	6386465
Bulga	31	313281	6386646
Bulga	32	313252	6387528
Bulga	33	313338	6386039
Bulga	34	313265	6388491
Bulga	35	313406	6386485
Bulga	36	313473	6385589
Bulga	37	313345	6387861
Bulga	38	313489	6385650
Bulga	39	313511	6385747
Bulga	40	313595	6385794
Bulga	41	313690	6384726
Bulga	42	313580	6386816
Bulga	43	313658	6385668
Bulga	44	313658	6385708
Bulga	45	313725	6385198

Table A.1 Properties included in the noise assessment

Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Bulga	46	313798	6385640
Bulga	47	313793	6385729
Bulga	48	313823	6385853
Bulga	49	313872	6385678
Bulga	50	313898	6385517
Bulga	52	313956	6385265
Bulga	53	313965	6385488
Bulga	54	314037	6384456
Bulga	55	313981	6385757
Bulga	56	314005	6385480
Bulga	57	314055	6385470
Bulga	58	314046	6385804
Bulga	60	314128	6385459
Bulga	61	314231	6384325
Bulga	62	314225	6385443
Bulga	63	314229	6385540
Bulga	64	314242	6385504
Bulga	65	314239	6385584
Bulga	66	314258	6385447
Bulga	67	314434	6383176
Bulga	70	314462	6383042
Bulga	71	314354	6385377
Bulga	72	314392	6385359
Bulga	73	314407	6385160
Bulga	74	314514	6384263
Bulga	75	314546	6385220
Bulga	80	314769	6383296
Bulga	82	314734	6384379
Bulga	84	314796	6383618
Bulga	89	314951	6383454
Bulga	210	314178	6385559
Bulga	211	314331	6385481
Bulga	215	313354	6386390
Bulga	217	312125	6386110
Bulga	218	311450	6386578
Bulga	219	311134	6386568
Bulga	220	311258	6385905
Bulga	221	311001	6385414
Bulga	222	311233	6385294
Bulga	223	311393	6385458
Bulga	224	311716	6385367
Bulga	225	312256	6385540

Table A.1 Properties included in the noise assessment

Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Bulga	226	312474	6385495
Bulga	227	312569	6385509
Bulga	228	312698	6385457
Bulga	229	312866	6385557
Bulga	230	312952	6385439
Bulga	231	313060	6385467
Bulga	234	314048	6384261
Bulga	235	314181	6384088
Bulga	236	314679	6384143
Bulga	237	314116	6383992
Bulga	238	314448	6383932
Bulga	243	314883	6383176
Bulga	252	314827	6384207
Bulga	253	312973	6385584
Bulga	254	314529	6384103
Bulga	255	312973	6386930
Bulga	266	310048	6389815
Bulga	267	309407	6389413
Bulga	268	308672	6389436
Bulga	903	314821	6383080
Bulga	904	314024	6382465
Bulga	905	313176	6382198
Bulga	909	314611	6382770
Bulga	911	313271	6382442
Bulga	917	314549	6382967
Bulga	918	314686	6382893
Bulga	919	313866	6385003
Bulga	920	314208	6385455
Bulga	921	313692	6384676
Bulga	922	313313	6384456
Bulga	927	314213	6382445
Bulga	927	314251	6382364
Bulga	927	314400	6382451
Bulga	927	314414	6381446
Bulga	927	314462	6381631
Bulga	927	314521	6381618
Bulga	927	313398	6381173
Bulga	927	313742	6381405
Bulga	927	313851	6381411
Bulga	927	313902	6381509
Bulga	928	314270	6382655
Bulga	929	314462	6382864

Table A.1 Properties included in the noise assessment

Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Bulga	936	314376	6382753
Gouldsville/Long Point	126	320764	6393699
Gouldsville/Long Point	127	320624	6396932
Gouldsville/Long Point	128	320916	6394511
Gouldsville/Long Point	130	321271	6394970
Gouldsville/Long Point	134	321472	6395034
Gouldsville/Long Point	139	321707	6394686
Gouldsville/Long Point	141	321604	6397030
Gouldsville/Long Point	167	322254	6396725
Gouldsville/Long Point	168	322468	6396793
Gouldsville/Long Point	169	321959	6396271
Gouldsville/Long Point	170	322379	6396285
Gouldsville/Long Point	172	321925	6395400
Gouldsville/Long Point	173	322099	6395301
Gouldsville/Long Point	174	322545	6395438
Gouldsville/Long Point	175	322633	6395534
Gouldsville/Long Point	176	322830	6395688
Gouldsville/Long Point	177	323156	6395384
Gouldsville/Long Point	178	323801	6395607
Gouldsville/Long Point	179	324177	6395141
Gouldsville/Long Point	248	322876	6395431
Gouldsville/Long Point	249	323284	6395685
Gouldsville/Long Point	250	324927	6395679
Gouldsville/Long Point	251	325339	6394874
Gouldsville/Long Point	262	320794	6393794
Hambledon Hill/Wylies Flat	152	323454	6392457
Hambledon Hill/Wylies Flat	155	323565	6393343
Hambledon Hill/Wylies Flat	156	323610	6393617
Hambledon Hill/Wylies Flat	157	323739	6393594
Hambledon Hill/Wylies Flat	180	324246	6392934
Hambledon Hill/Wylies Flat	181	323983	6392725
Hambledon Hill/Wylies Flat	182	324296	6392725
Hambledon Hill/Wylies Flat	183	323903	6392368
Hambledon Hill/Wylies Flat	184	324407	6392127
Hambledon Hill/Wylies Flat	185	324272	6391894
Hambledon Hill/Wylies Flat	186	324164	6391772
Hambledon Hill/Wylies Flat	187	324308	6391565
Hambledon Hill/Wylies Flat	191	323873	6391630
Hambledon Hill/Wylies Flat	192	323595	6391320
Hambledon Hill/Wylies Flat	263	323786	6391522
Hambledon Hill/Wylies Flat	937	322832	6393883
Hambledon Hill/Wylies Flat	937	322935	6394004

Table A.1 Properties included in the noise assessment

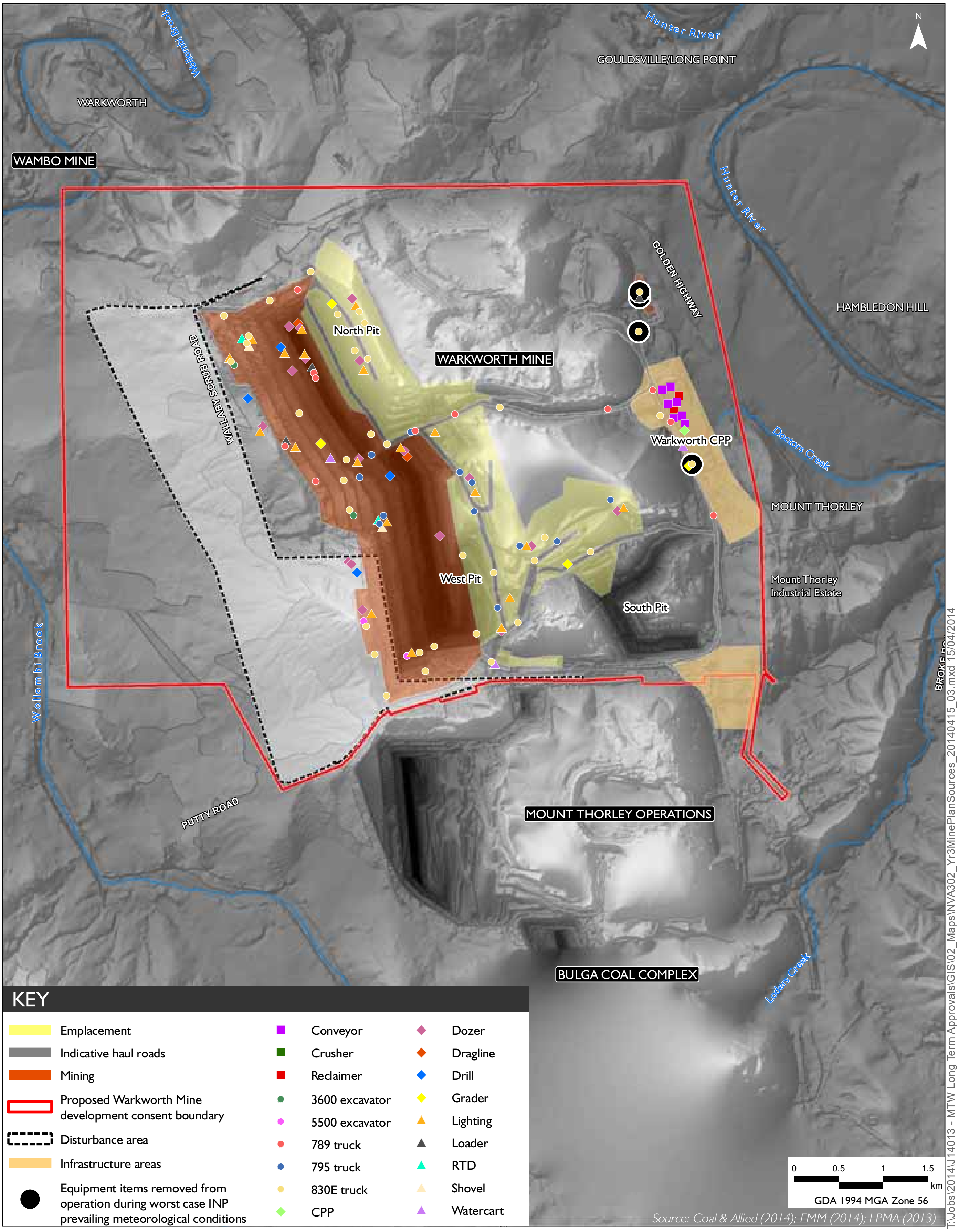
Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Hambledon Hill/Wylies Flat	937	323028	6394431
Hambledon Hill/Wylies Flat	937	323333	6393272
Hambledon Hill/Wylies Flat	937	323391	6393295
Maison Dieu	117	317982	6397794
Maison Dieu	118	318128	6397356
Maison Dieu	120	318504	6398457
Maison Dieu	121	318530	6398039
Maison Dieu	122	318608	6398554
Maison Dieu	123	318658	6398205
Maison Dieu	124	318655	6398582
Maison Dieu	160	317883	6399178
Maison Dieu	161	318010	6399448
Maison Dieu	162	318011	6399407
Maison Dieu	163	318114	6399572
Maison Dieu	244	318808	6399092
Maison Dieu	245	318679	6399194
Maison Dieu	246	318795	6399314
Maison Dieu	247	318879	6399292
Maison Dieu	256	317979	6399821
Maison Dieu	257	318793	6399221
Maison Dieu	258	318104	6399611
Maison Dieu	259	318211	6397178
Maison Dieu	260	318180	6399198
Maison Dieu	261	318030	6399106
Maison Dieu	265	318014	6397793
Milbrodale	111	316609	6382098
Milbrodale	193	316558	6380293
Milbrodale	197	317716	6380532
Milbrodale	199	317036	6377983
Milbrodale	200	317360	6378494
Milbrodale	201	316963	6378778
Milbrodale	202	316649	6378621
Milbrodale	203	316167	6378781
Milbrodale	204	316407	6379326
Milbrodale	205	316333	6379327
Milbrodale	206	316214	6379385
Milbrodale	207	315682	6379608
Milbrodale	208	314955	6381041
Milbrodale	923	314505	6381343
Milbrodale	926	315197	6381155
Mount Thorley	144	322654	6389614
Mount Thorley	146	322820	6389611

Table A.1 Properties included in the noise assessment

Locality	Assessment location ID	MGA Coordinates	
		Easting	Northing
Mount Thorley	148	323360	6389527
Mount Thorley	149	323510	6388982
Mount Thorley	150	323560	6389775
Mount Thorley	153	323662	6389415
Mount Thorley	188	324940	6390387
Mount Thorley	190	323552	6389746
Mount Thorley	915	322542	6389581
Mount Thorley	932	325626	6388538
Warkworth	77	314103	6394482
Warkworth	102	314808	6394346
Warkworth	264	314870	6394227

Appendix B

Mine plans and modelled equipment locations

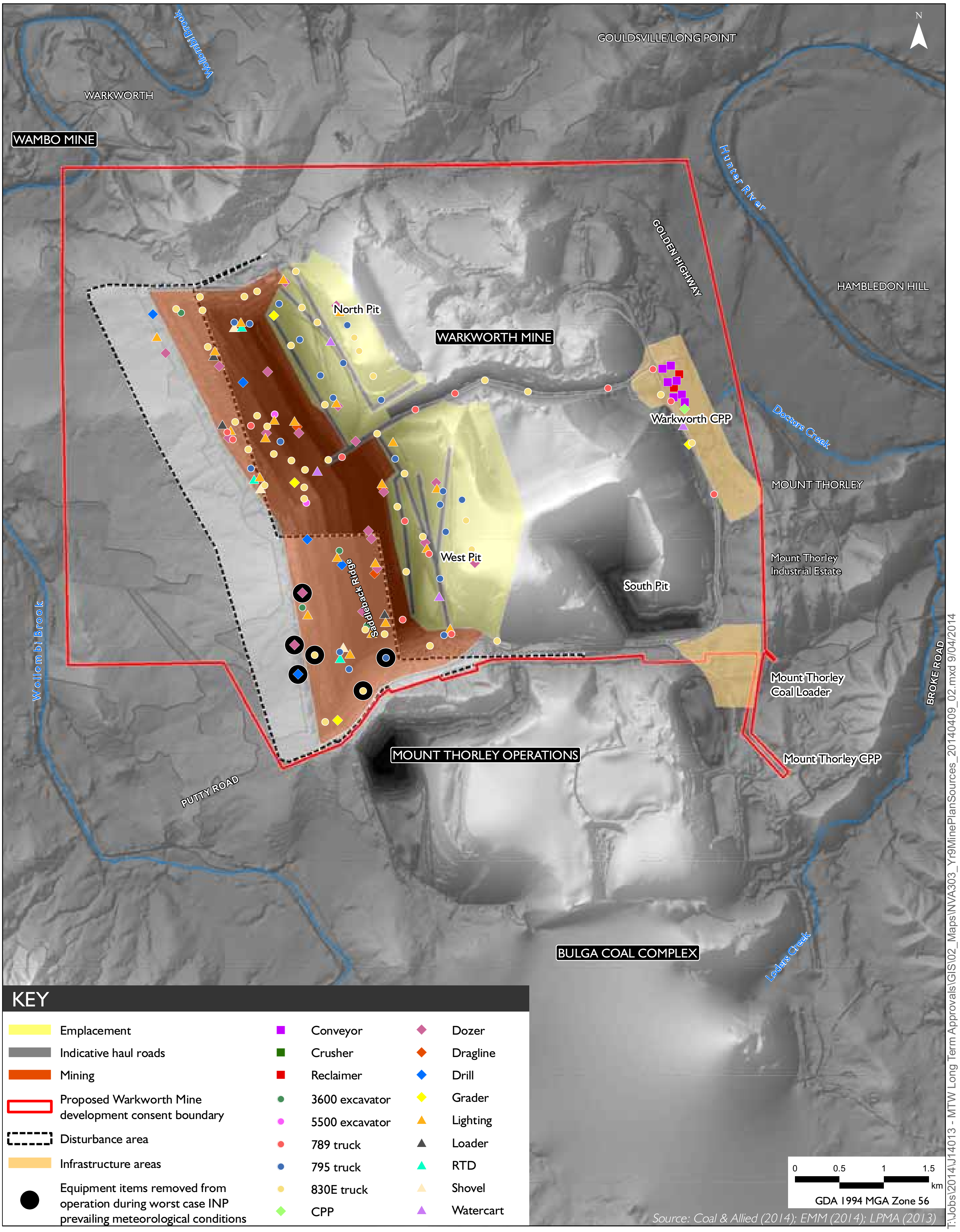


Year 3 mine plan and equipment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure B1

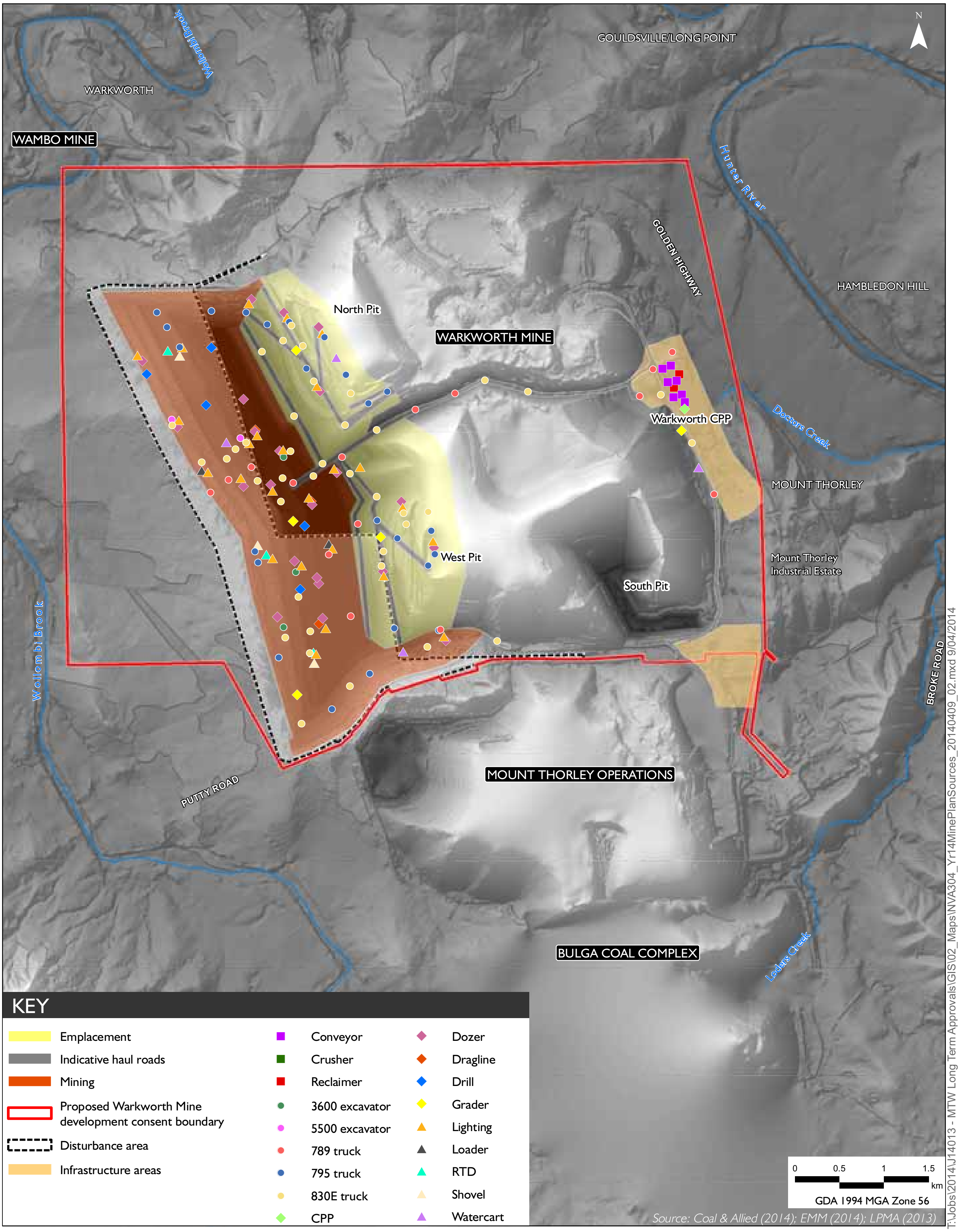


Year 9 mine plan and equipment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure B2



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Year 14 mine plan and equipment locations

Warkworth Mine continuation

Noise and vibration assessment

Figure B3

Appendix C

INP wind analysis

Table C.1 Day percentage of wind speed (vector at 22.5^{o} intervals)

Direction	Winter	Autumn	Spring	Summer
22.5^{o}	17.4	23.6	21.9	21
45^{o}	20.8	23.3	17.6	22.2
67.5^{o}	23	21.6	12.9	22
90^{o}	25.7	24.6	12.9	21.1
112 .5^{o}	27.8	28.9	15.3	22.1
135^{o}	27.2	29.3	16	21.7
157.5^{o}	24.9	28	16	19.7
180^{o}	21.5	24.9	15.5	16.3
202.5^{o}	16.8	21	14.6	13
225^{o}	12.4	17.5	13.4	10.1
247.5^{o}	6.4	12.5	13.3	7.3
270^{o}	5.6	14	16.9	8.3
292.5^{o}	9.3	19.1	22.5	13.1
315^{o}	11.3	20	23.3	15.2
337.5^{o}	12.7	20.8	23.6	16.6
360^{o}	14.6	22	23.3	18.6

Notes: 1. Bold highlight denotes occurrence of 30 % and greater.

Table C.2 Evening percentage of wind speed (vector at 22.5^{o} intervals)

Direction	Winter	Autumn	Spring	Summer
22.5^{o}	8.6	8.2	9	13
45^{o}	13	13.3	7.7	17.4
67.5^{o}	18.1	20.3	8.1	24.3
90^{o}	22	**30.6**	16.4	28.7
112 .5^{o}	22.8	**44.8**	**33.6**	**31.7**
135^{o}	22.7	**48.7**	**41.1**	**31.8**
157.5^{o}	21.8	**48.3**	**42.9**	**30.5**
180^{o}	18.9	**46.4**	**43.9**	28.1
202.5^{o}	13.6	**40.3**	**43.1**	21.8
225^{o}	8.2	**32.2**	**41.4**	13.9
247.5^{o}	5.1	20.8	**32.1**	10.7
270^{o}	4.3	9.4	18.1	9.6
292.5^{o}	4.3	7.4	15.3	9.9
315^{o}	4.4	7.1	14.4	9.8
337.5^{o}	5.3	7.1	13	10
360^{o}	6.4	6.9	11.2	10.8

Notes: 1. Bold highlight denotes occurrence of 30 % and greater.

Table C.3 Night percentage of wind speed (vector at 22.5° intervals)

Direction	Winter	Autumn	Spring	Summer
22.5°	7.2	9.8	17.4	13.6
45 °	9.4	7.1	10	10.9
67.5 °	18	7.6	4.2	12.3
90 °	**32**	23.1	9.7	25.4
112 .5 °	**44**	**43.1**	21.2	**39.3**
135 °	**46.8**	**47**	25.8	**43.6**
157.5 °	**47.1**	**48.5**	27.8	**45**
180 °	**46.2**	**49**	29.3	**45.1**
202.5 °	**41.9**	**48.6**	**31.3**	**43.6**
225 °	**30.8**	**44.4**	**33.1**	**38.1**
247.5 °	16	27.9	**30.6**	25.8
270 °	7.3	16	27.3	19.4
292.5 °	7	16.1	28	19.6
315 °	7.1	15.3	27.3	19
337.5 °	7.2	14.4	25.7	18
360 °	7.2	12.8	22.7	16.2

Notes: 1. Bold highlight denotes occurrence of 30 % and greater.

Appendix D

Predicted noise levels during calm and INP prevailing meteorological conditions

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
Bulga	1	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	2	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	3	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	4	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	36	35	40
	5	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	6	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	≤35	35	40
	7	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	36	35	40
	8	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	36	35	40
	9	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	36	35	40
	10	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	36	35	40
	12	30	≤35	≤35	36	≤35	≤35	38	≤35	≤35	37	35	40
	13	33	≤38	≤38	≤38	≤38	≤38	40	≤38	≤38	39	38	43
	14	30	≤35	≤35	36	≤35	≤35	38	≤35	≤35	37	35	40
	15	30	≤35	≤35	36	≤35	≤35	38	≤35	≤35	37	35	40
	16	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	17	33	≤38	≤38	39	≤38	≤38	40	≤38	≤38	39	38	43
	18	31	≤36	≤36	≤36	≤36	≤36	38	≤36	≤36	37	36	41
	19	33	≤38	≤38	39	≤38	≤38	40	≤38	≤38	39	38	43
	20	31	≤36	≤36	37	≤36	≤36	38	≤36	≤36	37	36	41
	21	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	22	31	≤36	≤36	37	≤36	≤36	38	≤36	≤36	38	36	41
	23	31	≤36	≤36	≤36	≤36	≤36	38	≤36	≤36	38	36	41
	24	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	26	31	≤36	≤36	37	≤36	≤36	38	≤36	≤36	37	36	41
	28	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	29	30	≤35	≤35	39	≤35	≤35	40	≤35	≤35	40	30	40

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	30	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	31	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	32	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	39	38	43
	33	32	≤37	≤37	≤37	≤37	≤37	≤37	≤37	≤37	≤37	37	42
	34	30	≤35	≤35	40	≤35	≤35	41	≤35	≤35	41	35	40
	35	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	36	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	37	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	38	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	39	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	40	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	41	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	42	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	43	32	≤37	≤37	≤37	≤37	≤37	39	≤37	≤37	39	37	42
	44	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	45	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	46	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	47	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	48	32	≤37	≤37	38	≤37	≤37	≤37	≤37	≤37	38	37	42
	49	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	50	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	52	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	39	38	43
	53	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	54	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	55	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	56	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	57	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	58	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	60	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	61	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	62	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	≤38	38	43
	63	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	64	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	65	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	66	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	67	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	70	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	71	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	≤38	38	43
	72	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	≤38	38	43
	73	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	74	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	75	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	39	38	43
	80	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	82	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	84	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	89	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	210	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	211	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	≤38	38	43
	215	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	217	30	≤35	≤35	≤35	≤35	≤35	38	≤35	≤35	37	35	40
	218	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	219	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	220	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	221	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	36	35	40
	222	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	36	35	40
	223	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	36	35	40
	224	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	225	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	37	35	40
	226	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	37	35	40
	227	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	37	35	40
	228	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	37	35	40
	229	31	≤36	≤36	≤36	≤36	≤36	38	≤36	≤36	37	36	41
	230	31	≤36	≤36	≤36	≤36	≤36	37	≤36	≤36	37	36	41
	231	31	≤36	≤36	≤36	≤36	≤36	37	≤36	≤36	38	36	41
	234	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	235	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	236	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	237	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	238	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	243	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	252	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	39	38	43
	253	31	≤36	≤36	≤36	≤36	≤36	38	≤36	≤36	38	36	41
	254	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	255	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	266	30	≤35	≤35	≤35	≤35	≤35	37	≤35	≤35	37	35	40
	267	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	268	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	903	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	904	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	905	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	909	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	911	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	917	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	918	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	919	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	920	33	≤38	≤38	≤38	≤38	≤38	39	≤38	≤38	≤38	38	43
	921	32	≤37	≤37	≤37	≤37	≤37	38	≤37	≤37	38	37	42
	922	32	≤37	≤37	≤37	≤37	≤37	≤37	≤37	≤37	≤37	37	42
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	927	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	928	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	929	33	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	≤38	38	43
	936	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
Gouldsville/ Long Point	126	33	≤38	≤38	41	≤38	≤38	40	≤38	≤38	41	38	43
	127	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	128	30	≤35	≤35	39	≤35	≤35	39	≤35	≤35	39	35	40
	130	30	≤35	≤35	38	≤35	≤35	37	≤35	≤35	37	35	40
	134	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	139	30	≤35	≤35	38	≤35	≤35	37	≤35	≤35	37	35	40
	141	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	167	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	168	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	169	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	170	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	172	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	173	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	174	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	175	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	176	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	177	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	178	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	179	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	248	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	249	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	250	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	251	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	262	33	≤38	≤38	41	≤38	≤38	40	≤38	≤38	41	38	43

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
Hambledon Hill/Wylies Flat	152	30	≤35	≤35	39	≤35	≤35	39	≤35	≤35	39	35	40
	155	30	≤35	≤35	36	≤35	≤35	≤35	≤35	≤35	36	35	40
	156	30	≤35	≤35	36	≤35	≤35	36	≤35	≤35	36	35	40
	157	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	36	35	40
	180	30	≤35	≤35	36	≤35	≤35	36	≤35	≤35	36	35	40
	181	30	≤35	≤35	37	≤35	≤35	37	≤35	≤35	37	35	40
	182	30	≤35	≤35	37	≤35	≤35	37	≤35	≤35	37	35	40
	183	30	≤35	≤35	38	≤35	≤35	38	≤35	≤35	38	35	40
	184	30	≤35	≤35	37	≤35	≤35	36	≤35	≤35	36	35	40
	185	30	≤35	≤35	37	≤35	≤35	37	≤35	≤35	37	35	40
	186	30	≤35	≤35	37	≤35	≤35	37	≤35	≤35	37	35	40
	187	30	≤35	≤35	37	≤35	≤35	36	≤35	≤35	36	35	40
	191	30	≤35	≤35	39	≤35	≤35	38	≤35	≤35	39	35	40
	192	30	≤35	≤35	40	≤35	≤35	40	≤35	≤35	40	35	40
	263	30	≤35	≤35	39	≤35	≤35	38	≤35	≤35	39	35	40
	937	30	≤35	≤35	36	≤35	≤35	36	≤35	≤35	37	35	40
	937	30	≤35	≤35	37	≤35	≤35	36	≤35	≤35	37	35	40
	937	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	937	30	≤35	≤35	36	≤35	≤35	≤35	≤35	≤35	36	35	40
	937	30	≤35	≤35	36	≤35	≤35	≤35	≤35	≤35	36	35	40
Maison Dieu	117	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	≤35	35	40
	118	30	≤35	≤35	36	≤35	≤35	37	≤35	≤35	36	35	40
	120	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	121	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	122	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	123	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	124	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	160	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	161	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	162	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	163	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	244	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	245	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	246	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	247	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	256	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	257	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	258	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	259	30	≤35	≤35	37	≤35	≤35	37	≤35	≤35	36	35	40
	260	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	261	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	265	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	≤35	35	40
Milbrodale	111	30	≤35	≤35	≤35	≤35	≤35	36	≤35	≤35	36	35	40
	193	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	197	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	199	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	200	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	201	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	202	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	203	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	204	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	205	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40

Table D.1 Predicted operational noise levels during calm and prevailing meteorological conditions, dB(A)

Locality	Assessment location	RBL	Indicative Year 3, $L_{eq,15min}$			Indicative Year 9, $L_{eq,15min}$			Indicative Year 14, $L_{eq,15min}$			INP PSNL, $L_{eq,15min}$	Potential acquisition criteria, $L_{eq,15min}$
			Calm		Prevailing	Calm		Prevailing	Calm		Prevailing		
			Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night	Day	Eve/Night	Eve/Night		
	206	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	207	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	208	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	923	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	926	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
Mount Thorley	144[2]	n/a	≤39	≤39	43	≤39	≤39	42	≤39	≤39	43	n/a	44[1]
	146[2]	n/a	≤37	≤37	41	≤37	≤37	40	≤37	≤37	42	n/a	42[1]
	148	30	≤35	≤35	36	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	149	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	150	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	153	30	≤35	≤35	37	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	188	30	≤35	≤35	36	≤35	≤35	36	≤35	≤35	36	35	40
	190	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
	915[2]	n/a	≤39	≤39	43	≤39	≤39	42	≤39	≤39	42	n/a	44[1]
	932	30	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	≤35	35	40
Warkworth	77	33	≤38	≤38	43	≤38	≤38	44	≤38	≤38	44	38	43
	102	33	≤38	≤38	44	≤38	≤38	44	≤38	≤38	44	38	43
	264	33	≤38	≤38	42	≤38	≤38	43	≤38	≤38	44	38	43

Notes: *1. Current acquisition limit in development consent.*

2. The colouring (green, blue, orange) has been assigned relative to the development consent current acquisition limit rather than the RBL which was undetermined at these locations.

Appendix E

ABL's used to derive RBL's

Table E.1 Location A - Wollemi Peak Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Thursday, 20-06-13	0	29.7	32.4
Friday, 21-06-13	30.6	36.4	34.3
Saturday, 22-06-13	30.4	28.9	31.8
Sunday, 23-06-13	0	35.8	27.8
Monday, 24-06-13	29.1	19.7	19.9
Tuesday, 25-06-13	27.7	31	31.4
Wednesday, 26-06-13	39.4	38.2	39.3
Thursday, 27-06-13	0	43.7	42.8
Monday, 01-07-13	0	45.5	43.2
Tuesday, 02-07-13	36.8	43	40.1
Wednesday, 03-07-13	40.1	0	40.1
Thursday, 04-07-13	37.5	38	35
Friday, 12-07-13	33.3	38.3	37.2
Saturday, 13-07-13	30.9	0	0
Monday, 15-07-13	33.3	0	38.9
Tuesday, 16-07-13	34	0	39.9
Wednesday, 17-07-13	35	0	40
Thursday, 18-07-13	36.1	0	0
Friday, 19-07-13	0	36.3	0
Saturday, 20-07-13	37.1	34.5	29.7
Sunday, 21-07-13	33.2	32.8	33.7
Monday, 22-07-13	33.6	29.6	31.4
Tuesday, 23-07-13	31	28.9	26.8
Wednesday, 24-07-13	31.5	30	0
Thursday, 25-07-13	33.9	0	0
Friday, 26-07-13	35.1	33.2	34.6
Saturday, 27-07-13	34	34.8	37.6
Sunday, 28-07-13	34.1	36	39.2
Monday, 29-07-13	30.7	35.5	37.7
Tuesday, 30-07-13	31.2	0	34.8
Wednesday, 31-07-13	32.5	31.9	0
Thursday, 01-08-13	31.6	35.8	38
Friday, 02-08-13	32.5	28.9	27.5
Saturday, 03-08-13	33.8	30.6	28.1
Sunday, 04-08-13	33.8	25.4	0
Monday, 05-08-13	33.8	29.5	32.3
Tuesday, 06-08-13	35.5	31.3	32.3
Wednesday, 07-08-13	31.8	0	34
Thursday, 08-08-13	33	32.7	31.2

Table E.1 Location A - Wollemi Peak Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 09-08-13	33.6	32	30.1
Saturday, 10-08-13	32.4	32.3	0
Monday, 12-08-13	0	30.7	30.8
Tuesday, 13-08-13	32.2	0	32.3
Rating Background Level (RBL)	**33.3**	**32.7**	**34**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 07-12-11	0	28	28.1
Thursday, 08-12-11	32.5	36.3	0
Friday, 09-12-11	0	36.4	0
Saturday, 10-12-11	28.1	32	34.8
Sunday, 11-12-11	28	36.4	35.9
Monday, 12-12-11	34.2	34.3	36.1
Tuesday, 13-12-11	28.3	36.4	36.3
Wednesday, 14-12-11	0	36.5	0
Thursday, 15-12-11	28.5	33.6	0
Saturday, 17-12-11	0	34.6	34.3
Sunday, 18-12-11	27	31.7	37.3
Monday, 19-12-11	33.6	32.6	34.3
Tuesday, 20-12-11	31.4	35.7	0
Thursday, 22-12-11	0	0	31.8
Saturday, 24-12-11	0	36	0
Wednesday, 28-12-11	0	35.8	33.4
Thursday, 29-12-11	0	35.7	34.2
Friday, 30-12-11	31.4	34.7	0
Saturday, 31-12-11	29.8	32.9	0
Sunday, 01-01-12	27.7	31.5	30.9
Monday, 02-01-12	28.9	32.9	34.5
Tuesday, 03-01-12	32.7	0	37.5
Wednesday, 04-01-12	28.9	29.6	34.1
Thursday, 05-01-12	30.3	29.3	0
Friday, 06-01-12	0	30.3	28.2
Saturday, 07-01-12	32.8	33.3	36
Sunday, 08-01-12	32	0	0
Monday, 09-01-12	35.1	34.6	34.3
Tuesday, 10-01-12	28	28	0
Tuesday, 17-01-12	0	34.9	35.8
Wednesday, 18-01-12	32.2	0	35.3
Thursday, 19-01-12	0	34	33.3
Friday, 20-01-12	32.2	31.4	34.3
Saturday, 21-01-12	32.3	0	35
Sunday, 22-01-12	0	35.3	0
Monday, 23-01-12	0	33.7	0
Tuesday, 24-01-12	32.3	0	0
Thursday, 26-01-12	0	0	39.8
Friday, 27-01-12	37.8	0	0

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 28-01-12	0	30.5	37.9
Sunday, 29-01-12	32.6	31.4	0
Monday, 30-01-12	34.7	0	38
Friday, 03-02-12	0	44.6	45.7
Saturday, 04-02-12	31.3	39	0
Sunday, 05-02-12	31.8	35.7	43.3
Monday, 06-02-12	34	36.6	37.5
Tuesday, 07-02-12	34.1	35.8	0
Thursday, 09-02-12	0	37.7	40.1
Friday, 10-02-12	0	38.3	0
Saturday, 11-02-12	0	0	38.4
Sunday, 12-02-12	29.3	0	0
Tuesday, 14-02-12	0	40.2	0
Wednesday, 15-02-12	0	40.1	37.9
Thursday, 16-02-12	0	0	38.1
Friday, 17-02-12	0	36.6	41.1
Saturday, 18-02-12	0	0	44
Sunday, 19-02-12	0	33.1	0
Tuesday, 21-02-12	38.8	43.8	48.4
Wednesday, 22-02-12	37	44.1	0
Thursday, 23-02-12	28.8	39.9	0
Saturday, 25-02-12	0	38.3	0
Monday, 27-02-12	30.1	35.5	41.6
Tuesday, 28-02-12	28.3	35.1	42.3
Thursday, 01-03-12	36.9	0	0
Saturday, 03-03-12	0	0	49.2
Sunday, 04-03-12	34.1	46.1	47.3
Monday, 05-03-12	35.7	43.4	47.5
Tuesday, 06-03-12	32.2	44.3	44.4
Wednesday, 07-03-12	33.4	0	0
Saturday, 10-03-12	0	41.3	0
Saturday, 17-03-12	0	40.6	0
Thursday, 22-03-12	29.4	39.6	38
Friday, 23-03-12	36.5	40.9	34.1
Saturday, 24-03-12	27.8	42.7	0
Sunday, 25-03-12	31.6	0	0
Tuesday, 27-03-12	31.7	0	0
Wednesday, 28-03-12	27.9	41.7	35.2
Thursday, 29-03-12	0	42	34.4

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 18-04-12	0	34.7	29.4
Thursday, 19-04-12	28.2	31.9	31.8
Friday, 20-04-12	31.7	0	0
Saturday, 21-04-12	0	33.5	0
Sunday, 22-04-12	26.1	0	0
Monday, 23-04-12	0	29.8	26.1
Tuesday, 24-04-12	0	26.5	22.8
Wednesday, 25-04-12	26.2	22.8	0
Thursday, 26-04-12	31.2	0	0
Tuesday, 01-05-12	25.2	32.2	34.1
Saturday, 05-05-12	0	28	0
Sunday, 06-05-12	24.5	0	24.5
Tuesday, 08-05-12	0	0	29.6
Saturday, 12-05-12	0	0	21.4
Sunday, 13-05-12	26.7	0	0
Tuesday, 15-05-12	0	0	29.6
Friday, 18-05-12	22.9	0	31.3
Tuesday, 22-05-12	26.4	22.3	25.7
Wednesday, 23-05-12	28.2	29.2	32.3
Friday, 25-05-12	27.8	34.9	31.7
Saturday, 26-05-12	31.2	30.4	24.3
Sunday, 27-05-12	22.9	29.2	27.5
Monday, 28-05-12	24.7	27	29
Tuesday, 29-05-12	26.3	28.1	24.3
Wednesday, 30-05-12	26.7	30.4	31.3
Thursday, 31-05-12	26.9	35	0
Friday, 01-06-12	31.6	34.3	36
Monday, 04-06-12	31.1	28.4	29.3
Tuesday, 05-06-12	29	0	35
Wednesday, 06-06-12	34	31.4	34.6
Sunday, 10-06-12	0	0	27.4
Tuesday, 12-06-12	0	34.5	0
Wednesday, 13-06-12	0	33.5	0
Saturday, 16-06-12	0	28.5	0
Sunday, 17-06-12	0	0	28.8
Tuesday, 19-06-12	0	0	31
Wednesday, 20-06-12	0	29.4	31.3
Thursday, 21-06-12	35.6	33.7	36
Friday, 22-06-12	0	25	26.4

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 23-06-12	28.6	26.4	30.5
Sunday, 24-06-12	0	31.6	33.3
Monday, 25-06-12	33.5	32.5	31.3
Tuesday, 26-06-12	0	29.8	32.9
Wednesday, 27-06-12	29.8	0	36.5
Thursday, 28-06-12	27.4	34.5	28.9
Friday, 29-06-12	29.4	32.2	27.7
Saturday, 30-06-12	25.3	32.3	0
Sunday, 01-07-12	0	32.2	26.4
Monday, 02-07-12	29.2	22.4	25
Tuesday, 03-07-12	30.4	22.8	25.3
Wednesday, 04-07-12	0	25.6	0
Thursday, 05-07-12	0	28.3	0
Saturday, 07-07-12	0	35.4	0
Monday, 09-07-12	29	0	0
Tuesday, 10-07-12	36.5	0	0
Saturday, 14-07-12	28.4	0	0
Sunday, 15-07-12	30	0	28.5
Wednesday, 18-07-12	0	32.2	0
Thursday, 19-07-12	0	35	0
Friday, 20-07-12	25.8	31.7	33.1
Saturday, 21-07-12	31.4	31.8	34.9
Sunday, 22-07-12	27.8	31.6	33
Monday, 23-07-12	31.1	33.5	34.1
Tuesday, 24-07-12	24.7	33	32.5
Wednesday, 25-07-12	26.8	36.4	35
Thursday, 26-07-12	33.7	33	27
Friday, 27-07-12	27.6	25.2	22.8
Saturday, 28-07-12	23.5	22.4	25.7
Sunday, 29-07-12	23.8	24.9	23.1
Monday, 30-07-12	29.1	27.6	28.9
Tuesday, 31-07-12	32.1	33	0
Monday, 13-08-12	0	31.7	0
Tuesday, 14-08-12	25.2	29.9	0
Wednesday, 15-08-12	0	0	23.1
Thursday, 16-08-12	0	26.3	0
Sunday, 19-08-12	0	24.1	0
Thursday, 30-08-12	0	32.1	21.8
Friday, 31-08-12	27.6	21.3	0

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 01-09-12	0	22.7	24.6
Sunday, 02-09-12	25.6	26	27.8
Monday, 03-09-12	23.3	28.9	32
Tuesday, 04-09-12	23.7	25	34.4
Wednesday, 05-09-12	36	38	28.7
Thursday, 06-09-12	0	21.8	25.9
Friday, 07-09-12	29.8	22.9	22.5
Saturday, 08-09-12	30.9	19.8	21.2
Sunday, 09-09-12	23.8	0	0
Monday, 10-09-12	23.7	25.1	28.7
Tuesday, 11-09-12	32	0	28.9
Wednesday, 12-09-12	26.2	0	0
Thursday, 13-09-12	0	19.6	19.6
Friday, 14-09-12	0	22	0
Saturday, 15-09-12	0	25	0
Sunday, 23-09-12	0	33.5	0
Monday, 24-09-12	25.5	0	0
Friday, 28-09-12	0	32.6	0
Saturday, 29-09-12	0	0	20.3
Sunday, 30-09-12	24.6	0	0
Monday, 01-10-12	26.1	0	0
Friday, 05-10-12	0	36.9	29.7
Tuesday, 09-10-12	26.3	0	0
Wednesday, 10-10-12	25.9	0	0
Thursday, 11-10-12	0	29.6	0
Tuesday, 16-10-12	0	34.1	0
Thursday, 18-10-12	29.9	0	0
Saturday, 20-10-12	0	38.2	0
Monday, 22-10-12	26.7	36.3	0
Tuesday, 23-10-12	34.7	34	0
Friday, 26-10-12	0	30.7	0
Wednesday, 31-10-12	0	28	0
Friday, 02-11-12	0	32.9	0
Saturday, 03-11-12	29.6	0	0
Monday, 05-11-12	0	30.4	33.5
Friday, 09-11-12	0	29.2	0
Saturday, 10-11-12	0	32.9	0
Monday, 12-11-12	0	0	28
Tuesday, 13-11-12	0	32.2	0

Table E.2 Location B - 367 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 14-11-12	0	34.9	0
Tuesday, 20-11-12	34.2	0	0
Wednesday, 21-11-12	22.9	23	0
Friday, 23-11-12	29.5	0	0
Saturday, 24-11-12	0	0	30.4
Rating Background Level (RBL)	**29.4**	**32.8**	**32.7**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Table E.3 Location C - 128 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Tuesday, 01-01-13	35	33.8	36.9
Wednesday, 02-01-13	37.5	0	0
Thursday, 03-01-13	0	37.4	0
Friday, 04-01-13	35.4	37.5	0
Saturday, 05-01-13	36.3	35.6	0
Sunday, 06-01-13	38.4	40.2	0
Monday, 07-01-13	39.9	37.9	0
Tuesday, 08-01-13	37.7	37.1	39
Wednesday, 09-01-13	0	38.6	0
Thursday, 10-01-13	38	39.9	0
Friday, 11-01-13	38.3	37.3	0
Saturday, 12-01-13	37.4	38.7	38.9
Sunday, 13-01-13	36.5	0	0
Monday, 14-01-13	35.9	37	35.7
Tuesday, 15-01-13	36	38.3	36.8
Wednesday, 16-01-13	35.8	38.5	0
Thursday, 17-01-13	0	36.8	0
Friday, 18-01-13	0	37.1	37.6
Saturday, 19-01-13	36.5	35.6	0
Sunday, 20-01-13	0	0	38.8
Monday, 21-01-13	35.9	37.6	39.6
Tuesday, 22-01-13	0	0	0
Wednesday, 23-01-13	0	36.2	39.3
Thursday, 24-01-13	35.6	36.8	0
Friday, 25-01-13	36.7	36.7	40.1
Saturday, 26-01-13	38.1	39.3	0
Tuesday, 29-01-13	36.2	0	0
Wednesday, 30-01-13	0	38.7	0
Thursday, 31-01-13	37.9	38	0
Saturday, 02-02-13	37.3	41.4	0
Sunday, 03-02-13	36.3	0	0
Monday, 04-02-13	36.8	39.9	0
Tuesday, 05-02-13	36.2	0	0
Wednesday, 06-02-13	35.3	38.2	0
Thursday, 07-02-13	0	36.3	0
Friday, 08-02-13	0	35.8	0
Saturday, 09-02-13	0	0	38.2
Sunday, 10-02-13	35.9	0	0
Monday, 11-02-13	0	39.9	0

Table E.3 Location C - 128 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Tuesday, 12-02-13	35.7	39.1	0
Thursday, 14-02-13	36.3	40.3	0
Friday, 15-02-13	35.6	39	0
Saturday, 16-02-13	0	40.8	40.1
Sunday, 17-02-13	36	38.9	0
Monday, 18-02-13	0	39.2	0
Tuesday, 19-02-13	35.9	37.6	0
Wednesday, 20-02-13	37.7	38.5	0
Thursday, 21-02-13	38.7	37.9	0
Sunday, 24-02-13	39.8	0	0
Monday, 25-02-13	38	37	0
Tuesday, 26-02-13	38.3	39.5	0
Wednesday, 27-02-13	0	38.6	0
Thursday, 28-02-13	39	40	0
Sunday, 03-03-13	40.4	43.6	0
Monday, 04-03-13	0	44.3	0
Tuesday, 05-03-13	38.8	42.9	0
Wednesday, 06-03-13	37.8	43.1	0
Thursday, 07-03-13	39.2	42.1	0
Friday, 08-03-13	36.3	42.4	0
Saturday, 09-03-13	38.2	41.7	0
Sunday, 10-03-13	38.5	40.6	0
Monday, 11-03-13	38.1	40.4	0
Tuesday, 12-03-13	37.5	41.5	0
Wednesday, 13-03-13	39	41.5	0
Thursday, 14-03-13	37.1	40.3	39.8
Friday, 15-03-13	36.8	38.8	39.2
Saturday, 16-03-13	0	38.6	37.8
Sunday, 17-03-13	37.7	40.9	0
Monday, 18-03-13	36.7	39.3	37.9
Tuesday, 19-03-13	36.4	40.3	0
Wednesday, 20-03-13	36.7	41.2	0
Thursday, 21-03-13	38.3	39.2	0
Friday, 22-03-13	39.5	37.2	36.3
Saturday, 23-03-13	37.3	0	39.9
Sunday, 24-03-13	35.8	39.1	0
Monday, 25-03-13	37.8	38.9	38.6
Tuesday, 26-03-13	34.5	37.4	37.8
Wednesday, 27-03-13	32.9	37.2	38.2

Table E.3 Location C - 128 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Thursday, 28-03-13	33.4	0	0
Friday, 29-03-13	34.9	38	34.9
Saturday, 30-03-13	32.8	35.9	33.8
Sunday, 31-03-13	31.1	34.7	0
Monday, 01-04-13	32	39.6	31.4
Tuesday, 02-04-13	32	0	31.9
Wednesday, 03-04-13	35	33.8	32.8
Thursday, 04-04-13	32.5	0	0
Friday, 05-04-13	34	0	0
Saturday, 06-04-13	0	0	31.6
Sunday, 07-04-13	30.6	39.1	0
Monday, 08-04-13	31.4	37	31.1
Tuesday, 09-04-13	31.2	37.4	35
Wednesday, 10-04-13	31.4	38.5	29.9
Thursday, 11-04-13	30.8	37.3	37
Friday, 12-04-13	33.1	37.4	36.3
Saturday, 13-04-13	30.9	0	0
Sunday, 14-04-13	30.9	0	0
Monday, 15-04-13	30.6	0	0
Tuesday, 16-04-13	0	31.6	0
Wednesday, 17-04-13	31	34.1	28.6
Thursday, 18-04-13	30.8	33.2	28.2
Sunday, 21-04-13	0	36.1	0
Monday, 22-04-13	31.6	30.8	0
Tuesday, 23-04-13	31.1	30.4	29.1
Wednesday, 24-04-13	31.9	34.3	29.2
Thursday, 25-04-13	30.8	30.3	29.9
Friday, 26-04-13	31.5	0	0
Saturday, 27-04-13	30.9	0	30.6
Sunday, 28-04-13	31.1	32.3	30
Monday, 29-04-13	0	37.1	31.7
Tuesday, 30-04-13	30.4	0	0
Wednesday, 01-05-13	30.8	0	0
Thursday, 02-05-13	32.6	30.9	0
Saturday, 04-05-13	29.9	0	28.4
Sunday, 05-05-13	30	32.1	31.5
Monday, 06-05-13	31.1	30	31.1
Tuesday, 07-05-13	31	0	0
Wednesday, 08-05-13	30.9	34.1	34.2

Table E.3 Location C - 128 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Thursday, 09-05-13	0	35.5	31.8
Friday, 10-05-13	30	33.7	31.8
Saturday, 11-05-13	29.5	36.2	35.5
Sunday, 12-05-13	29.9	36.5	33.3
Monday, 13-05-13	31.6	31.8	28.6
Tuesday, 14-05-13	29.2	30	29
Wednesday, 15-05-13	30.8	28.2	28
Friday, 17-05-13	30.3	0	0
Saturday, 18-05-13	30.1	0	26.9
Sunday, 19-05-13	0	27.7	27.3
Monday, 20-05-13	30.6	0	0
Tuesday, 21-05-13	31.8	29.3	31.1
Wednesday, 22-05-13	0	39.9	0
Thursday, 23-05-13	41.3	41.3	0
Saturday, 25-05-13	27.1	0	32.7
Sunday, 26-05-13	27.4	35	33.1
Monday, 27-05-13	30.8	30.8	0
Tuesday, 28-05-13	30.6	37.6	29.3
Wednesday, 29-05-13	28.9	36.5	0
Thursday, 30-05-13	28.5	37.3	0
Friday, 31-05-13	27.5	0	0
Saturday, 01-06-13	32.8	34.6	0
Sunday, 02-06-13	0	30.3	28.2
Monday, 03-06-13	26.4	31.7	31.2
Tuesday, 04-06-13	26.8	0	0
Wednesday, 05-06-13	0	33	31.1
Thursday, 06-06-13	31.8	32.8	30.7
Friday, 07-06-13	31.3	33.3	32.6
Sunday, 09-06-13	27.5	0	0
Monday, 10-06-13	0	29.7	30.6
Tuesday, 11-06-13	28.3	33.9	36.4
Wednesday, 12-06-13	0	29.3	28.5
Thursday, 13-06-13	29.7	28.1	27.6
Friday, 14-06-13	0	29.1	26.5
Saturday, 15-06-13	27.5	30.1	30.7
Sunday, 16-06-13	25.6	29.6	29
Monday, 17-06-13	25.5	26.7	25
Tuesday, 18-06-13	26.4	0	25.3
Wednesday, 19-06-13	29.1	0	33.7

Table E.3 Location C - 128 Wambo Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Thursday, 20-06-13	26	31.1	29
Friday, 21-06-13	27.2	33.8	30.8
Saturday, 22-06-13	27.2	27.2	26.5
Sunday, 23-06-13	0	0	28.7
Monday, 24-06-13	27	31.1	30.3
Tuesday, 25-06-13	0	28.8	30
Wednesday, 26-06-13	0	34.7	33.9
Sunday, 30-06-13	31.1	35.2	0
Tuesday, 02-07-13	28.3	0	0
Wednesday, 03-07-13	28.8	0	0
Thursday, 04-07-13	32.5	34.2	0
Friday, 05-07-13	0	30	27.8
Saturday, 06-07-13	30.6	35.6	34.5
Sunday, 07-07-13	34.4	36.2	35.4
Monday, 08-07-13	0	38.1	0
Tuesday, 09-07-13	0	34.7	0
Wednesday, 10-07-13	0	34.8	0
Friday, 12-07-13	31.5	38.1	35.6
Saturday, 13-07-13	31.7	0	0
Monday, 15-07-13	33.1	38.3	0
Tuesday, 16-07-13	33	42.1	39
Wednesday, 17-07-13	0	0	38.3
Thursday, 18-07-13	33.8	0	38
Friday, 19-07-13	0	37.5	0
Saturday, 20-07-13	35.3	37.2	34.1
Sunday, 21-07-13	35.4	33.8	34.8
Monday, 22-07-13	36.4	32.8	32.9
Tuesday, 23-07-13	0	34.5	0
Wednesday, 24-07-13	33.4	0	0
Thursday, 25-07-13	0	36.7	0
Sunday, 28-07-13	33.6	36.2	36.8
Monday, 29-07-13	0	35.9	0
Wednesday, 31-07-13	34.4	36.4	0
Rating Background Level (RBL)	**33.1**	**37.1**	**32.7**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Table E.4 Location D - 193 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 09-12-11	0	32.6	0
Saturday, 10-12-11	0	29.8	0
Sunday, 11-12-11	0	33.4	37
Monday, 12-12-11	29.8	33.7	34.8
Tuesday, 13-12-11	28.3	32.7	0
Wednesday, 14-12-11	29.8	35.2	35.9
Thursday, 15-12-11	0	32.5	0
Saturday, 17-12-11	0	33.7	0
Sunday, 18-12-11	29.8	32.4	39.1
Monday, 19-12-11	30.9	32	37.9
Tuesday, 20-12-11	32.4	33.6	35
Wednesday, 21-12-11	31.3	0	0
Thursday, 22-12-11	28.8	0	36.5
Saturday, 24-12-11	0	34.4	0
Monday, 26-12-11	0	30.2	39.2
Tuesday, 27-12-11	32.2	33.3	35
Wednesday, 28-12-11	32.2	31	37.1
Thursday, 29-12-11	32.8	32.1	38.1
Friday, 30-12-11	33.6	32	0
Saturday, 31-12-11	32.7	32.4	0
Sunday, 01-01-12	33.6	33.9	32.9
Monday, 02-01-12	34.7	33.4	35.6
Tuesday, 03-01-12	34.8	33.4	36.4
Wednesday, 04-01-12	37.8	35.3	35
Thursday, 05-01-12	30.9	31	0
Friday, 06-01-12	0	30.4	32.9
Saturday, 07-01-12	37.8	34.9	39.1
Sunday, 08-01-12	37.8	0	0
Monday, 09-01-12	39.4	36	37.5
Tuesday, 10-01-12	35.8	31.5	34.4
Wednesday, 11-01-12	35.6	34.5	21.5
Thursday, 12-01-12	28.7	32.6	0
Friday, 13-01-12	35.8	34.5	33.5
Saturday, 14-01-12	32.1	33.5	35.1
Sunday, 15-01-12	31.3	35.8	0
Monday, 16-01-12	0	0	40.2
Tuesday, 17-01-12	0	37	39.6
Wednesday, 18-01-12	39.7	36.7	38.1
Thursday, 19-01-12	39.9	37	39.4

Table E.4 Location D - 193 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 20-01-12	36.2	34.5	33.5
Saturday, 21-01-12	31.4	31.5	33.8
Sunday, 22-01-12	35.7	35.1	0
Monday, 23-01-12	0	37.2	0
Tuesday, 24-01-12	0	33.3	0
Thursday, 26-01-12	0	39.3	42.1
Friday, 27-01-12	37.9	37.6	0
Saturday, 28-01-12	0	33.7	39.1
Sunday, 29-01-12	0	33.1	0
Monday, 30-01-12	36	34.1	39.7
Friday, 03-02-12	0	43.4	44
Saturday, 04-02-12	0	38.6	0
Sunday, 05-02-12	33.9	33	0
Monday, 06-02-12	32.5	32.3	38.1
Tuesday, 07-02-12	29.1	35.7	38.4
Wednesday, 08-02-12	31.2	37.3	0
Friday, 10-02-12	0	37.8	39.4
Saturday, 11-02-12	33.5	36.2	35
Sunday, 12-02-12	32.1	0	0
Monday, 13-02-12	0	0	38.1
Tuesday, 14-02-12	32.9	33.6	0
Wednesday, 15-02-12	30.4	38.1	36.1
Thursday, 16-02-12	0	34.9	34.9
Friday, 17-02-12	30.7	36.4	36
Saturday, 18-02-12	30.5	0	36
Sunday, 19-02-12	30.4	29.2	0
Monday, 20-02-12	27.6	0	0
Tuesday, 21-02-12	0	30.6	42.7
Wednesday, 22-02-12	30.3	31.2	33.8
Thursday, 23-02-12	30.3	31.2	0
Friday, 24-02-12	0	33.4	0
Saturday, 25-02-12	31.5	31.4	0
Sunday, 26-02-12	28.6	28.4	0
Monday, 27-02-12	28.8	27.4	33.8
Tuesday, 28-02-12	29.5	26.7	0
Wednesday, 29-02-12	30.9	0	0
Thursday, 01-03-12	33.6	0	0
Saturday, 03-03-12	0	35.1	37.3
Sunday, 04-03-12	32.3	31.7	33.2

Table E.4 Location D - 193 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Monday, 05-03-12	30	34.2	30.3
Tuesday, 06-03-12	31.5	29.2	28
Wednesday, 07-03-12	30.4	29.6	0
Thursday, 08-03-12	30.1	31.5	23.5
Friday, 09-03-12	30.1	28.7	28.2
Saturday, 10-03-12	0	33.5	24.9
Sunday, 11-03-12	30.1	29	30.4
Monday, 12-03-12	31.3	32.6	0
Tuesday, 13-03-12	0	31.8	23.6
Wednesday, 14-03-12	27.5	29.1	28.1
Thursday, 15-03-12	29.7	28.5	30
Friday, 16-03-12	29.7	34.1	0
Saturday, 17-03-12	0	29.3	26.2
Sunday, 18-03-12	31.8	0	0
Monday, 19-03-12	34.7	0	0
Wednesday, 21-03-12	30.5	28	27.8
Thursday, 22-03-12	27.2	30.2	28
Friday, 23-03-12	30.5	25.6	18.7
Saturday, 24-03-12	28.2	25.6	0
Monday, 26-03-12	27.9	34	27.7
Tuesday, 27-03-12	29.5	34.4	0
Wednesday, 28-03-12	27.4	33	25.7
Thursday, 29-03-12	0	29.8	24
Friday, 30-03-12	27.4	0	24
Saturday, 31-03-12	27.5	31.4	0
Sunday, 01-04-12	28.7	27.2	0
Monday, 02-04-12	27.3	31.3	30.7
Tuesday, 03-04-12	27.5	29.9	30.5
Wednesday, 04-04-12	0	31.8	0
Thursday, 05-04-12	31.3	0	0
Friday, 06-04-12	0	0	30.4
Saturday, 07-04-12	0	24.9	0
Sunday, 08-04-12	0	0	25
Monday, 09-04-12	0	23.3	22.3
Tuesday, 10-04-12	30.2	23.9	28.7
Wednesday, 11-04-12	0	25.1	25.8
Thursday, 12-04-12	0	24.9	27.7
Friday, 13-04-12	0	0	30.1
Saturday, 14-04-12	27.1	32.4	21.9

Table E.4 Location D - 193 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Sunday, 15-04-12	27.3	28.8	25.8
Monday, 16-04-12	28.6	27.9	28.6
Tuesday, 17-04-12	0	0	28.5
Wednesday, 18-04-12	0	29.8	28.7
Thursday, 19-04-12	28.7	29.9	22.7
Friday, 20-04-12	29.6	32.6	0
Saturday, 21-04-12	28.3	31.1	27.9
Sunday, 22-04-12	28.1	31.5	0
Monday, 23-04-12	0	27.6	22.6
Tuesday, 24-04-12	0	25.4	19.2
Wednesday, 25-04-12	27.2	22.3	20
Thursday, 26-04-12	25.3	30	29.6
Friday, 27-04-12	28.5	31.6	28.6
Saturday, 28-04-12	28.6	29.2	24.1
Sunday, 29-04-12	27.7	26.5	31.1
Monday, 30-04-12	28.3	31.3	0
Tuesday, 01-05-12	29.3	29.6	30.5
Wednesday, 02-05-12	28.2	27	20.4
Thursday, 03-05-12	0	32.8	25.3
Friday, 04-05-12	27.1	29.7	25.5
Saturday, 05-05-12	26.3	26.8	26
Sunday, 06-05-12	25.9	24	20.9
Monday, 07-05-12	23.6	28.9	26.7
Tuesday, 08-05-12	25.8	27.5	25
Wednesday, 09-05-12	26.5	28.6	0
Thursday, 10-05-12	27.6	31.3	27
Friday, 11-05-12	28.8	26.6	23.3
Saturday, 12-05-12	26.7	23.4	19.2
Sunday, 13-05-12	24	21.6	18.8
Monday, 14-05-12	23.9	23.8	0
Tuesday, 15-05-12	25.6	24.1	24.2
Wednesday, 16-05-12	25.7	29.5	30.5
Thursday, 17-05-12	25.3	29.9	30.8
Friday, 18-05-12	25.7	27.8	27.1
Saturday, 19-05-12	25.8	28.4	26
Sunday, 20-05-12	27.3	27.5	27.5
Monday, 21-05-12	24.4	28.1	27.3
Tuesday, 22-05-12	25.8	21.5	24.8
Wednesday, 23-05-12	25	26.6	31.3

Table E.4 Location D - 193 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 25-05-12	29.4	33.4	25.4
Saturday, 26-05-12	29.9	25.2	23.9
Sunday, 27-05-12	26.9	26.7	27
Rating Background Level (RBL)	**29.8**	**31.5**	**30.2**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Table E.5 Location E - 339 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Monday, 18-03-13	0	31	31.8
Tuesday, 19-03-13	31.7	0	0
Thursday, 21-03-13	30.4	30.5	30.5
Friday, 22-03-13	31.6	29.9	0
Saturday, 23-03-13	0	32.4	0
Sunday, 24-03-13	0	0	28.4
Monday, 25-03-13	30.2	31.1	31
Wednesday, 27-03-13	29.9	0	0
Friday, 29-03-13	0	30	31.9
Saturday, 30-03-13	30.9	0	0
Sunday, 31-03-13	29.1	0	0
Monday, 01-04-13	0	30.6	0
Tuesday, 02-04-13	29.4	27.2	0
Wednesday, 03-04-13	30.5	32.8	32.4
Friday, 05-04-13	31.9	0	0
Sunday, 07-04-13	0	29.6	0
Monday, 08-04-13	0	30	29.5
Wednesday, 10-04-13	0	29.3	0
Thursday, 11-04-13	28.9	0	0
Friday, 12-04-13	0	29	28.5
Sunday, 14-04-13	27.4	26.9	25.1
Monday, 15-04-13	28.1	0	0
Tuesday, 16-04-13	0	27.8	0
Wednesday, 17-04-13	29	28.9	0
Thursday, 18-04-13	29.6	0	21
Friday, 19-04-13	0	24.5	0
Saturday, 20-04-13	0	30.1	27.6
Sunday, 21-04-13	0	0	26.8
Monday, 22-04-13	26.6	23.2	21.2
Tuesday, 23-04-13	0	26.6	0
Wednesday, 24-04-13	25.8	22.7	22.6
Thursday, 25-04-13	26	0	0
Friday, 26-04-13	0	21.8	23.4
Saturday, 27-04-13	0	27.8	0
Sunday, 28-04-13	0	22.4	0
Monday, 29-04-13	27.9	0	0
Tuesday, 30-04-13	0	28.3	0
Wednesday, 01-05-13	27.1	0	20.7
Friday, 03-05-13	0	26.3	0

Table E.5 Location E - 339 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 04-05-13	0	29.8	18
Sunday, 05-05-13	26	25.4	26.7
Monday, 06-05-13	28.8	23.5	0
Wednesday, 08-05-13	27.2	29.5	0
Thursday, 09-05-13	27.3	0	27
Friday, 10-05-13	0	0	29.4
Saturday, 11-05-13	27.8	28	28.3
Sunday, 12-05-13	27.4	28.1	0
Monday, 13-05-13	0	0	17
Tuesday, 14-05-13	0	0	18.8
Wednesday, 15-05-13	24.8	18.8	18.6
Thursday, 16-05-13	25.5	18.7	18.3
Friday, 17-05-13	0	17.9	0
Saturday, 18-05-13	0	18.7	0
Sunday, 19-05-13	23.5	17.7	0
Monday, 20-05-13	0	19	20.8
Tuesday, 21-05-13	25.6	17.3	20.4
Wednesday, 22-05-13	31.1	28.7	0
Thursday, 23-05-13	0	33.6	0
Friday, 24-05-13	0	34.5	0
Saturday, 25-05-13	0	28	0
Sunday, 26-05-13	0	30	0
Monday, 27-05-13	30.2	0	0
Tuesday, 28-05-13	0	28.7	25.8
Wednesday, 29-05-13	29.3	29.6	0
Thursday, 30-05-13	29	27.9	28.4
Friday, 31-05-13	0	26.7	0
Saturday, 01-06-13	28.6	30.5	0
Sunday, 02-06-13	0	29.4	27.2
Monday, 03-06-13	0	24.1	25.7
Tuesday, 04-06-13	0	28.1	0
Wednesday, 05-06-13	0	23.1	21.6
Thursday, 06-06-13	0	24.3	20.8
Friday, 07-06-13	0	22.8	21.6
Saturday, 08-06-13	0	29.4	0
Sunday, 09-06-13	0	0	27.1
Monday, 10-06-13	26.5	21.7	21.3
Wednesday, 12-06-13	0	0	20.3
Thursday, 13-06-13	0	0	21

Table E.5 Location E - 339 Inlet Road - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 14-06-13	26.5	0	20.4
Saturday, 15-06-13	25.5	0	20.7
Sunday, 16-06-13	26.6	0	19.8
Tuesday, 18-06-13	25.9	0	0
Wednesday, 19-06-13	0	21.8	0
Thursday, 20-06-13	28.1	21.8	23.5
Friday, 21-06-13	28.4	0	26
Saturday, 22-06-13	25	23.4	0
Monday, 24-06-13	0	20.6	0
Tuesday, 25-06-13	0	0	20.8
Wednesday, 26-06-13	0	31.5	0
Friday, 28-06-13	31.2	0	0
Sunday, 30-06-13	29.3	0	0
Rating Background Level (RBL)	**28.1**	**28.0**	**23.5**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 07-12-11	0	32.8	38.7
Thursday, 08-12-11	37.3	36.5	0
Friday, 09-12-11	34.4	38.2	0
Saturday, 10-12-11	31.7	35	36.3
Sunday, 11-12-11	33.5	38.3	42.5
Monday, 12-12-11	34.9	37.5	40.8
Tuesday, 13-12-11	32.7	38	39.3
Wednesday, 14-12-11	31.1	41.3	0
Thursday, 15-12-11	32.8	39.2	40.8
Saturday, 17-12-11	0	40.8	0
Sunday, 18-12-11	0	0	42.2
Monday, 19-12-11	36.2	36.3	39.7
Tuesday, 20-12-11	0	38.6	40.3
Wednesday, 21-12-11	33.2	0	0
Thursday, 22-12-11	34.7	0	42.7
Monday, 26-12-11	0	0	44.5
Tuesday, 27-12-11	0	38.9	43.3
Wednesday, 28-12-11	33.4	34.8	41.4
Thursday, 29-12-11	35.7	39.1	41.4
Friday, 30-12-11	35.3	39.7	0
Saturday, 31-12-11	33.5	37.4	0
Sunday, 01-01-12	0	0	39.1
Monday, 02-01-12	0	0	38.9
Friday, 06-01-12	33.7	33.2	38.3
Saturday, 07-01-12	0	0	39.9
Tuesday, 10-01-12	0	0	38.3
Wednesday, 11-01-12	0	0	27.2
Thursday, 12-01-12	0	37	35
Friday, 20-01-12	0	0	35.3
Saturday, 21-01-12	0	31.1	37.6
Monday, 23-01-12	0	35.7	0
Tuesday, 24-01-12	34.4	33.3	0

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Thursday, 26-01-12	0	0	45.2
Friday, 03-02-12	0	41.8	44.9
Saturday, 04-02-12	0	33.6	0
Monday, 06-02-12	0	35.3	41
Tuesday, 07-02-12	31.1	32.9	39.8
Wednesday, 08-02-12	32	35.6	0
Friday, 10-02-12	0	0	38.6
Saturday, 11-02-12	0	35	0
Sunday, 12-02-12	0	0	38.3
Monday, 13-02-12	0	0	38.3
Tuesday, 14-02-12	33.2	38	38.6
Wednesday, 15-02-12	33	0	0
Thursday, 16-02-12	0	0	37.3
Saturday, 18-02-12	0	0	38.4
Tuesday, 21-02-12	31.9	35.3	39.9
Wednesday, 22-02-12	30.3	36.4	0
Saturday, 25-02-12	0	36.4	38
Sunday, 26-02-12	33.5	33.6	0
Monday, 27-02-12	34.3	0	0
Thursday, 01-03-12	38.8	0	0
Sunday, 04-03-12	37	40.5	44.9
Monday, 05-03-12	36.6	41.8	41.1
Tuesday, 06-03-12	34.5	39.6	37.5
Wednesday, 07-03-12	35	37.3	0
Thursday, 08-03-12	37.5	39.7	35
Friday, 09-03-12	34.4	37.3	0
Saturday, 10-03-12	31.3	40.3	37.2
Sunday, 11-03-12	32.8	0	0
Monday, 12-03-12	34.6	0	0
Tuesday, 13-03-12	0	0	37.7
Wednesday, 14-03-12	33.4	0	38.2
Thursday, 15-03-12	33.8	0	39.4

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 16-03-12	36.2	0	0
Saturday, 17-03-12	0	39.1	38.3
Sunday, 18-03-12	0	0	38.5
Tuesday, 20-03-12	33.7	0	0
Wednesday, 21-03-12	33.6	0	0
Thursday, 22-03-12	33.4	40.9	37
Friday, 23-03-12	39.6	39.2	29.5
Saturday, 24-03-12	33.2	38.7	0
Monday, 26-03-12	32.5	0	0
Tuesday, 27-03-12	31.2	0	0
Wednesday, 28-03-12	0	0	37
Thursday, 29-03-12	0	39.2	35.6
Friday, 30-03-12	31.7	0	34.1
Saturday, 31-03-12	31	0	0
Sunday, 01-04-12	31.3	39.8	0
Monday, 02-04-12	31.3	41.2	0
Tuesday, 03-04-12	30.4	40.9	0
Wednesday, 04-04-12	33.4	44.8	0
Thursday, 05-04-12	34.5	0	0
Saturday, 07-04-12	0	39.9	35.1
Sunday, 08-04-12	32.1	0	33.3
Monday, 09-04-12	33.5	37.8	30.1
Tuesday, 10-04-12	0	34.1	34.1
Wednesday, 11-04-12	33.1	33.7	34.1
Thursday, 12-04-12	30.7	38.1	0
Friday, 13-04-12	31.2	0	0
Saturday, 14-04-12	31	0	0
Sunday, 15-04-12	31.1	43	35.8
Monday, 16-04-12	32.2	39.5	35.7
Tuesday, 17-04-12	0	0	35.2
Wednesday, 18-04-12	0	41.5	0
Thursday, 19-04-12	32	42.6	33.9

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Friday, 20-04-12	31.4	0	31.8
Saturday, 21-04-12	29.5	0	0
Sunday, 22-04-12	31.8	0	0
Monday, 23-04-12	0	41.3	36.6
Tuesday, 24-04-12	0	37.1	31.8
Wednesday, 25-04-12	34.5	30.1	30.1
Thursday, 26-04-12	29.2	36.8	34.8
Friday, 27-04-12	30.8	0	0
Saturday, 28-04-12	31.2	37.2	33.7
Sunday, 29-04-12	0	37.9	33.1
Monday, 30-04-12	30.8	0	0
Tuesday, 01-05-12	30.8	0	0
Wednesday, 02-05-12	0	0	32
Friday, 04-05-12	29.6	37	31.3
Saturday, 05-05-12	29.6	35.5	32.6
Sunday, 06-05-12	31.9	0	0
Monday, 07-05-12	30.3	0	0
Wednesday, 09-05-12	0	34.3	0
Thursday, 10-05-12	0	0	33.2
Friday, 11-05-12	0	34.5	0
Saturday, 12-05-12	33.3	0	0
Monday, 14-05-12	0	32.1	0
Tuesday, 15-05-12	0	34.4	31.5
Wednesday, 16-05-12	0	0	33.4
Sunday, 20-05-12	0	0	30.4
Monday, 21-05-12	31.2	0	0
Tuesday, 22-05-12	0	26.2	31.3
Friday, 25-05-12	0	34.5	29.8
Saturday, 26-05-12	34.6	29	31.2
Sunday, 27-05-12	28.8	33.8	30.5
Monday, 28-05-12	30.3	32.3	31.8
Tuesday, 29-05-12	29.3	32.2	28.9

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Wednesday, 30-05-12	30.3	34.6	33.9
Thursday, 31-05-12	30.1	0	0
Friday, 01-06-12	0	34.4	0
Saturday, 02-06-12	0	39.3	37.8
Monday, 04-06-12	0	38.8	36.1
Tuesday, 05-06-12	36.9	38.3	37.1
Wednesday, 06-06-12	37.1	36.3	36.7
Thursday, 07-06-12	31.5	38.8	36.7
Saturday, 09-06-12	0	0	35.4
Tuesday, 12-06-12	0	39.4	35.5
Wednesday, 13-06-12	32.2	37.9	35.6
Thursday, 14-06-12	30.5	0	0
Friday, 15-06-12	0	38	0
Saturday, 16-06-12	36.9	40.2	37.8
Monday, 18-06-12	0	33.1	32.3
Tuesday, 19-06-12	0	33	34.1
Wednesday, 20-06-12	0	0	32.3
Thursday, 21-06-12	37.3	31.4	32.1
Friday, 22-06-12	38.9	31	30.5
Saturday, 23-06-12	34.6	31.9	32.2
Sunday, 24-06-12	34.3	34.5	0
Monday, 25-06-12	0	0	34
Tuesday, 26-06-12	34.6	33.7	35.4
Wednesday, 27-06-12	0	0	39.3
Thursday, 28-06-12	0	0	35.8
Friday, 29-06-12	34.8	40.6	36.2
Sunday, 01-07-12	34.4	31.6	30.2
Monday, 02-07-12	35.1	28	28.1
Tuesday, 03-07-12	32.9	28.7	30.6
Wednesday, 04-07-12	31.7	31.5	29.9
Thursday, 05-07-12	0	32	33.4
Friday, 06-07-12	34.2	34.7	33.9

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 07-07-12	30.5	0	33.7
Sunday, 08-07-12	30.8	0	0
Wednesday, 11-07-12	33.7	0	0
Thursday, 12-07-12	0	39.4	0
Friday, 13-07-12	0	41.8	38.1
Saturday, 14-07-12	37.4	39.2	37
Sunday, 15-07-12	36.8	35.6	33
Monday, 16-07-12	32.4	0	0
Wednesday, 18-07-12	34.6	37.3	34.7
Thursday, 19-07-12	0	36.5	32.2
Friday, 20-07-12	31.9	37.3	35
Saturday, 21-07-12	0	36.2	36.4
Sunday, 22-07-12	33.9	37.9	37.4
Monday, 23-07-12	34.1	39.4	38.6
Tuesday, 24-07-12	28.9	41.9	0
Wednesday, 25-07-12	34.3	0	0
Thursday, 26-07-12	0	39.6	34.7
Friday, 27-07-12	33.9	31.4	29.5
Saturday, 28-07-12	30.9	29.2	28.2
Sunday, 29-07-12	33.1	28.7	28.6
Monday, 30-07-12	32.1	33.1	31.2
Tuesday, 31-07-12	31	33.8	0
Wednesday, 01-08-12	31.8	31.7	31.5
Thursday, 02-08-12	31.7	0	0
Friday, 03-08-12	0	31.4	0
Saturday, 04-08-12	0	29.6	0
Sunday, 05-08-12	34.1	28.3	25.8
Monday, 06-08-12	0	24.2	27.2
Tuesday, 07-08-12	33.1	33.6	0
Wednesday, 08-08-12	0	28.8	26.6
Thursday, 09-08-12	34.4	28.5	29.7
Friday, 10-08-12	0	31.2	27.8

Table E.6 Location F - Scout Hall - Warkworth Mine filtered out ABL's and RBL's

Date	ABL Day	ABL Evening	ABL Night
Saturday, 11-08-12	0	0	33.6
Monday, 13-08-12	0	37.8	0
Tuesday, 14-08-12	33.4	36.2	0
Wednesday, 15-08-12	34.8	32.8	0
Thursday, 16-08-12	31.1	29.9	30.4
Friday, 17-08-12	0	29.2	28
Saturday, 18-08-12	0	25.2	26.8
Sunday, 19-08-12	0	29.4	0
Monday, 20-08-12	31.4	38.4	33.8
Tuesday, 21-08-12	33.5	38.1	37.1
Wednesday, 22-08-12	0	34.8	34.4
Thursday, 23-08-12	0	0	35.5
Friday, 24-08-12	0	32.6	32.1
Saturday, 25-08-12	0	35.5	33.9
Sunday, 26-08-12	0	32.1	33.3
Monday, 27-08-12	32.3	38.1	0
Tuesday, 28-08-12	32.6	37.2	0
Wednesday, 29-08-12	36.2	33.4	0
Thursday, 30-08-12	0	24	23.6
Friday, 31-08-12	30.8	26.1	24.4
Saturday, 01-09-12	27.1	25.9	25.6
Sunday, 02-09-12	30.3	29.7	0
Monday, 03-09-12	25.8	34.7	0
Tuesday, 04-09-12	0	28.4	0
Rating Background Level (RBL)	**33.1**	**36.2**	**35.0**

Notes: 1. '0' Values indicate excluded data due to weather or inadequate sampling as per the INP. When calculating the median value, these '0' samples are ignored as per the INP.

Appendix F

Peer review letter

15 May 2014

WM Project Number: 14109
Our Ref: EMGA150514NG
Email: nishac@emgamm.com

Najah Ishac
EMGA Mitchell McLennan
Ground Floor, Suite 01, 20 Chandos Street
ST LEONARDS NSW 2065

Dear Najah

Re: Warkworth MTO Noise Assessment Peer Review

This letter report summarises our review process and comments in relation to the Warkworth and MTO Noise and Vibration reports prepared by EMGA Mitchell McLennan ("the reports") initially in April 2014 and again in May 2014. My comments in this letter are restricted to issues of content as I have separately provided "tracked changes" versions of the documents including a variety of comments and suggestions for better clarification.

Prior to receiving the draft reports I attended a meeting with EMGA to discuss their approach and for me to provide input. In addition to this meeting I also attended a further meeting following review of the Warkworth report to inspect the model and discuss my comments.

General Comments re Approach:

My email comments following the first meeting are summarised below

- *Understand the reasons behind approach to consider as 2 sites, noting you have also included a cumulative assessment.*
- *Note your desire to conform as closely as possible to letter as well as intent of INP*
- *Will review your background determination methodology – including using all available data rather than a random week*
- *Note your use of Predictor / ENM*
- *Note use of varying wind speed (rather than just 3)*
- *Note use of 3.9 degrees/100m for temp inversions with limited drainage flow in 1 year*
- *Note your approach to determining predicted levels based on different met conditions. Whilst our approach is not identical its aims are similar and meets the intent of the INP.*
- *Aware of Low frequency noise detail and need to confirm this should be assessed at the residence based on total noise from all mine noise. Agree that dBC – dBA is not ideal and you should check what differences exist even when no mine noise. Also should review other methodologies if dBC-dBA is greater than 15..*
- *Sleep disturbance – review source data, what is the real range of measured data at source to justify 125 as typical.*

Please also provide some plans / cross sections showing source and receiver locations so I can do a sanity check on source RLs and check expected noise levels for neutral and adverse wind / temp inversions.

Comments re Reports

These have primarily been included in tracked changes but the main issues addressed are summarised below.

Background Levels – We consider the assessment approach is more thorough than the minimum of 1 week of data and also consider the approach to extract data when noise from each site may influence its own background is valid and would appear to give sensible answers. Make sure it is clear which background monitor is used for each residence and why. Also explain approach at residences near Mt Thorley industrial estate where no data taken.

Criteria - We believe your approach to adopt the lower of day evening and night as the intrusive criteria at all times is conservative and given the "instruction" to assess the sites separately not essential for this project. We note Amenity criteria is applied to cumulative noise.

Receiver Locations – Would hope these are all identified correctly by mine and appreciate you have relied on this data. In terms of classifying as suburban or rural, given the numbers don't change I would just call it all rural.

Plant Location, SWL and numbers – Believe for a project of this size with total plant numbers that approach to split trucks to one or other is reasonable for typical scenario. Believe plant has been located appropriately in terms of elevation and proximity to receivers with and without shielding for respective years. SWL are typical for Leq. Need to consider SWL used for Lmax and what it is meant to represent and under what met conditions this is calculated.

Meteorological Effects – Whilst your approach is slightly different to ours, we note the intent to understand wind directions and prevalence of temperature inversions to provide a range of results for each receiver. We believe this approach is reasonable. Believe ENM is best available to handle this.

Low Frequency Noise – Would be interesting to show how often the difference can be greater than 15 with no mine noise to show that criterion is not totally suitable but good screening test. Note you have done some measurements internally in typical house which assists in using DEFRA.

Cumulative Noise – Agree with adopting -3dB to convert $L_{eq,15min}$ to $L_{eq,9hour}$ and agree with looking into wind direction to add worst case to calm for the different combinations.

Off site noise – Some reference should be made to changes in Policy since the original approval rather than no changes in operations and whether this is important.

I trust this information is sufficient for your present purposes. Please contact us if you have any further queries.

Yours faithfully
WILKINSON MURRAY

N.L.Gross

Neil Gross
Director

Appendix G

Ombudsman letter regarding low frequency noise

Ombudsman
New South Wales

ABN 76 325 886 267
Level 24, 580 George Street, Sydney NSW 2000
T 02 9286 1000 | **F** 02 9283 2911
Tollfree 1800 451 524 | **TTY** 02 9264 8050
www.ombo.nsw.gov.au

22 January 2014

Our reference: C/2013/6408
Your reference: 13/17860
Contact: Veronica Brogden
Telephone: (02) 9286 0933

Mr Sam Haddad
Director-General
Department of Planning and Infrastructure
GPO Box 39
SYDNEY NSW 2001

RECEIVED
28 JAN 2014
Director-General

Dear Mr Haddad

Complaint by EDO NSW on behalf of Bulga Milbrodale Progress Association (BMPA)

We wrote to your office on 23 October 2013 seeking response to a number of questions about a complaint by BMPA. A/Director General, Mr Richard Pearson responded on 27 November 2013.

I have now completed my assessment of that matter, and have written to the NSW EDO advising that I do not propose to take any further action. My letter, with reasons for my decision is attached for your records.

Please pass on my thanks to all staff involved in responding to our inquiries.

Yours sincerely

Veronica Brogden
Senior Investigation Officer, Local Government

Ombudsman
New South Wales

ABN 76 325 886 267
Level 24, 580 George Street, Sydney NSW 2000
T 02 9286 1000 | F 02 9283 2911
Tollfree 1800 451 524 | TTY 02 9264 8050
www.ombo.nsw.gov.au

22 January 2014

Our reference: C/2013/6408
Contact: Veronica Brogden
Telephone: (02) 9286 0933

Sue Higginson
Principal Solicitor
Environmental Defenders Office, NSW
Level 5, 263 Clarence Street
SYDNEY NSW 2000

COPY

Dear Ms Higginson

Complaint by Bulga Milbrodale Progress Association Inc (BMPA) about NSW Department of Planning and Infrastructure (DPI)

I refer to your letter dated 22 August 2013 in which you forward a complaint on behalf of the BMPA, about the DPI's decision to refuse to apply Low Frequency Noise (LFN) data in accordance with the Industrial Noise Policy (INP) and condition of consent for Mount Thorley and Warkworth coal mines.

As you are aware, Bryce Purches of this office had made inquiries with the DPI and the NSW Office of Environment and Heritage (OEH). Mr Purches has recently left, and the file has been reallocated to me for assessment of the information received by those agencies.

The Ombudsman is primarily concerned to ensure government agencies are fair and reasonable in their dealings. It is clear that opinions, even by experts, may differ. We are unwilling in such situations to question expert opinion, except in those rare cases where the opinion appears so unsupportable that it suggests something improper may have occurred. It is seldom appropriate for us to decide between differing technical views, nor do we have the resources to routinely obtain our own independent expert opinion.

To this end, we sought information from DPI and OEH about the review of the INP, and the application of LFN data to the operations of Mount Thorley Warkworth open cut mine in accordance with the conditions of consent DA 300-9-2002-I.

DPI has provided information and evidence to demonstrate that the (then) DECCW (OEH) had from 2010 made a commitment to revise the INP in relation to low frequency noise, and to review the INP as a whole. While progress on this has been slower than expected, our verbal interactions with OEH has confirmed that they anticipate a review will be completed later this year.

Assessment of LFN appears to be quite contentious, especially in rural settings. I do not propose to develop a view as to which position is most likely accurate, as I have explained above, we do not have that expertise, or the resources to seek that expertise.

It would appear to me, however, that the following points have been agreed by DPI and OEH:

- There may be technical merit as to the difficulty in applying the low frequency modifying factor in rural areas, subject to further study. OEH has commissioned a comprehensive study of LFN as a part of the INP review, titled *Low Frequency Noise & Infrasound*, still underway;
- That OEH would not include conditions about LFN in Environment Protection Licences; and
- A review of the INP would be conducted, and LFN would be a priority issue.

When we receive complaints about compliance and enforcement, failure to take action alone is generally not sufficient grounds to justify an investigation by this office. We look closely at the facts of each case, including the agency's reasons for its decisions.

In this case, there appears to be appropriate consideration of professional advice from qualified staff and experts about LFN that casts doubt as to the practicality of strict enforcement of the condition of consent. Notwithstanding this, OEH has also acknowledged that any review of LFN in the INP will include consultation with NSW Health given the health issues said to be associated with LFN.

Noise monitoring continues to be a high priority issue, and a Noise Management Plan and Noise Monitoring Programme for the whole mining complex are in place. Further, DPI has advised that there will be a requirement to provide separate noise management and monitoring documents for the Mount Thorley and Warkworth mines, in consultation with OEH and DPI due to a Land and Environment Court decision.

For the reasons outlined above, it appears to me the information and evidence provided by the agencies is sufficient to satisfy me that the DPI has provided adequate reasons for its decision and has properly considered all relevant issues, and there is no other evidence of wrong conduct that requires intervention by this office.

I appreciate why you forwarded this matter to this office, and I acknowledge the importance of noise monitoring and the impacts of noise on the local community. BMPA should continue to engage with the agencies and the mine operators as is appropriate and participate in community consultation and engagement as opportunities arise.

I will now close this file and take no further action.

Yours sincerely COPY

Veronica Brogden
Senior Investigation Officer, Local Government

NSW GOVERNMENT | Planning & Infrastructure

Office of the Director General

Mr Bruce Barbour
NSW Ombudsman
Lvl 24, 580 George St
Sydney NSW 2000

13/17860

Attention: Mr Bryce Purches

Dear Mr Barbour

I refer to your letter requesting information about the regulation of low frequency noise at the Mt Thorley and Warkworth Coal Mines (MTW) following a complaint from the NSW Environmental Defender's Office on behalf of the Bulga Milbrodale Progress Association.

I understand that the request from the NSW Ombudsman is part of a preliminary investigation in accordance with s13AA of the *Ombudsman Act 1974*, to determine whether this matter should be formally investigated.

I have responded to each of the questions you have raised in the attachment to this letter.

Should you have any further enquiries about this matter, I have arranged for Mike Young, Manager Mining and Industry Projects, to assist you. Mr Young can be contacted on 02 9228 2091.

Yours sincerely

27/11/13

Richard Pearson
A/Director General

Enclosed:

- Attachment addressing information request from NSW Ombudsman
- Mount Thorley Warkworth *Noise Management Plan*
- Mount Thorley Warkworth *Interim Noise Monitoring Programme*
- Mount Thorley Warkworth Annual Environmental Management Report (extract)
- Mount Thorley Warkworth *Independent Noise Monitoring Report*
- Letter from Director General of DECCW, dated 20 December 2010

Response to Questions Raised by NSW Ombudsman

1) *Please provide a copy of the current Noise Management Plan and Noise Monitoring Programme which apply to the consent.*

As requested, copies of the Noise Management Plan and the Noise Monitoring Programme for MTW are enclosed. However, these documents apply to the MTW complex as a whole, and Coal & Allied will be required to prepare and implement separate documents for the Mount Thorley and Warkworth mines in the near future as a result of the NSW Land & Environment Court decision to disallow the application of complex-wide noise criteria. The revised plans will need to be developed in consultation with the NSW Environmental Protection Authority (EPA), and will require approval from the Department.

2) *Is live monitoring of low frequency noise currently undertaken by either the operators of the mine or the Department in relation to cl.28 of the consent? If not, please explain why?*

The real time monitoring is undertaken using an automated system installed in various locations around the mine by Coal & Allied. However, the real time monitoring is limited to the assessment of A-weighted noise levels only, and hence it is not possible to apply the low frequency modifying factors which require C-weighted noise levels to be measured. Furthermore, the real time monitoring is only used for proactive management of noise on the site, and is not used to determine compliance with the noise criteria in condition 28 of the Warkworth consent.

Instead, attended monitoring undertaken by the operators of the mine is used to determine compliance with the noise criteria in the consent. Attended monitoring can measure both A-weighted and C-weighted noise levels and is therefore used to determine if the modifying factor should be applied to the monitoring data.

3) *Are the modification factors for low frequency noise in Section 4 of the INP currently applied to all the reported/measured noise levels relating to the monitoring of the consent?*

The low frequency modifying factor is only applied to the monitoring data where a low frequency impact is identified during the attended monitoring. Under Section 4 of the INP, this modifying factor should be applied if the difference between the C weighted and A weighted noise level is greater than 15 dB.

In the case of Warkworth, Coal & Allied has been applying the low frequency modifying factor since 2010. The most recent *Annual Environmental Management Report* (AEMR), shows that the low frequency penalty was applied on 7 occasions out of a total of 130 attended noise measurements undertaken during 2012 (see extract from the 2012 AEMR attached).

4) *If the modification factors for low frequency noise in Section 4 of the INP have been applied, please provide a document, by way of example which shows how these modification factors have been applied and reported.*

The 2012 AEMR provides an example of how the low frequency modifying factor has been applied and reported. The AEMR is submitted to the Department, and made available on the company's website.

A further example is the *Independent Noise Monitoring Report* prepared by SKM in April 2012 for the Mount Thorley and Warkworth mines. The Independent Noise Monitoring Report provides a comprehensive discussion about low frequency noise and the difficulties of measuring low frequency noise generated by mines, particularly at distances greater than 3 km (see page 12 of the attached report). I understand that presentations were given to the community about the outcomes of the independent monitoring undertaken by SKM.

5) *If the modification factors have not been applied please explain why*

The low frequency modification factor for the Warkworth mine is applied and reported as described above.

6) *Are the modification factors for low frequency noise in Section 4 of the INP currently applied to the data contained in the Annual Environmental Management Reports submitted to the Department by the operators of the mine?*

The low frequency modifying factor is applied to the data at the time of the attended monitoring, and then reported in the AEMR that is submitted to the Department.

7) *Please explain on what basis the Department formed the view that the OEH or EPA has been conducting a review of the relevant sections of the INP in 2011 and 2012.*

There has been ongoing collaboration between the Department and the EPA regarding the assessment of low frequency noise and the need to review the applicable sections of the INP since 2009.

For example, enclosed is a letter from the Director General of the Department of Environment, Climate Change and Water (formerly OEH and EPA) dated December 2010. This letter highlights:

- the difficulties in applying the low frequency modification factor in rural settings;
- that the EPA did not intend to include conditions regarding low frequency noise in Environment Protections Licences; and
- a commitment to review the policy in regard to low frequency noise as a priority ahead of a full review of the INP.

Furthermore, the *Upper Hunter Strategic Regional Land Use Plan* (SRLUP) issued by the NSW Government in September 2012, indicates that a review of the INP as it relates to mining projects was already underway at that time (see page 62 of the SRLUP which is available on the Department's website).

Finally, the EPA has commissioned SKM to prepare a comprehensive study of low frequency noise as part of the review of the INP. The report is titled *Low Frequency Noise & Infrasound*, and is expected to be finalised in the near future.

8) *Please provide copies of any correspondence between the OEH or EPA which confirms that a review of Section 4 of the INP has been ongoing since at least the 15 December 2011.*

A copy of the letter from the Director General of DECCW, dated 20 December 2010, is enclosed.

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Appendix G

Air quality and greenhouse gas study

Appendix G — Air quality and greenhouse gas study

G

AIR QUALITY AND GREENHOUSE GAS ASSESSMENT
WARKWORTH CONTINUATION 2014

EMGA Mitchell McLennan

12 June 2014

Job Number 14010272

Prepared by

Todoroski Air Sciences Pty Ltd

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Air Quality and Greenhouse Gas Assessment Warkworth Continuation 2014

Author(s): Aleks Todoroski Philip Henschke

Position: Director Atmospheric Physicist

Signature:

Date: 12/06/2014 12/06/2014

DOCUMENT CONTROL

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DRAFT - 001	18/03/2014	P Henschke	A Todoroski
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DRAFT - 004	17/04/2014	P Henschke/ A Todoroski	A Todoroski
FINAL - 001	23/05/2014	P Henschke	A Todoroski
FINAL - 002	12/06/2014	P Henschke	A Todoroski

EXECUTIVE SUMMARY

This assessment investigates the potential air quality effects and calculates the greenhouse gas emissions that may arise as a result of the proposed modifications to the Warkworth Mine. The Warkworth Mine is located in the Hunter Valley, NSW and is operated by Coal & Allied on behalf of Warkworth Mining Limited. The mine currently operates under Development Consent No. DA 300-9-2002-i.

The assessment is prepared in general accordance with the applicable regulatory requirements and guidelines and forms part of the environmental impact statement prepared for the development application. Environmental impacts are assessed against relevant criteria developed as benchmarks set to protect the general health and amenity of the general community.

The existing environment in the conditions of the area is typical of the Hunter Valley region with common wind flows aligned along a northwest to southeast flow. The ambient air quality in the area is generally fair considering the various industrial and commercial activities of the region.

The assessment has focused on three indicative mine plan years chosen to represent a range of potential impacts over the life of the mining operation with reference to surrounding operations in the area which would also contribute to dust emissions in each year. Air dispersion modelling with the CALPUFF modelling suite is utilised in conjunction with estimated emission rates for air pollutants generated by the various activities. Best practice mitigation and management measures are considered to ameliorate any potential adverse air quality impacts and respond to government and community concerns regarding the regional air quality in the Hunter Valley.

The assessment predicts potential dust impacts at mine-owned assessment locations, two privately owned assessment locations in Warkworth, and the Warkworth community hall. These three non-mine owned properties are within the area encompassed by the acquisition zone of neighbouring mines (although not all properties are explicitly identified). All of the affected properties would also be afforded acquisition rights should the proposal proceed.

The assessment indicates that adverse air quality impacts are unlikely from diesel combustion and whilst blasting has potential to lead to impacts in the late afternoon periods, this would be averted with appropriate management measures that prevent blasting under impacting conditions.

The estimated annual greenhouse emissions for the Warkworth is 1.038Mt CO_2-e and equates to approximately 0.18 per cent and 0.65 per cent of the total Australian and NSW greenhouse emissions respectively.

Overall the assessment indicates that whilst adverse air quality impacts may arise at a small number of assessment locations due to the proposed modifications to the Warkworth Mine, these can be managed and mitigated effectively.

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1 INTRODUCTION

Warkworth Mine is an open cut coal mine approximately 8 kilometres (km) south-west of Singleton in the Hunter Valley, NSW. The mine is operated by Coal & Allied on behalf of Warkworth Mining Limited (WML). The site currently operates under Development Consent No. DA 300-9-2002-i (the development consent) issued by the then Minister for Planning in May 2003 under Part 4 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The site also operates under two separate Commonwealth approvals (*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)): EPBC 2002/629 and EPBC 2009/5081.

Warkworth Mine has been in operation since 1981 and the originally approved operation has been modified several times. Immediately to the south of Warkworth Mine is Mount Thorley Operations (MTO). Since 2004, the two mines have integrated at an operational level and are known as Mount Thorley Warkworth (MTW), with a single management team responsible for all the operations. Equipment, personnel, water, rejects and coal preparation are all shared between the mines. The operations involve an existing workforce of approximately 1,300 persons, which includes full-time personnel and a small number of short-term contractors. Ownership of the two mines remains separate.

Warkworth Mine currently operates three integrated open cut mining areas, namely North, West and South pits with West and North pits being the focus of production. Run-of-mine (ROM) coal from Warkworth Mine is transported to either the Warkworth or Mount Thorley coal preparation plant (CPP) for processing. Product coal from the CPPs is transported via conveyor to either the Mount Thorley Coal Loader (MTCL) or to the Redbank Power Station. Coal loaded onto trains at the MTCL is transported to the Port of Newcastle for export.

The Warkworth Continuation 2014 (the proposal) seeks an approval under Part 4, Division 4.1 of the EP&A Act to extend mining beyond the current limits.

1.1 Project description

Warkworth Mine has approval to operate until 19 May 2021 under its development consent. The proposal seeks a 21 year development consent period from the date of any approval. If approval is granted in late 2014, operations at Warkworth Mine are forecast to continue to 2035, a 14 year extension over the current approval. The proposal seeks a continuation of all aspects of Warkworth Mine as it presently operates together with:

- an extension of the approved mining footprint by approximately 698ha to the west of current operations (referred to herein as the proposed 2014 extension area);
- the ability to transfer overburden to MTO to complete MTO's final landform;
- the closure of Wallaby Scrub Road;
- an option to develop an underpass beneath Putty Road for the third bridge crossing yet to be constructed (while retaining the current approval for an overpass);
- minor changes to the design of the Northern out-of-pit (NOOP) dam; and

- the continued use of secondary access gates to the mine site and offsets for activities such as drilling, offset management, equipment shutdown pad access amongst other things.

The proposal is shown in **Figure 1-1**.

1.2 Report purpose

This air quality impact and greenhouse gas assessment has been prepared in general accordance with the Secretary's Requirements and the New South Wales (NSW) Environment Protection Authority (EPA) document "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**NSW DEC, 2005**). The assessment forms part of the environmental impact statement prepared in support of the development application for the proposal.

The assessment investigates the potential for adverse air quality impacts occurring at surrounding assessment locations as a result of the proposal. Air dispersion modelling is utilised in conjunction with estimated emission rates of air pollutants and the consideration of mitigation measures in ameliorating any potential air quality impacts.

This report comprises of:

- A review of the existing environment surrounding the proposal;
- A description of the dispersion modelling approach used to assess potential impacts;
- The results of the dispersion modelling;
- A discussion of the potential air quality impacts as a result of the proposal;
- An estimation of the greenhouse gas emissions generated; and
- Measures to avoid or mitigate potential air quality impacts.

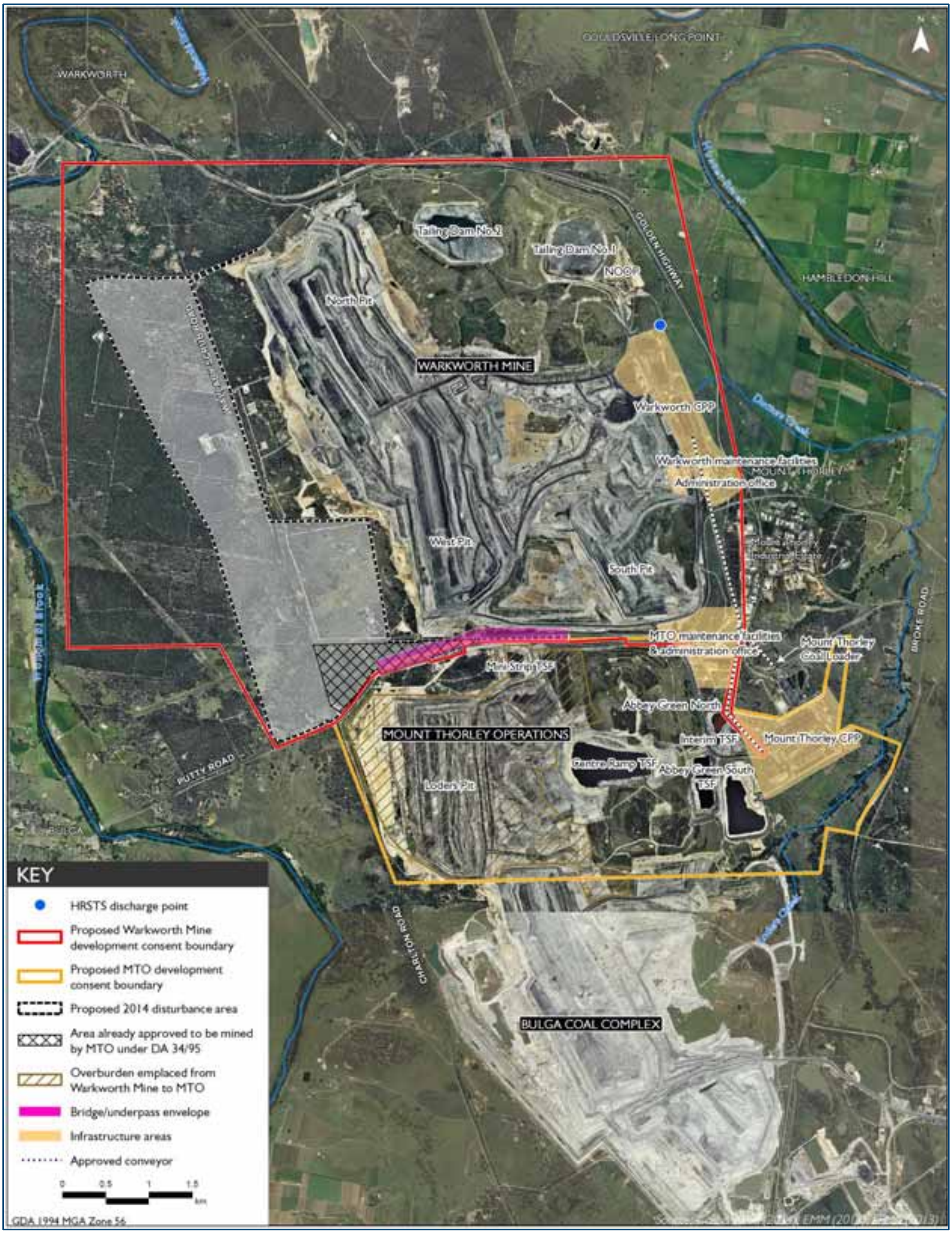

Figure 1-1: The proposal

2 LOCAL SETTING

The area surrounding Warkworth Mine is comprised of various open cut coal mining operations, agriculture, forest, national park and rural residential areas.

Figure 2-1 presents the location of the proposal in relation to the neighbouring coal mining operations and the assessment locations of relevance to this study. **Appendix A** provides a detailed list of all the assessment locations considered in this report.

Figure 2-2 presents a three-dimensional (3D) visualisation of the topography in the vicinity of Warkworth Mine. The surrounding topography is characterised by the steep escarpment to the west and south which forms part of the Wollemi National Park and the Pokolbin State Forest respectively. To the north and east, the terrain is generally open to form the Hunter Valley. In the general vicinity of Warkworth Mine, the terrain is moderately hilly. The complex terrain features of the surrounding area have a significant effect on the local wind distribution patterns.

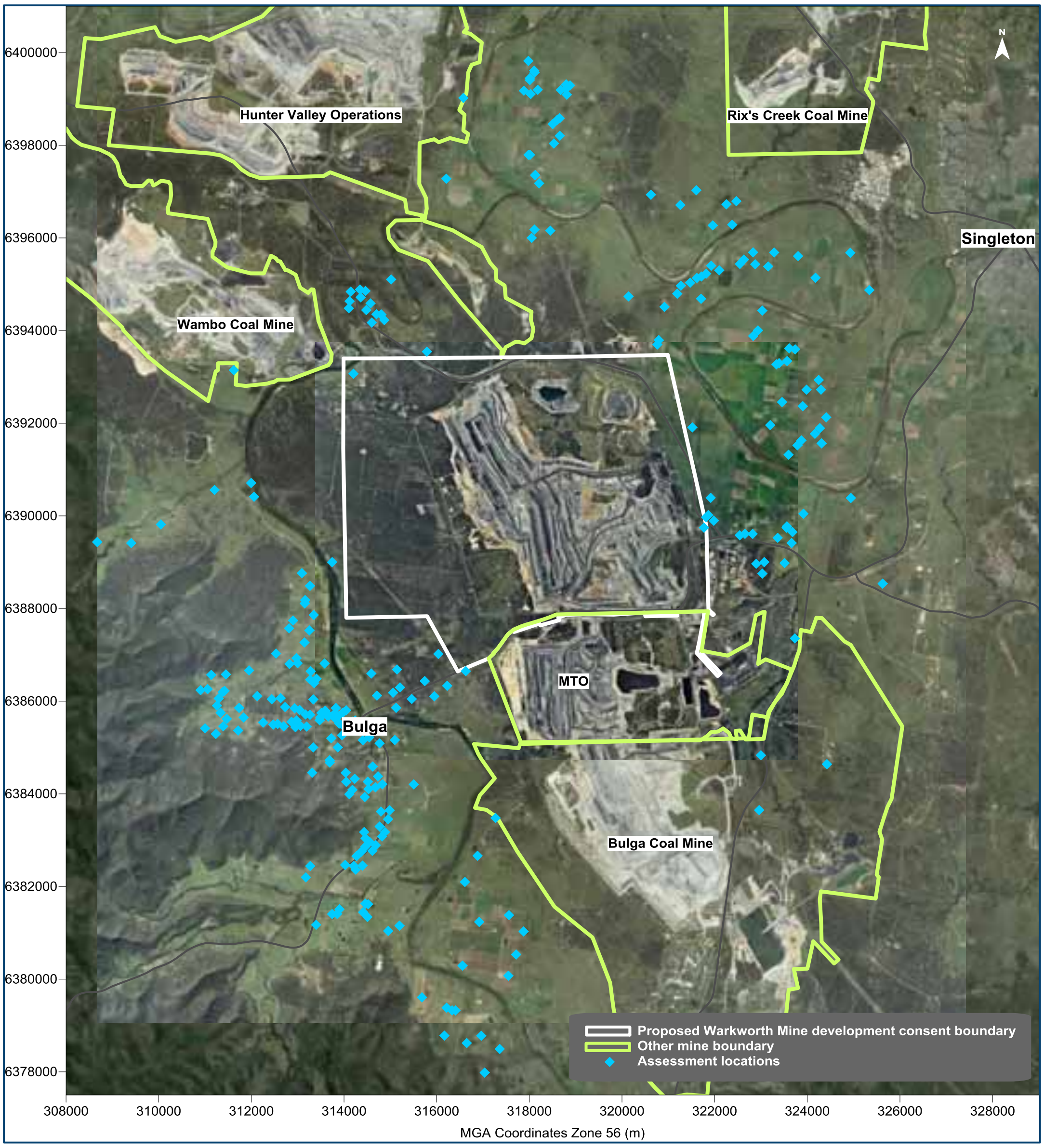

Figure 2-1: Proposal setting

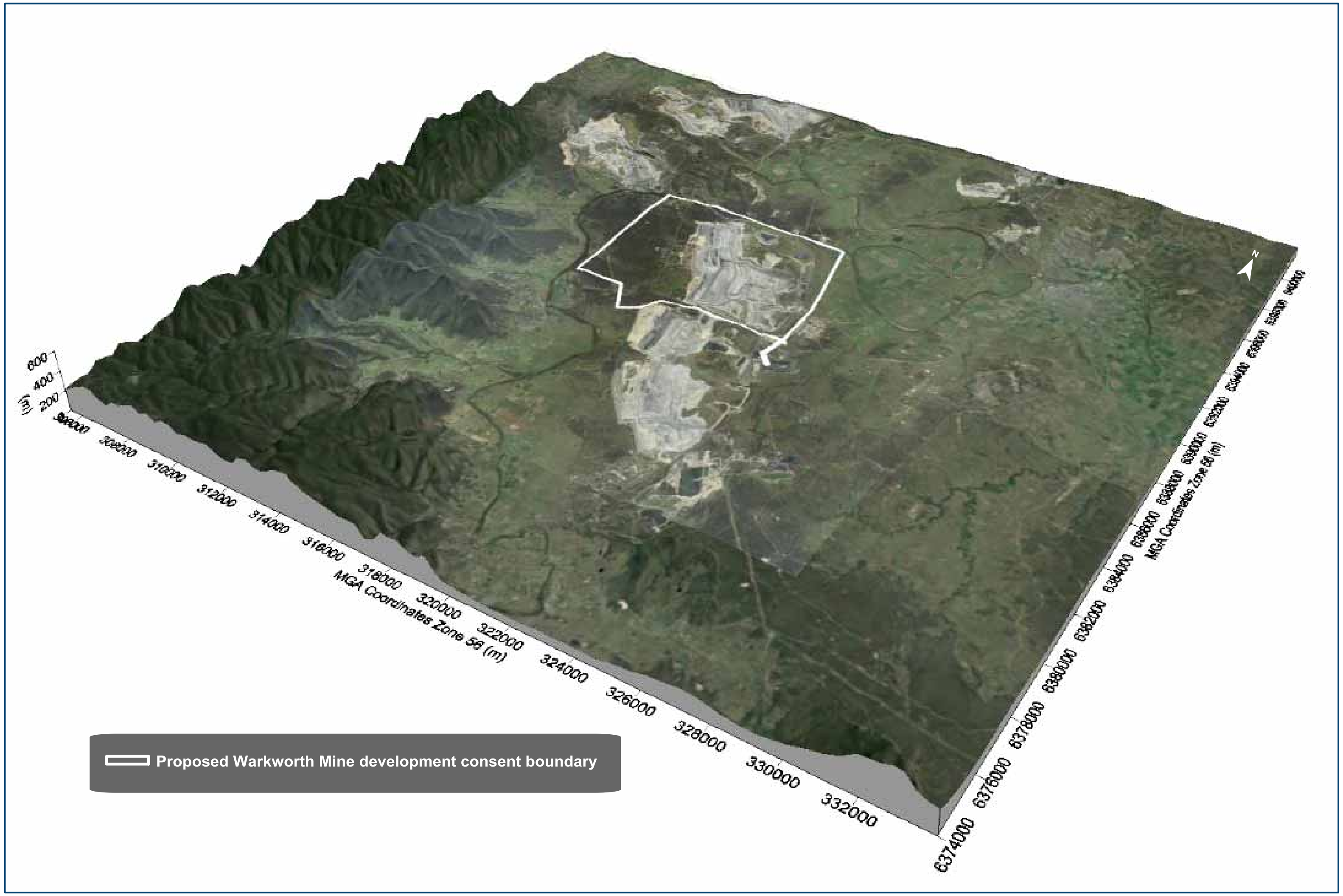

Figure 2-2: Topography surrounding the proposal

3 AIR QUALITY ASSESSMENT CRITERIA

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the proposal and the applicable air quality criteria.

3.1 Particulate matter

Particulate matter refers to particles of varying size and composition. The air quality goals relevant to this assessment refer to three classes of particulate matter based on the sizes of the particles. The first class is referred to as Total Suspended Particulate matter (TSP) which measures the total mass of all particles suspended in air. The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice, particles larger than 30 to 50µm settle out of the atmosphere too quickly to be regarded as air pollutants.

The second and third class are sub-classes of TSP, namely PM_{10}, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Mining activities generate particles in all the above size categories. The great majority of the particles generated are due to the abrasion or crushing of rock and coal and general disturbance of dusty material. These particulate emissions will be generally larger than 2.5µm as these fine sub-2.5µm particles are usually generated through combustion processes or as secondary particles formed from chemical reactions rather than through mechanical processes that dominate emissions on mine sites.

Combustion particulates can be more harmful to human health as the particles have the ability to penetrate deep into the human respiratory system as they are small and can be comprised of acidic and carcinogenic substances.

A study of the particle size distribution from mine dust sources in 1986 conducted by the State Pollution Control Commission (SPCC) found that of approximately 120 samples showed $PM_{2.5}$ comprised 4.7 per cent of the TSP, and PM_{10} comprised 39.1 per cent of the TSP in the samples (**SPCC, 1986**). The emissions of $PM_{2.5}$ occurring from mining activities are small in comparison to the total dust emissions and in practice, the concentrations of $PM_{2.5}$ in the vicinity of mining dust sources are likely to be low.

3.1.1 NSW EPA impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this study as outlined in the NSW EPA document "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**NSW DEC, 2005**). The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the proposal. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90µg/m^3
PM_{10}	Annual	Total	30µg/m^3
	24 hour	Total	50µg/m^3
Deposited dust	Annual	Incremental	2g/m^2/month
		Total	4g/m^2/month

Source: **NSW DEC, 2005**

The criterion for 24-hour average PM_{10} originates from the National Environment Protection Measure (NEPM) goals (**NEPC, 1988**). These goals apply to the population as a whole, and are not recommended to be applied to "hot spots" such as locations near industry, busy roads or mining. However, in the absence of alternative measures, NSW EPA does apply the criteria to assess the potential for impacts to arise at such locations.

The NEPM permits five days annually above the 24-hour average PM_{10} criterion to allow for bush fires and similar events. Similarly, it is normally the case that days, where ambient dust levels are affected by such events, are excluded from assessment as per the NSW EPA criterion.

It is important to note the Mining SEPP non-discretionary standard with respect to air quality of PM_{10} annual average criterion of 30µg/m^3 is a key matter for consideration.

3.1.2 NSW Planning & Infrastructure private residential property acquisition criterion for particulate matter

While the NSW EPA applies the maximum 24-hour average PM_{10} level in any year to assess the potential for impacts from a project, the NSW Planning & Infrastructure (P&I) in contemporary planning approvals has invoked requirements for acquisition and negotiated agreements with private residential landowners if there are systemic exceedances of the NSW EPA criterion. In the context of impact assessments for approval of new projects and modifications to existing projects, this is interpreted to mean where the NSW EPA criterion is exceeded on more than five days in any year (a 98.6 percentile level of compliance). This P&I criterion and other relevant criteria are outlined in **Table 3-2**.

Table 3-2: P&I private residential property acquisition criteria for particulate matter

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90µg/m^3
PM_{10}	Annual	Total	30µg/m^3
	24 hours	Incremental	50µg/m^3
Deposited dust	Annual	Incremental	2g/m^2/month
		Total	4g/m^2/month

3.1.3 $PM_{2.5}$ concentrations

The NSW EPA currently does not have impact assessment criteria for $PM_{2.5}$ concentrations; however the National Environment Protection Council (NEPC) has released a variation to the NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$ (see **Table 3-3**).

The advisory reporting standards for $PM_{2.5}$ are a maximum 24-hour average of 25µg/m^3 and an annual average of 8µg/m^3, and as with the NEPM goals, apply to the average, or general exposure of a population, rather than to "hot spot" locations.

Table 3-3: Advisory standard for $PM_{2.5}$ concentrations

Pollutant	Averaging Period	Criterion
$PM_{2.5}$	24 hours	25µg/m^3
	Annual	8µg/m^3

Source: **NEPC, 2003**

3.2 Other air pollutants

Emissions of other air pollutants will also potentially arise from mining operations such as the diesel powered equipment used on-site. Emissions from diesel powered equipment generally include carbon monoxide (CO), nitrogen dioxide (NO_2) and other pollutants, such as sulphur dioxide (SO_2).

CO is a colourless, odourless and tasteless gas generated from the incomplete combustion of fuels when carbon molecules are only partially oxidised. It can reduce the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

NO_2 is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called nitrogen oxides (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**USEPA 2011**). NO_X may also be generated by blasting activities. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generated.

Sulphur dioxide (SO_2) is a colourless, toxic gas with a pungent and irritating smell. It commonly arises in industrial emissions due to the sulphur content of the fuel. SO_2 can have impacts upon human health and the habitability of the environment for flora and fauna. SO_2 emissions are a precursor to acid rain, which can be an issue in the northern hemisphere; however it is not known to have any widespread impact in NSW, and is generally only associated with large industrial activities. Due to its potential to impact on human health, sulphur is actively removed from fuel to prevent the release and formation of SO_2. The sulphur content of Australian diesel is controlled to a low level by national fuel standards. Therefore the emissions of SO_2 generated from diesel powered equipment at mine sites are generally considered to be too low to generate any significant off-site pollutant concentrations and have not been assessed further in this study.

Table 3-4 summarises the air quality goals for CO and NO_2 assessed in this report.

Table 3-4: NSW EPA air quality impact assessment criteria of air toxics

Pollutant	Averaging period	Criterion
Carbon monoxide (CO)	15 minute	100mg/m²
	1 hour	30mg/m²
	8 hour	10mg/m²
Nitrogen dioxide (NO_2)	1 hour	246µg/m³
	Annual	62µg/m³

Source: **NSW DEC, 2005**

4 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding Warkworth Mine.

4.1 Local climate

Long term climate data collected at the nearest Bureau of Meteorology (BoM) station, Jerrys Plains Post Office (Station Number 061086), are summarised in **Table 4-1** and **Figure 4-1**. Climatic parameters have been collected from the Jerrys Plains Post Office over a 45 to 128 year period. These data assist in characterising the local climatic conditions based on the long term meteorological parameters. The Jerrys Plains Post Office is located approximately 20km northwest of Warkworth Mine.

The data indicates that January is the hottest month with a mean maximum temperature of 31.7°C and July is the coldest month with a mean minimum temperature of 3.8°C.

Relative humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9am relative humidity levels range from 59 per cent in October to 80 per cent in June. Mean 3pm relative humidity levels vary from 42 per cent in October – December to 54 per cent in June.

Rainfall peaks during the summer months and declines during winter. The data show January is the wettest month with an average rainfall of 77.7mm over 6.4 days and August is the driest month with an average rainfall of 36.1mm over 5.2 days.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. The mean 9am wind speeds range from 8.6km/h in April to 11.7km/h in September. The mean 3pm wind speeds vary from 11.0km/h in May to 14.7km/h in September.

Table 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (°C)	31.7	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.2	29.1	31.2
Mean min. temperature (°C)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7
Rainfall												
Rainfall (mm)	77.7	73.1	59.1	44.0	40.7	48.1	43.4	36.1	41.7	51.9	61.9	67.5
Mean No. of rain days (≥1mm)	6.4	6.0	5.8	4.9	4.9	5.5	5.2	5.2	5.2	5.8	6.2	6.3
9am conditions												
Mean temperature (°C)	23.4	22.7	21.2	18.0	13.6	10.6	9.4	11.4	15.3	19.0	21.1	23.0
Mean relative humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61
Mean wind speed (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9
3pm conditions												
Mean temperature (°C)	29.8	28.9	27.2	24.1	20.1	17.1	16.4	18.2	21.2	24.2	26.9	29.0
Mean relative humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42
Mean wind speed (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2

Source: **Bureau of Meteorology, 2014**

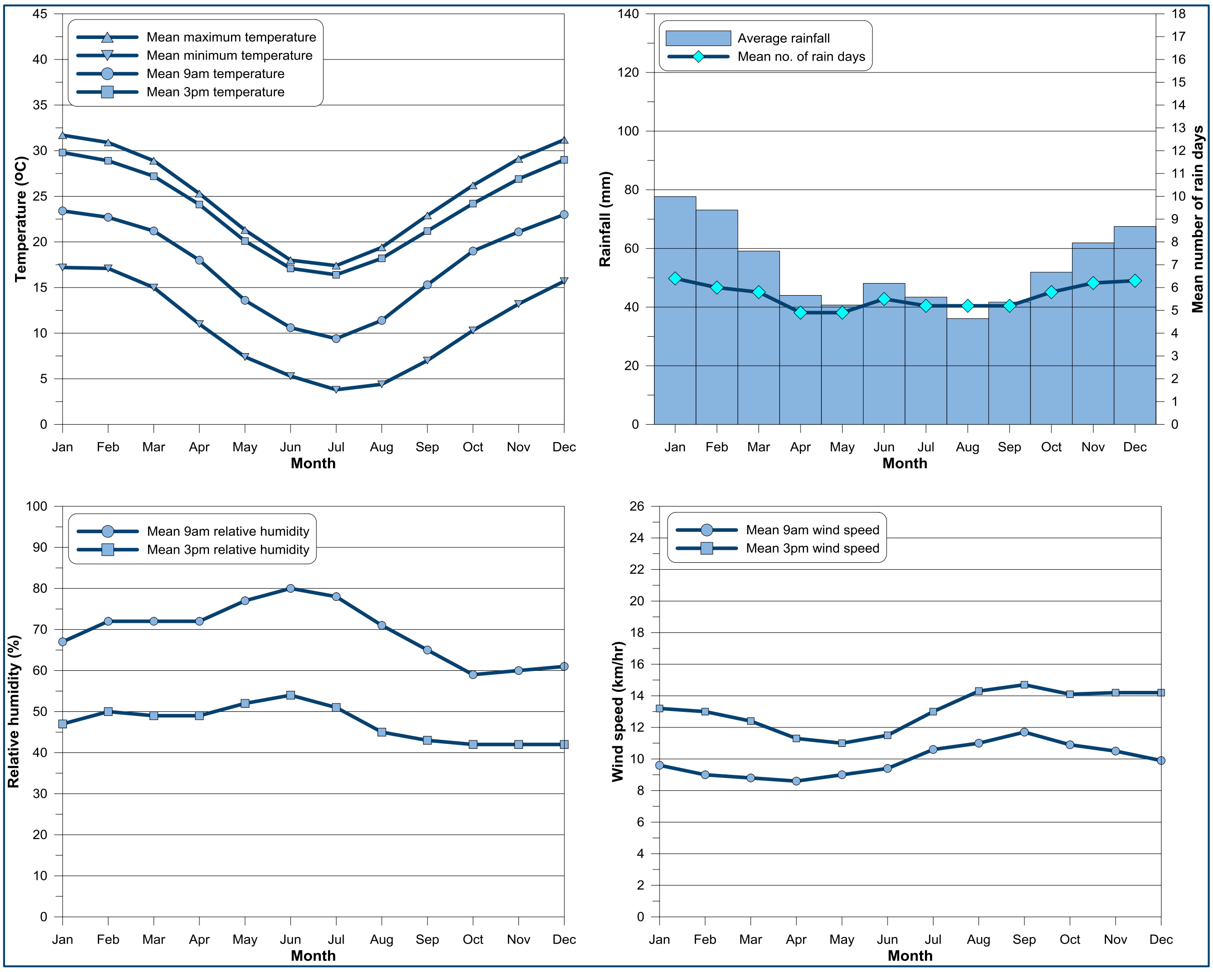

Figure 4-1: Monthly climate statistics summary – Jerrys Plains Post Office

4.2 Local meteorological conditions

MTW operate the Charlton Ridge meteorological station to assist with environmental management of site operations. The location of this station is shown in **Figure 4-2**.

Annual and seasonal windroses prepared from the available data collected for the 2012 period are presented in **Figure 4-3**.

Analysis of the windroses shows that the most common winds on an annual basis are from the south-southeast and south. Very few winds originate from the northeast and southwest sectors. In the summertime the wind predominately occurs from the south-southeast. The autumn distribution is similar to the annual distribution pattern. During winter, winds from the south-southeast and northwest dominate the distribution with some winds from the south. In the spring time, the majority of winds are from the south-southeast with varied winds from east-southeast, south and northwest.

Figure 4-2: Charlton Ridge meteorological station

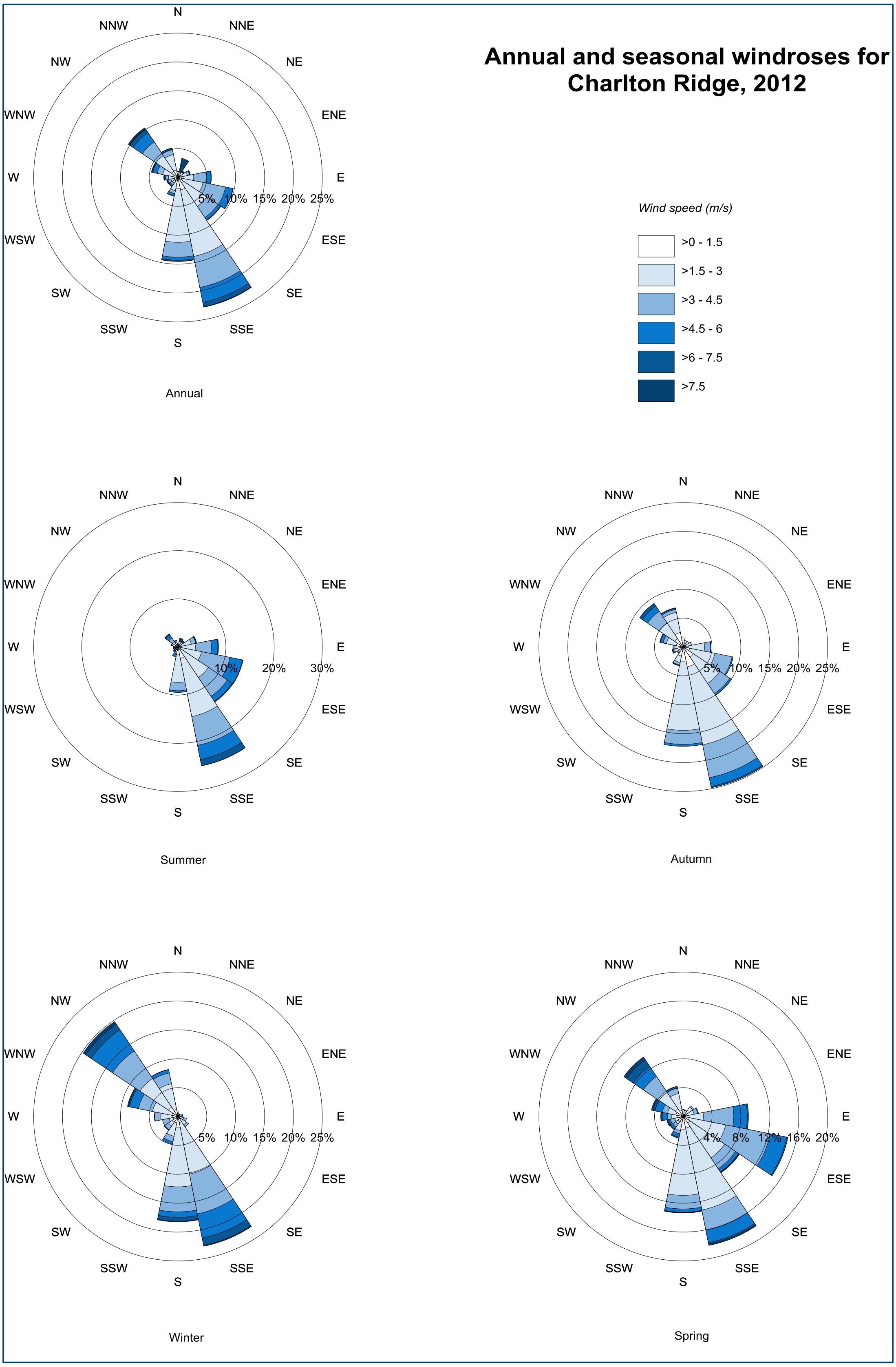

Figure 4-3: Annual and seasonal windroses for Charlton Ridge weather station (2012)

4.3 Ambient air quality

The main sources of particulate matter in the wider area include active mining, agricultural activities, emissions from local anthropogenic activities such as motor vehicle exhaust and domestic wood heaters, urban activity and various other commercial and industrial activities. Other pollutant emissions considered in the study include NO_2 and CO, which can potentially arise from mining operations such as the diesel powered equipment used on site and methane flaring operations, and power generation, including the Liddell, Bayswater and Redbank power stations. This section reviews the ambient monitoring data collected from a number of ambient monitoring locations in the vicinity of Warkworth Mine.

The air quality monitors reviewed in this assessment include 12 Tapered Element Oscillating Microbalances (TEOMs), 11 High Volume Air Samplers (HVAS) measuring either TSP or PM_{10}, 13 dust deposition gauges and three NO_2 monitors surrounding Warkworth Mine.

Table 4-2 lists the monitoring stations reviewed in this section which includes data from surrounding mining operations and the NSW EPA stations. **Figure 4-4** shows the approximate location of each of the monitoring stations reviewed in this assessment. **Appendix B** provides a summary of the mining operations monitoring data reviewed in this assessment.

Table 4-2: Summary of ambient monitoring stations

Monitoring site ID	Type	Monitoring data review period
Bulga	TEOM	January 2010 – December 2013
Wallaby Scrub Road	TEOM	January 2010 – December 2013
Warkworth	TEOM	January 2010 – December 2013
Knodlers Lane	TEOM	November 2011 – December 2013
Maison Dieu	TEOM	January 2010 – December 2013
MTIE	TEOM	January 2010 – December 2013
Bulga (NSW EPA)	TEOM	August 2011 – March 2014
Warkworth (NSW EPA)	TEOM	December 2011 – March 2014
Maison Dieu (NSW EPA)	TEOM	March 2011 – March 2014
Singleton NW (NSW EPA)	TEOM	July 2011 – March 2014
Singleton (NSW EPA)	TEOM	December 2010 – March 2014
Mt Thorley (NSW EPA)	TEOM	July 2011 – March 2014
MTO PM10	HVAS – PM_{10}	January 2012 – December 2013
WML PM10	HVAS – PM_{10}	August 2012 – December 2013
Knodlers Lane PM10	HVAS – PM_{10}	January 2012 – December 2013
Long Point PM10	HVAS – PM_{10}	Jan-Feb 2012 – Oct-Dec 2013
MTIE PM10	HVAS – PM_{10}	January 2012 – February 2013
Loders Creek PM10	HVAS – PM_{10}	March 2013 – December 2013
MTO TSP	HVAS – TSP	January 2012 – December 2013
WML TSP	HVAS – TSP	January 2012 – December 2013
Warkworth TSP	HVAS – TSP	January 2012 – December 2013
Long Point TSP	HVAS – TSP	October 2013 – December 2013
Loders Creek TSP	HVAS – TSP	March 2013 – December 2013
DW21A	Dust gauge	January 2012 – December 2013
Warkworth	Dust gauge	January 2012 – December 2013
DL30	Dust gauge	January 2012 – December 2013
DL22	Dust gauge	January 2012 – December 2013
Knodlers Lane	Dust gauge	January 2012 – December 2013

Monitoring site ID	Type	Monitoring data review period
DL21	Dust gauge	January 2012 – December 2013
DL14	Dust gauge	January 2012 – December 2013
D122	Dust gauge	January 2012 – December 2013
DW15	Dust gauge	January 2012 – December 2013
DW20A	Dust gauge	January 2012 – December 2013
DW14	Dust gauge	January 2012 – December 2013
D125	Dust gauge	January 2012 – December 2013
D124	Dust gauge	January 2012 – December 2013
Beresfield (NSW EPA)	NO_2 monitor	January 2008 – January 2014
Muswellbrook (NSW EPA)	NO_2 monitor	November 2011 – January 2014
Singleton (NSW EPA)	NO_2 monitor	November 2011 – January 2014

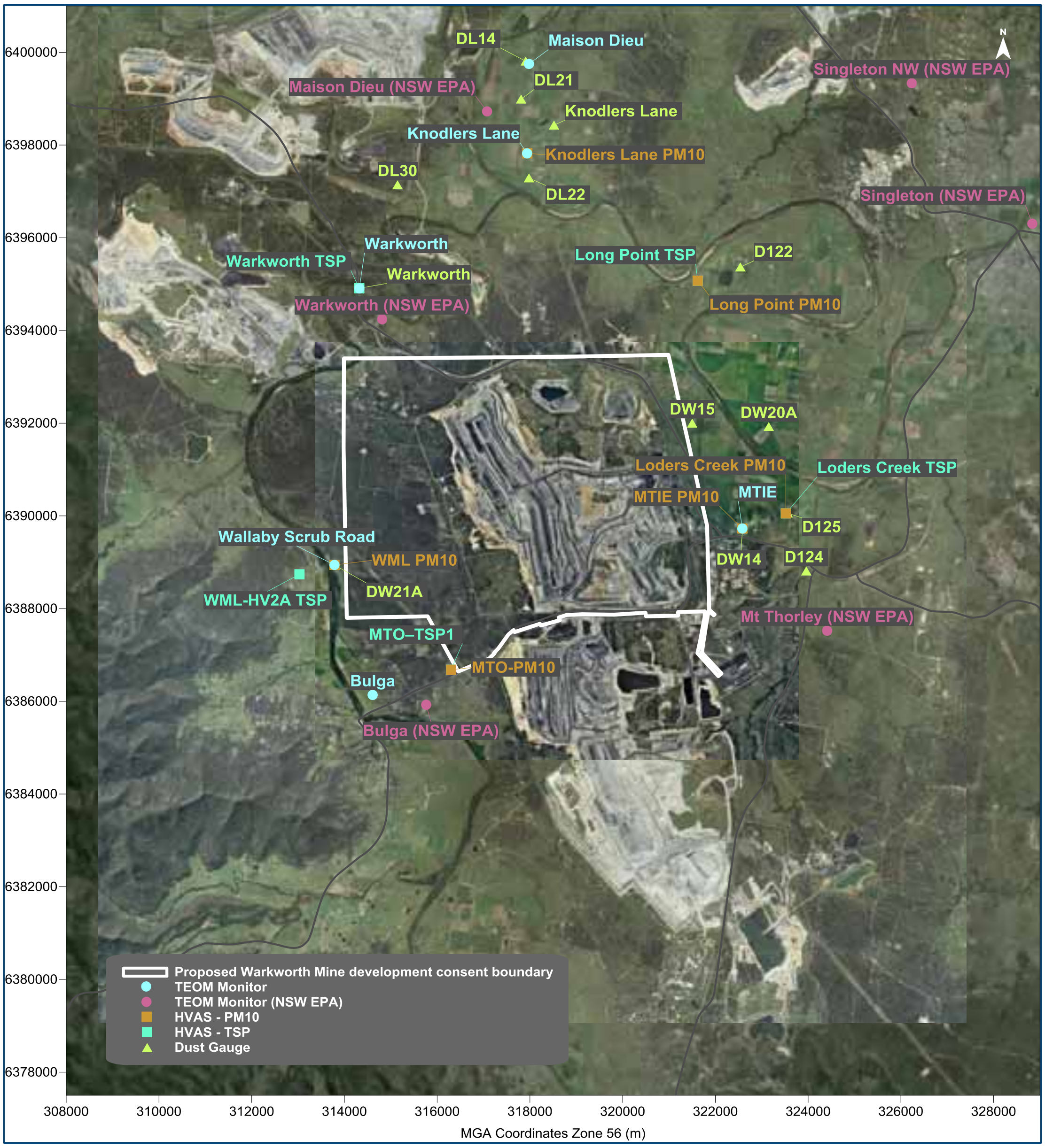

Figure 4-4: Monitoring locations

4.3.1 PM_{10} monitoring - TEOMs

Ambient PM_{10} monitoring using TEOMs is conducted by the Coal & Allied operations of Warkworth Mine and Hunter Valley Operations and NSW EPA at various locations surrounding Warkworth Mine. The location of each of these monitors is shown in **Figure 4-4**. The monitoring data includes all emission sources in the vicinity of Warkworth Mine.

4.3.1.1 Warkworth Mine and Hunter Valley Operations

A summary of the available data collected from Warkworth Mine and Hunter Valley Operations monitors from January 2010 to December 2013 is presented in **Table 4-3**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-5**.

Table 4-3 indicates that the annual average PM_{10} concentrations for each of the monitoring stations were below the relevant criterion of 30µg/m³ and that the maximum 24-hour average PM_{10} concentrations were on occasion above 50µg/m³ on days during the monitoring period. Further details regarding individual elevated days of dust concentrations are described in the Annual Environmental Management Report (Annual Review) for the mining operations.

It can be seen from **Figure 4-5** that PM_{10} concentrations are nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and pollen levels.

The yellow shaded band in **Figure 4-5** represents the period containing the data used to make the assessment of cumulative impacts. It can be seen that this period has the highest baseline PM_{10} levels in Bulga village and does not contain the anomalous high peaks that occurred during the bushfire period in late 2013 or the relatively low levels that occurred in Bulga village in 2013.

Table 4-3: Summary of PM_{10} levels from Warkworth Mine and Hunter Valley Operations TEOM monitoring (µg/m³)

	2010	2011	2012	2013
	Annual average			
Bulga	12.8	12.9	14.3	13.3
Knodlers Lane(1)	-	9.2	18.1	18.9
Wallaby Scrub Road	13.4	13.0	16.6	15.9
Maison Dieu	17.1	18.2	21.4	21.5
MTIE	22.2	19.9	24.9	27.5
Warkworth	11.2	13.7	16.5	18.2
	Maximum 24-hour average			
Bulga	39.5	42.8	56.1	78.8
Knodlers Lane(1)	-	15.6	56.3	62.1
Wallaby Scrub Road	45.6	54.0	46.0	72.0
Maison Dieu	77.0	64.7	76.0	74.7
MTIE	85.0	76.0	77.0	103.0
Warkworth	32.0	44.6	41.2	58.0

(1)Data available from November 2011

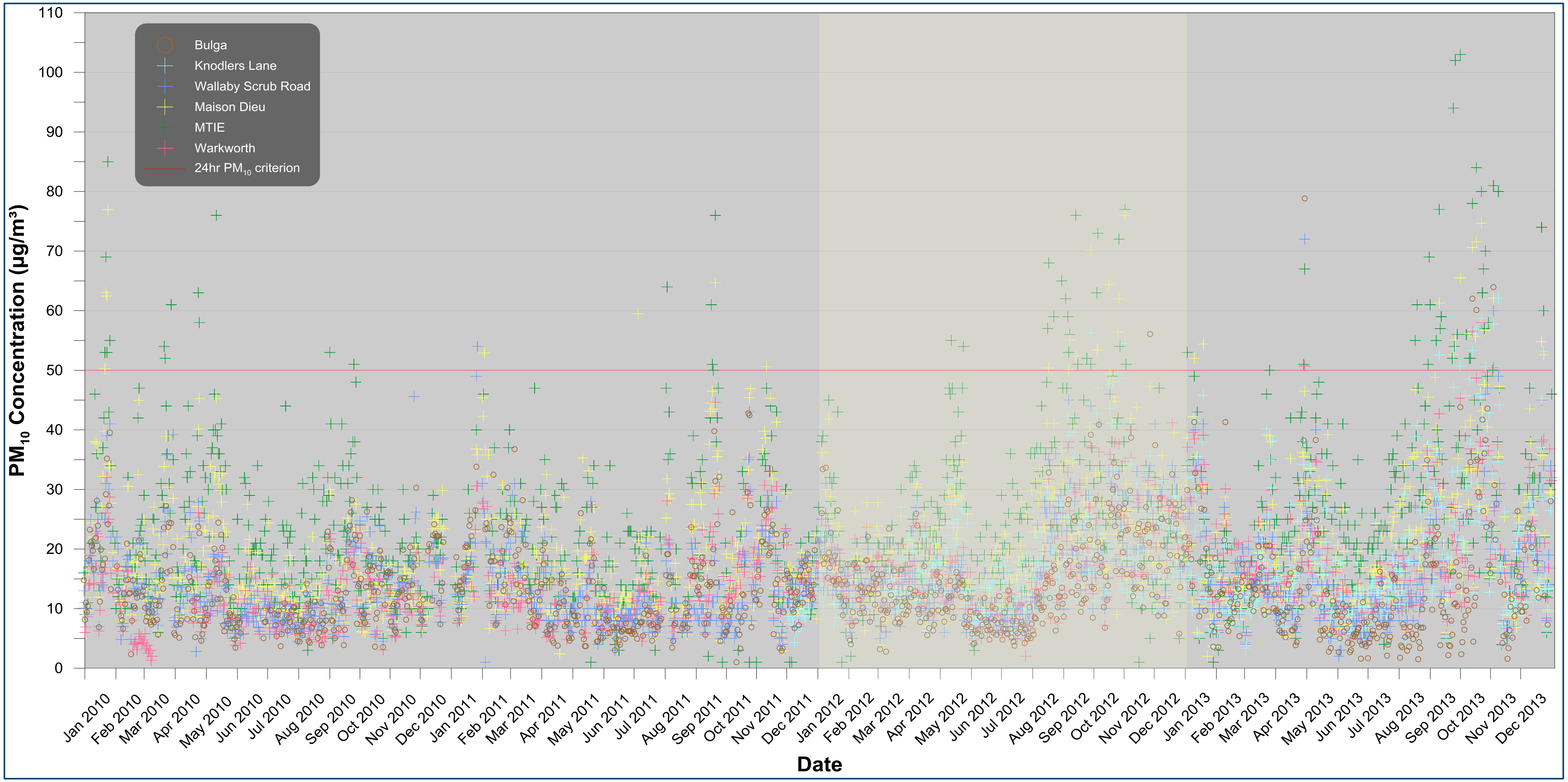

Figure 4-5: TEOM 24-hour average PM_{10} concentrations at Warkworth Mine and Hunter Valley Operations monitors

4.3.1.2 NSW EPA

A summary of the available data from the NSW EPA monitoring stations is presented in **Table 4-4**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-6**.

A review of **Table 4-4** indicates that the annual average PM_{10} concentrations for each monitoring station were below the relevant criterion on 30µg/m³. The maximum 24-hour average PM_{10} concentrations recorded at these stations were found to exceed the relevant criterion of 50µg/m³ at times during the review period.

Figure 4-6 shows a relatively similar trend to the Warkworth and Hunter Valley Operations TEOM station data (shown in **Figure 4-5**). Variation between the monitoring data sites are largely attributed to the proximity of these monitors to various dust sources located in the surrounding area.

Table 4-4: Summary of PM_{10} levels from NSW EPA TEOM monitoring (µg/m³)

	2010	2011	2012	2013	2014(1)
	Annual average				
Bulga(2)	-	16.8	18.7	19.2	23.9
Singleton(3)	20.0	19.8	22.3	23.3	21.4
Maison Dieu(4)	-	22.1	25.8	25.8	23.7
Singleton NW(5)	-	24.8	25.9	25.9	20.0
Mount Thorley(5)	-	22.5	24.8	24.7	19.0
Warkworth(6)	-	19.7	21.1	21.5	28.4
	Maximum 24-hour average				
Bulga(2)	-	41.6	55.1	88.4	54.3
Singleton(3)	32.8	60.5	63.6	62.7	45.3
Maison Dieu(4)	-	78.3	87.7	84.2	53.1
Singleton NW(5)	-	72.2	85.2	91.7	45.4
Mount Thorley(5)	-	58.5	88.7	88.3	46.1
Warkworth(6)	-	26	49.9	65.4	67.9

(1)Data available till March 2014
(2)Data available from August 2011
(3)Data available from December 2010
(4)Data available from March 2011
(5)Data available from July 2011
(6)Data available from December 2011

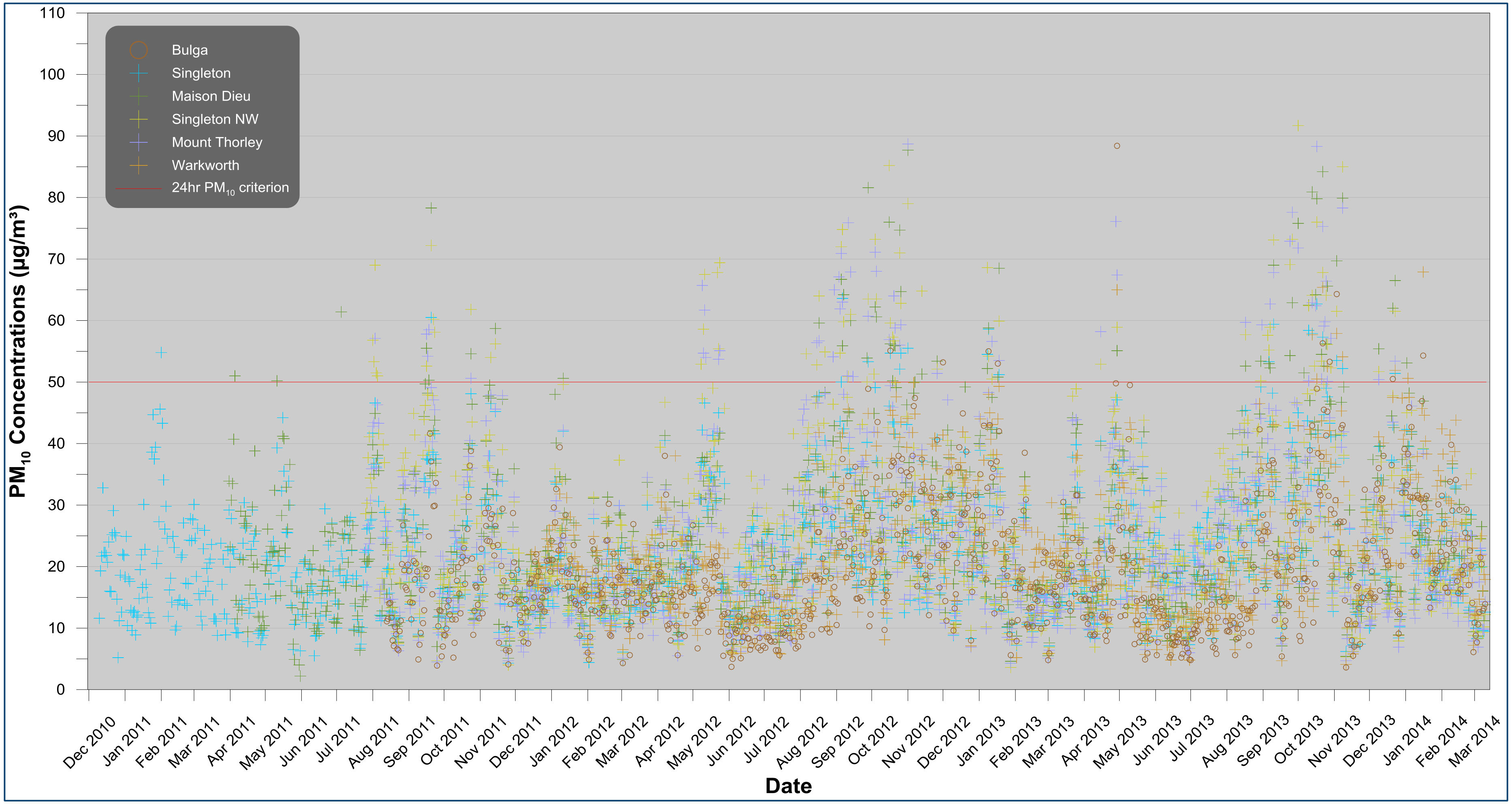

Figure 4-6: TEOM 24-hour average PM_{10} concentrations at NSW EPA monitors

4.3.2 PM_{10} monitoring - HVAS

A summary of the PM_{10} readings from the six HVAS monitoring stations is presented in **Table 4-5**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 4-7**. The data in **Table 4-5** indicate that the annual average PM_{10} concentrations for each of the monitoring stations were below the relevant criterion of 30µg/m³ for the years reviewed. The maximum 24-hour average concentrations exceed the relevant criterion of 50µg/m³ at these monitors and this can generally be attributed to events such as bushfires, dust storms, localised sources and dust emissions as a result of mining activity. Further details regarding individual elevated days of dust concentrations are described in the Annual Review for the mining operations.

The seasonal trends in PM_{10} concentrations can be seen in **Figure 4-7**, elevated days tend to occur in the warmer months with regional events indicated by most monitors showing elevated levels over the same period.

Table 4-5: Summary of PM_{10} levels from HVAS monitoring (µg/m³)

	Annual average		Maximum 24-hour average	
	2012	2013	2012	2013
Loders Creek PM10(1)	-	26.6	-	74
MTIE PM10(2)	27.9	21.1	98	58
MTO PM10	17.3	17.4	54	67
WML PM10(3)	17.5	13.5	43	47
Knodlers Lane PM10	20.8	24.9	59	84
Long Point PM10(4)	8.7	21.4	16	45

(1) Data available from March 2013
(2) Data available till February 2013
(3) Data available from August 2012
(4) Data available from Jan to Feb 2012 and Oct to Dec 2013

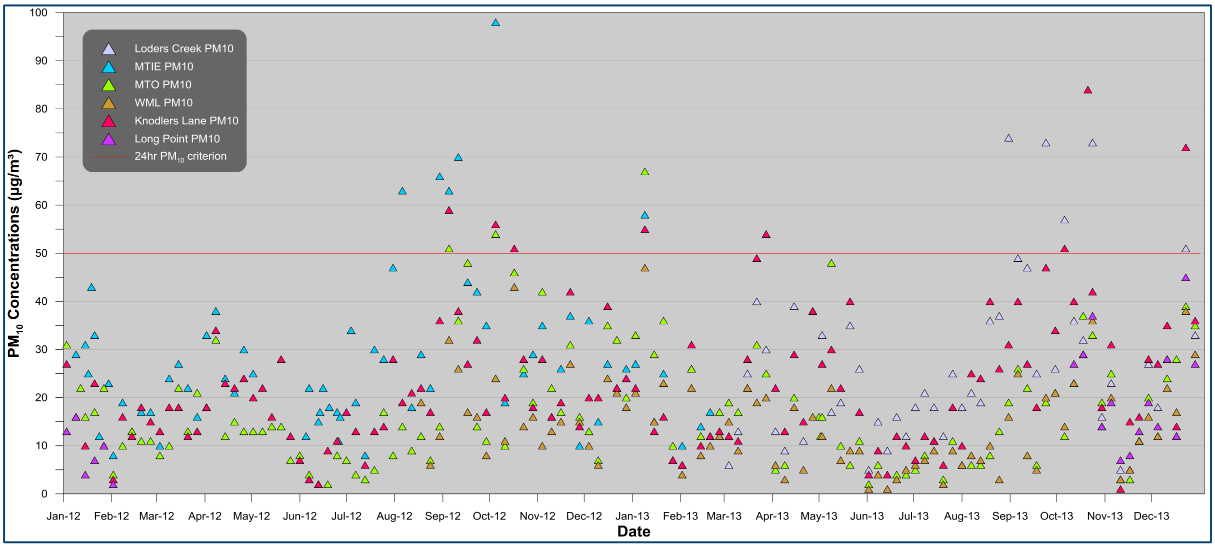

Figure 4-7: HVAS 24-hour average PM_{10} concentrations

4.3.3 TSP monitoring

TSP monitoring data are available from the five HVAS monitors surrounding the Warkworth Mine (see **Figure 4-4**). A summary of the results collected between January 2012 and December 2013 at these stations is shown in **Table 4-6**. Recorded 24-hour average TSP concentrations are presented in **Figure 4-8**.

The monitoring data presented in **Table 4-6** indicate that the annual average TSP concentrations for each monitoring station were less than the criterion of 90µg/m³. **Figure 4-8** shows that the recorded 24-hour average TSP concentrations at each monitor are generally consistent and follow a similar trend. The Loders Creek monitor shows slightly higher concentrations compared with the other monitoring locations and may be influenced by local sources.

Table 4-6: Summary of annul average TSP levels from HVAS monitoring (µg/m³)

	2012	2013
Loders Creek TSP(1)	-	71.6
MTO TSP	58.0	56.1
WML TSP	46.4	41.9
Warkworth TSP	50.7	55.7
Long Point TSP(2)	-	61.9

(1)Data available from March 2013
(2)Data available from October 2013

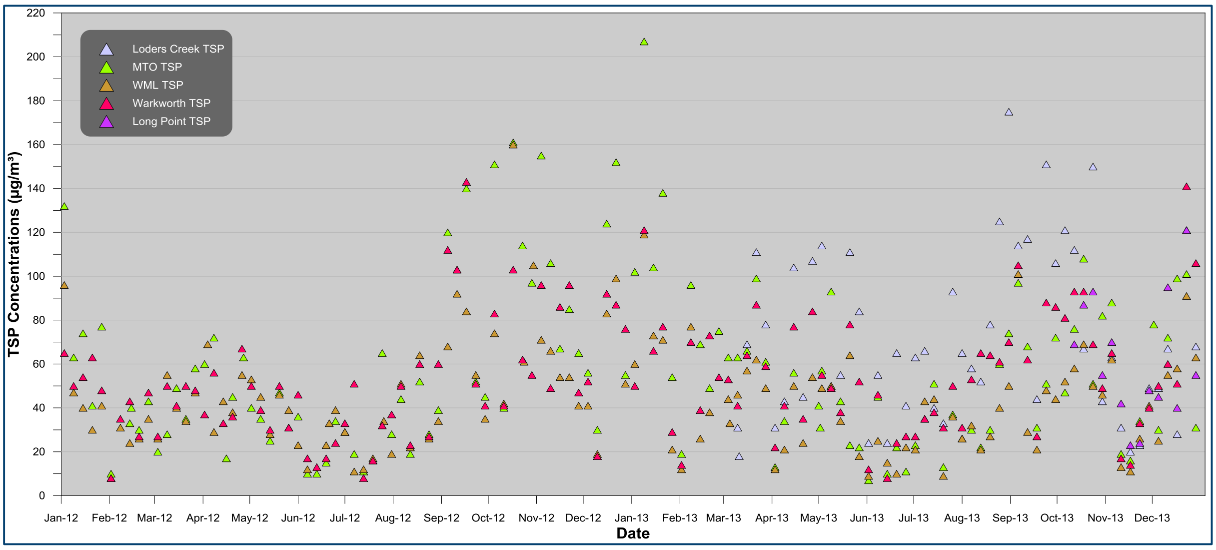

Figure 4-8: HVAS 24-hour average TSP concentrations (criteria is 90 µg/m³ as an annual average)

4.3.4 Dust deposition monitoring

The location of the dust deposition monitoring sites reviewed in this assessment are shown in **Figure 4-4**. **Table 4-7** summarises the annual average deposition levels at each gauge during 2012 and 2013.

Field notes accompanying the monitoring indicate that some of the samples were contaminated with materials such as bird droppings, insects or plant matter. This is a relatively common occurrence for this type of monitoring, and accordingly, contaminated samples have been excluded from the reported annual average results.

All gauges recorded an annual average insoluble deposition level below the criterion of 4g/m^2/month and in general, the air quality in terms of dust deposition is considered good.

Table 4-7: Annual average dust deposition (g/m^2/month)

	2012	2013
DW21A	2.5	2.4
Warkworth	3.4	3.3
DL30	2.9	2.6
DL22	2.1	1.9
Knodlers Lane	1.3	1.1
DL21	3.0	2.3
DL14	2.2	1.8
D122	2.3	1.6
DW15	3.9	3.1
DW20A	1.2	1.4
DW14	2.1	2.8
D125	1.7	1.9
D124	2.0	1.7

4.3.5 Nitrogen dioxide

Figure 4-9 presents the maximum daily 1-hour average NO_2 concentrations from the Beresfield, Muswellbrook and Singleton NSW EPA monitoring sites from 2008 to January 2014. As shown in **Figure 4-9**, the Muswellbrook and Singleton monitoring sites were commissioned in November 2011 and data are only available after this date for these locations.

Ambient air quality monitoring data collected at these locations would include emissions from sources such as the Liddell, Bayswater and Redbank power stations, methane gas flaring operations at mining operations as well as other various combustion sources.

The monitoring data recorded are well below the NSW EPA 1-hour average goal of 246µg/m^3 during this period at all of the monitors. The data in **Figure 4-9** indicate that levels of NO_2 are relatively low compared to the criterion level and show a seasonal fluctuation.

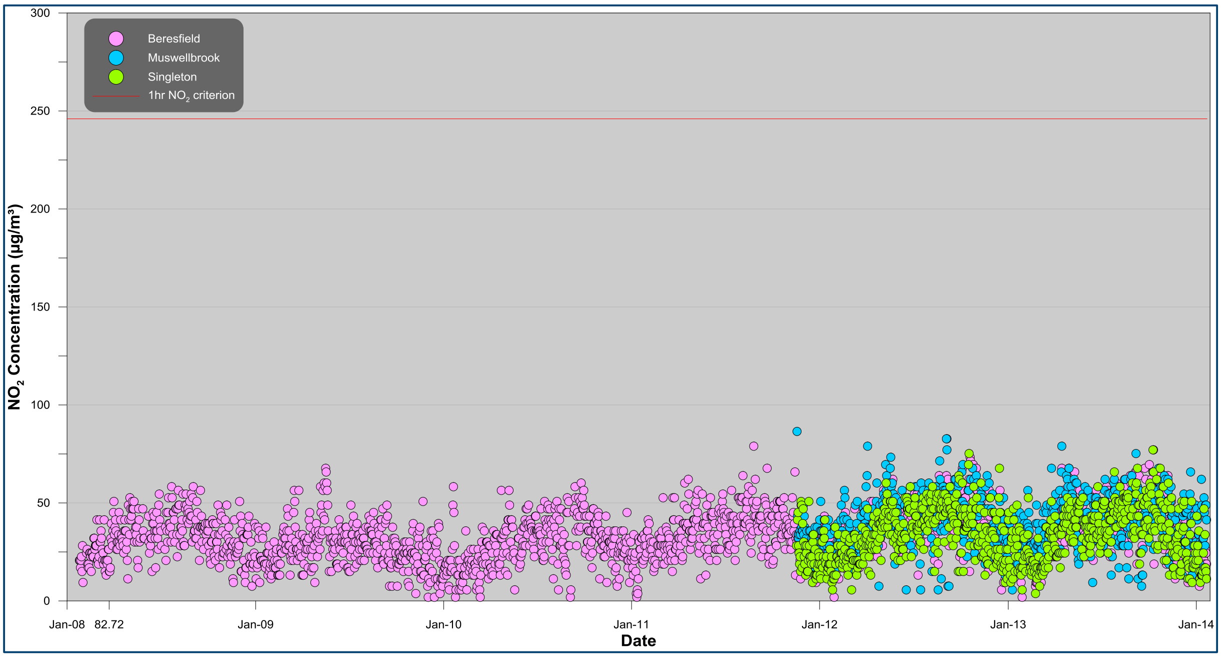

Figure 4-9: Daily 1-hour maximum NO_2 concentrations – Beresfield, Muswellbrook and Singleton

4.3.6 Carbon monoxide

The NSW EPA monitoring sites at Beresfield, Muswellbrook and Singleton do not record ambient concentrations of CO. Combustion activities are the cause of CO emissions and spatially there is very little such activity in the area apart from power generation, motor vehicles and wood heaters. Therefore, ambient concentrations of CO are expected to be low.

Ambient air quality goals for CO are set at higher concentration levels than NO_2 goals. Based on the NO_2 monitoring data which are low compared to the goals, and consideration of the typical mix of ambient pollutant levels, the indication is that ambient levels of CO would similarly also be well below the air quality goals.

5 MODELLING SCENARIOS

The assessment considers three indicative mine plan years (Year 3, 9 and 14) chosen to represent a range of potential impacts over the life of the proposal by reference to the location of the operations and the potential to generate dust in each year.

Indicative mine plans for each of the respective years are presented in **Figure 5-1**.

The indicative Year 3 mine plan shows the Warkworth Mine continuing the general progression of the mine in a westerly direction. In this scenario, ROM extraction is occurring at both Warkworth Mine and MTO. Overburden material is emplaced to the east, behind the mine as it progresses. Some overburden material from Warkworth mine is transported and emplaced at MTO.

The indicative Year 9 mine plan shows mining continuing into the proposed extension area with large portions of the past overburden emplacement areas being rehabilitated. Mining at MTO is completed and overburden material from Warkworth Mine continues to be emplaced into the Loders Pit void. It is expected that Abbey Green North (AGN) will commence mining in 2018 or 2019 and be completed within approximately two years before becoming a tailings storage facility (TSF) as approved. For modelling purposes and to ensure a worst case scenario is captured the study has conservatively assumed that mining in AGN is still taking place in 2023, however in practice it is likely to be completed and being used as a TSF before 2023.

The indicative Year 14 mine plan shows mining reaching near to its westernmost extent in Warkworth Mine. The MTO area is almost completely rehabilitated with remaining activities consisting of the operation of the MTO CPP and the final void being used for tailings storage.

The air quality environment in the vicinity of Bulga village and for the assessment locations generally to the west and south west of the proposal is likely to improve beyond Year 14. This arises as the dust emissions from the other mines in the area show reductions in emissions and/ or move further away from the assessment locations.

The emissions reductions beyond year 14 occur as mining activity/ footprints reduce and also as some of the mines' consents expire. It should however be noted that all of the neighbouring mines were included in the modelling assessment for Year 14 (even those without a consent or known plans to operate at this time).

Dust emissions and impacts from the Bulga Coal Mine would progressively reduce at the majority of the receptors as the proposed operation moves to the east (away from assessment locations) and its emissions and footprint reduce over time.

During all indicative years extracted ROM coal is hauled to and processed at either the Warkworth Mine or MTO CPPs. Completed overburden emplacement areas are progressively rehabilitated commensurate with the mine progression.

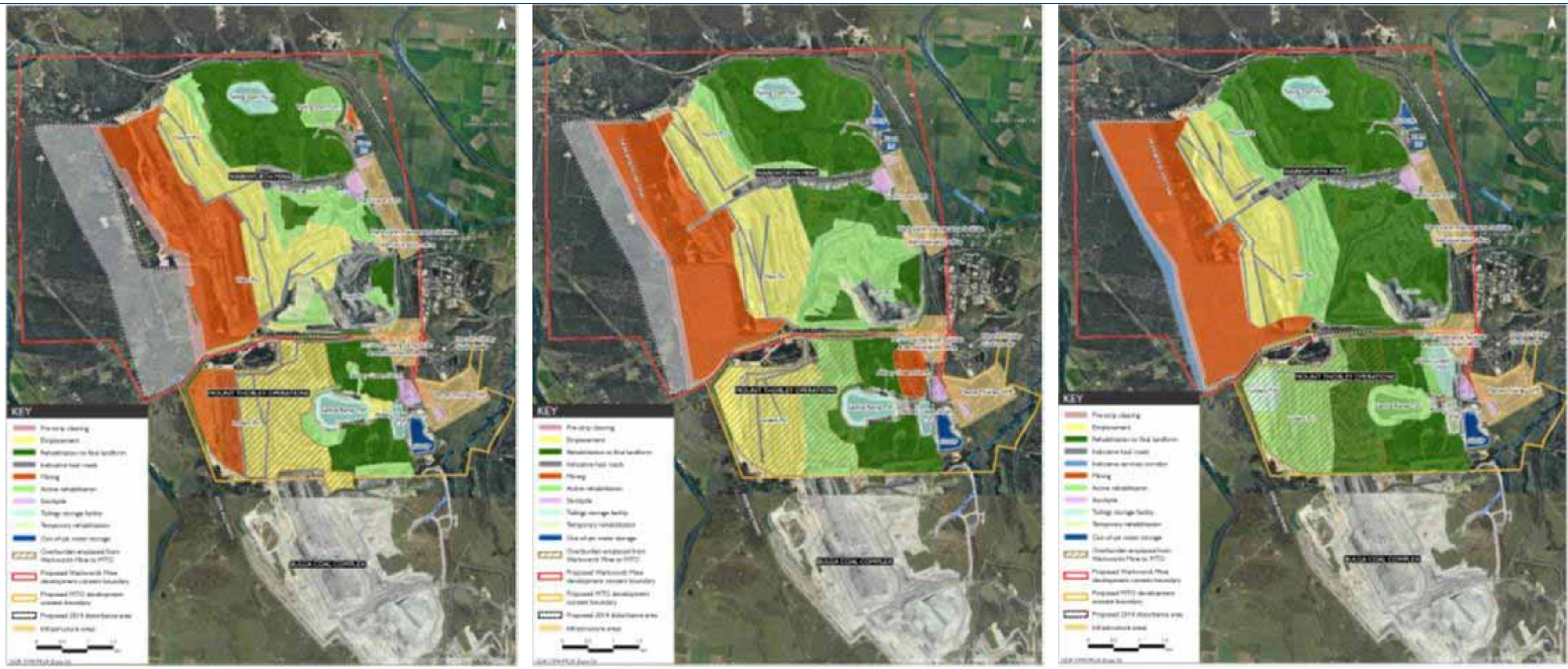

Figure 5-1: Indicative Year 3, 9 and 11 mine plans for the proposal

5.1 Emission estimation

5.1.1 The proposal

For each of the three indicative years selected to represent the key stages over the life of the proposal, the rate of dust emission has been calculated by analysing the various types of dust generating activities taking place in each year and applying suitable emission factors.

The emission factors applied are considered the most applicable and representative factor available for calculating the dust generation rates for the proposed activities. The emission factors were sourced mainly from studies supported by the US EPA and from Australian studies and site specific data where possible. Total dust emissions from all significant dust generating activities for the proposal are presented in **Table 5-1**. Detailed emission inventories and emission estimation calculations are presented in **Appendix C**.

The estimated dust emissions presented in **Table 5-1** reflect the application of best practice dust mitigation currently being implemented at MTW in accordance with its Air Quality Management Plan (AQMP) and Pollution Reduction Program (PRP) (refer to **Section 6**). The dust control measures are described in the following section.

Table 5-1: Estimated emission for the proposal (kg of TSP)

Activity	Year 3	Year 9	Year 14
OB - Dozers stripping topsoil	1,674	1,674	1,674
OB - Drilling	14,392	18,099	16,917
OB - Blasting	369,336	465,263	433,255
OB - Dragline	945,555	971,494	1,015,067
OB - Loading OB to haul truck	258,482	341,247	321,756
OB - Hauling to emplacement area at Warkworth Mine	2,038,306	2,676,598	4,020,000
OB - Hauling to emplacement area at MTO	253,513	567,891	-
OB - Emplacing at area	218,361	258,863	321,756
OB - Dozers in pit	838,446	1,061,405	1,061,405
OB - Dozers on dump and rehab	323,134	313,118	412,760
CL - Drilling	1,109	1,382	1,288
CL - Blasting	15,821	19,580	18,260
CL - Dozers ripping/pushing/clean-up	193,688	242,401	242,401
CL - Loading ROM coal to haul truck	805,789	996,671	1,000,304
CL - Hauling ROM to hopper - Warkworth CPP	279,696	364,457	354,311
CL - Hauling ROM to hopper - MTO CPP	47,731	112,681	175,462
CPP - Unloading ROM to hopper - Warkworth CPP	91,569	97,624	86,997
CPP - Rehandle ROM at hopper - Warkworth CPP	18,314	19,525	17,399
CPP - Dozer pushing ROM coal - Warkworth CPP	42,997	42,997	42,997
CPP - Dozer pushing Product coal - Warkworth CPP	13,593	13,593	13,593
CPP - Loading Product coal to stockpile - Warkworth CPP	890	948	845
CPP - Loading Product coal to train - Warkworth CPP	356	379	338
CPP - Loading rejects - Warkworth CPP	407	448	394
CPP - Hauling rejects - Warkworth CPP	39,165	43,138	39,240
CPP - Conveying to Redbank from Warkworth CPP	1,047	1,047	1,047
CPP - Conveying to train load out from Warkworth CPP	732	732	732
WE - Overburden emplacement areas – Warkworth Mine	837,000	910,984	805,161
WE - Open pit – Warkworth Mine	1,945,083	2,261,952	2,462,373
WE - ROM stockpiles – Warkworth Mine	34,269	34,269	34,269
WE - Product stockpiles – Warkworth Mine	14,839	14,839	14,839
Grading roads	110,784	110,784	110,784
Total	**9,756,076**	**11,966,083**	**13,027,625**

OB – overburden, CL – coal, CPP – coal preparation plant, WE – wind erosion

5.1.2 Other mining operations

In addition to the estimated dust emissions from the proposal, emissions from all nearby approved mining operations were also modelled, per their current consent (or current proposed project), to assess potential cumulative dust effects. Emissions estimates from these sources were derived from information provided in the air quality assessments available in the public domain at the time of modelling. These estimates are likely to be conservative, as in many cases, mines do not continually operate at the maximum extraction rates assessed in their respective environmental assessments. This is evident when examining Annual Reviews for coal mines in the Hunter Valley that typically show that the mines actual rate of activity is below the approved level of activity. **Table 5-2** summarises the emissions adopted in this assessment for each of the nearby mining operations.

Table 5-2: Estimated emissions from nearby mining operations (kg of TSP)

Mining operation	Year 3	Year 9	Year 14
MTO(1)	3,533,619	3,525,498	501,011
Bulga Coal Mine(2)	10,004,386	7,762,460	6,736,792
Wambo Coal Mine(3)	4,186,080	4,186,080	4,186,080
Hunter Valley Operations(4)	9,029,790	7,568,834	7,568,834
Rix's Creek Coal Mine(5)(6)	3,396,250	6,113,250	2,173,600

(1)Todoroski Air Sciences (2014)
(2)Pacific Environment Limited (2013)
(3)Holmes Air Sciences (2003)
(4)Holmes Air Sciences (2008)
(5) Holmes Air Sciences (1994)
(6)AECOM (2013)

It is noted that only a Preliminary Environmental Assessment (**AECOM, 2013**) has been lodged at this stage for the Rix's Creek Mine Continuation of Mining Project, and not a full environmental assessment. Estimates of the potential dust emissions included in the cumulative assessment have been made based on the indicative production rate of this project.

Further, it is noted that consents for some mining operations would expire at some stage during the proposal. However to assess potential worst case cumulative dust effects, it has been assumed that these operations would continue until the end of the proposal. This also adds considerable conservatism to the model predictions.

Emissions from nearby mining operations would contribute to the background level of dust in the area surrounding the proposal, and these emissions were explicitly included in the modelling assessment. Additionally, there would be numerous smaller or very distant sources that contribute to the total background dust level. Modelling these sources explicitly is impractical; however, the residual level of dust due to all other such non-modelled sources has been included in the cumulative results, and the method for doing this is discussed further in **Section 7**.

6 DUST MITIGATION AND MANAGEMENT

6.1 Dust management

Warkworth Mine and MTO have integrated their management of air quality and operate per an integrated MTW AQMP.

The possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of mine operation consistent with current best practice for the control of dust emissions from coal mines in NSW has been carefully considered in the implementation of such measures at MTW. The measures applied to MTW reflect those outlined in the recent NSW EPA document, "*NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*", prepared by Katestone Environmental (**Katestone, 2010**), and also imposed on mines in the current NSW EPA PRP's that relate to haul road emissions, and dust mitigation in response to adverse weather conditions.

Dust management practices are in place at Warkworth Mine that respond to government and community concerns regarding the impacts of mining on regional air quality in the Hunter Valley.

These measures include implementation of best practice management techniques to reduce dust, and staff guidance for the visual identification and hence control of dust. Other measures include alarms based on monitoring to manage potentially rising dust levels and to help prevent or reduce potential impacts. Operational measures such as enforcing a cessation of particular operations during periods of high dust provide additional assistance in reducing the potential dust impacts.

MTW utilises meteorological forecast data to guide the day to day planning of mining operations. These systems identify potentially adverse conditions that may arise over the coming day, giving MTW time to prepare in advance means to mitigate dust appropriately.

The NSW EPA has also placed a PRP on the Warkworth Mine Environment Protection Licence which requires identification and assessment of the practicality of implementing further best practice measures. The best practice controls currently implemented were considered in this assessment. Where applicable these controls have been applied in the dust emission estimates as shown in **Appendix C**.

The operation of dust mitigation and management measures commensurate with best practice is a key aspect of Warkworth Mine operations. An outline of such measures is set out in the air quality chapter in the main body of the EIS, and the overall approach is detailed in the air quality and greenhouse gas management plan. This is available on the company's website: http://www.riotintocoalaustralia.com.au/documents/MTW_Air_Quality_and_Greenhouse_Gas_Management_(Approved_31Jan2013).pdf. It should be noted that attainment of best practice requires ongoing improvement and thus the current best practice mitigation and dust management measures are likely to improve over time, as they are regularly reviewed and updated through the management plan framework.

6.2 Monitoring network

The MTW air quality monitoring network, is illustrated in **Figure 4-4**. The network of monitors surround the mine operation and are positioned in areas representative of the surrounding assessment locations.

This network is augmented by ambient air quality monitoring stations operated by the NSW EPA and provide an extensive network of stations from which to measure ambient air quality.

Air quality monitoring at MTW is supplemented with portable real-time PM_{10} monitoring and visual surveillance to support the reactive air quality management system. The monitors are portable to enable relocation as mining and seasonal conditions change. These monitors are aimed for use as a warning tool for mine operations and provide advance warning of degrading air quality which serves to prompt appropriate actions. Visual surveillance monitoring is also used in the network to assist with identification of problem dust sources, informing a management response and verifying the effectiveness of controls implemented.

7 DISPERSION MODELLING APPROACH

7.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach.

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The CALPUFF model is an advanced "puff" model that can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a 3D, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document "*Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia*" (**TRC**, **2011**).

7.2 Modelling methodology

Modelling was undertaken using a combination of the CALPUFF Modelling System and TAPM. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for 3D simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three-dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the 3D meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

7.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a 3D upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 32deg38min south and 151deg5min east. The simulation involved four nesting grids of 30km, 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the 3D wind field from the coarser grid outer domain is used as the initial (or starting) field for the finer grid inner domains. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative 3D wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality, also the coarse scale wind flow fields give a better set of starting conditions with which to operate the finer grid run.

The CALMET initial domain was run on a 150 x 150km grid with a 3km grid resolution and refined for a second domain on a 50 x 50km grid with a 1km grid resolution and further refined for a final domain on a 30 x 30km grid with a 0.3km grid resolution.

The available meteorological data for January 2012 to December 2012 from ten nearby meteorological monitoring sites were included in the simulation. The 2012 calendar year was chosen as a representative meteorological year based on a long-term meteorological analysis.

Table 7-1 outlines the parameters used from each station. The 3D upper air data was sourced from TAPM output. Further detail regarding input variables are presented in **Appendix D**.

Table 7-1: Surface observation stations

Weather station	Parameters
Charlton Ridge Weather Station	Wind speed, wind direction, temperature, humidity.
Cheshunt Weather Station	Wind speed, wind direction, temperature, humidity.
HVO Corp Weather Station	Wind speed, wind direction, temperature, humidity.
Cessnock Airport Automatic Weather Station (BoM) (Station No. 061260)	Wind speed, wind direction, temperature, humidity, sea level pressure.
Merriwa (Roscommon) Weather Station (BoM) (Station No, 061287)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Murrurundi Gap Automatic Weather Station (BoM) (Station No. 061392)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Paterson (Tocal) Automatic Weather Station (BoM) (Station No. 061250)	Wind speed, wind direction, temperature, humidity.
Scone Airport Automatic Weather Station (BoM) (Station No. 061363)	Wind speed, wind direction, temperature, humidity, sea level pressure.
Williamtown RAAF (BoM) (Station No. 061078)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Nullo Mountain Automatic Weather Station (BoM) (Station No. 062100)	Wind speed, wind direction, temperature, humidity.

Local land use and detailed topographical information including local mine topography was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 7-1**.

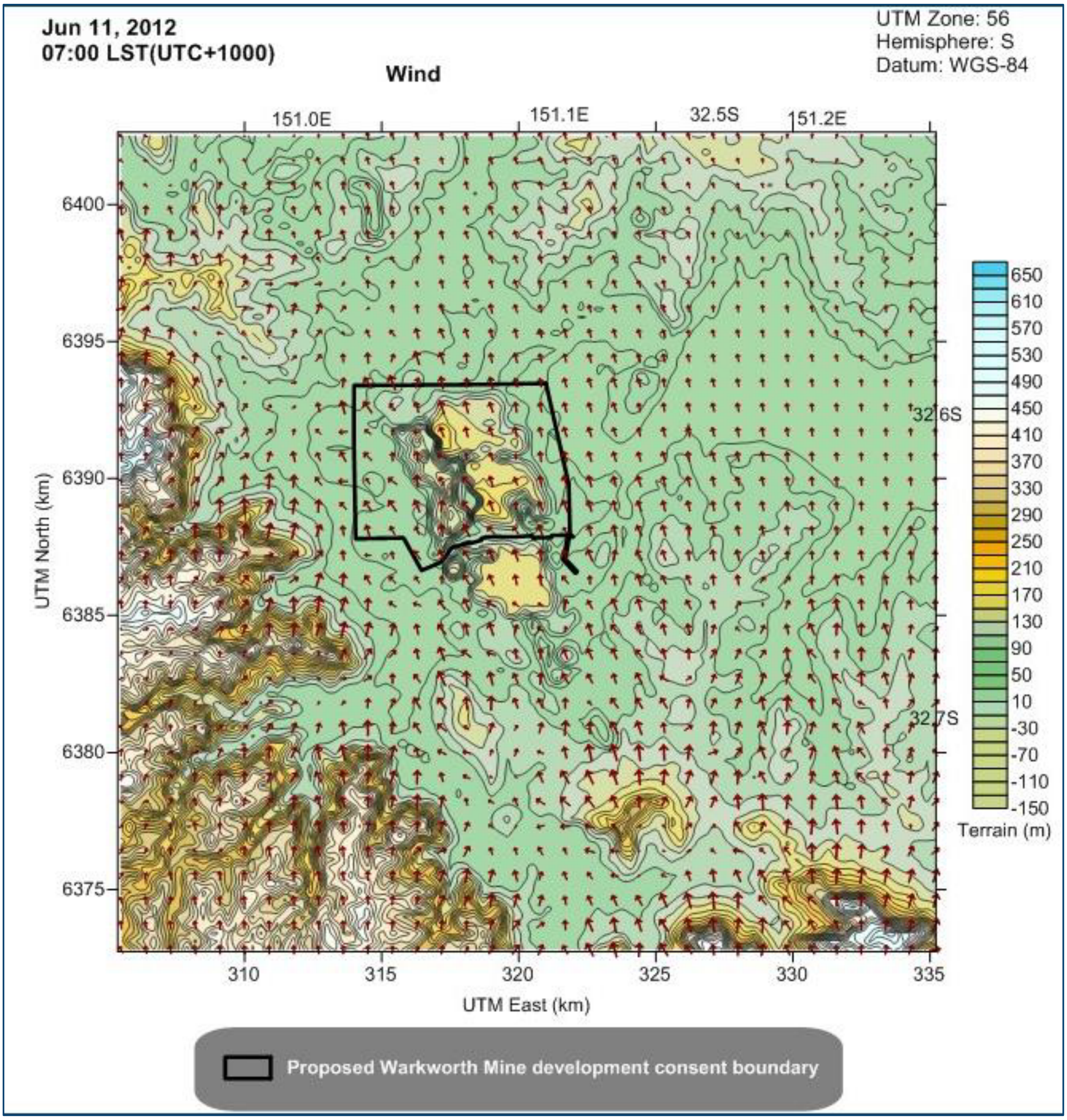

Figure 7-1: Representative snapshot of wind field for the proposal

CALMET generated meteorological data was extracted from a central point within the CALMET domain and is graphically represented in **Figure 7-2** and **Figure 7-3**.

Figure 7-2 presents annual and seasonal windroses extracted from one central point in the CALMET domain. On an annual basis, winds from the south-southeast are most frequent. During summer, winds from the south-southeast dominate the distribution with a spread of winds from the southeast quadrant. The autumn wind distribution shows the majority of winds originating from the south-southeast and south with some winds from the northwest. In winter, winds from the northwest are the most predominant. In spring, the wind distribution is more varied compared to the other seasons with winds from the northwest and southeast quadrants.

Overall the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. This is evident as the windroses based on the CALMET data also compare well with the windroses generated with the measured data, as presented in **Figure 4-3**.

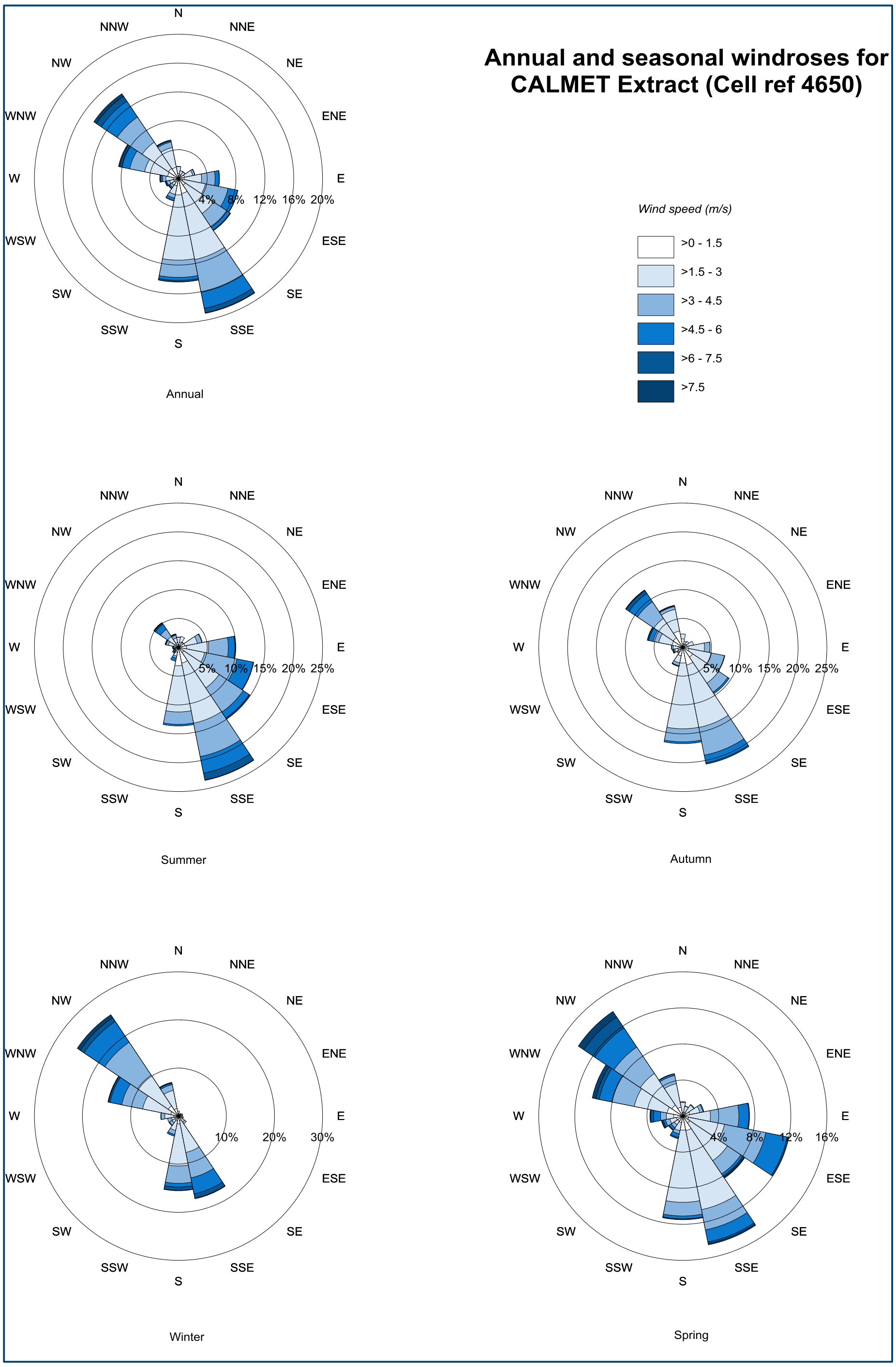

Figure 7-2: Windroses from CALMET extract (Cell ref 4650)

Figure 7-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

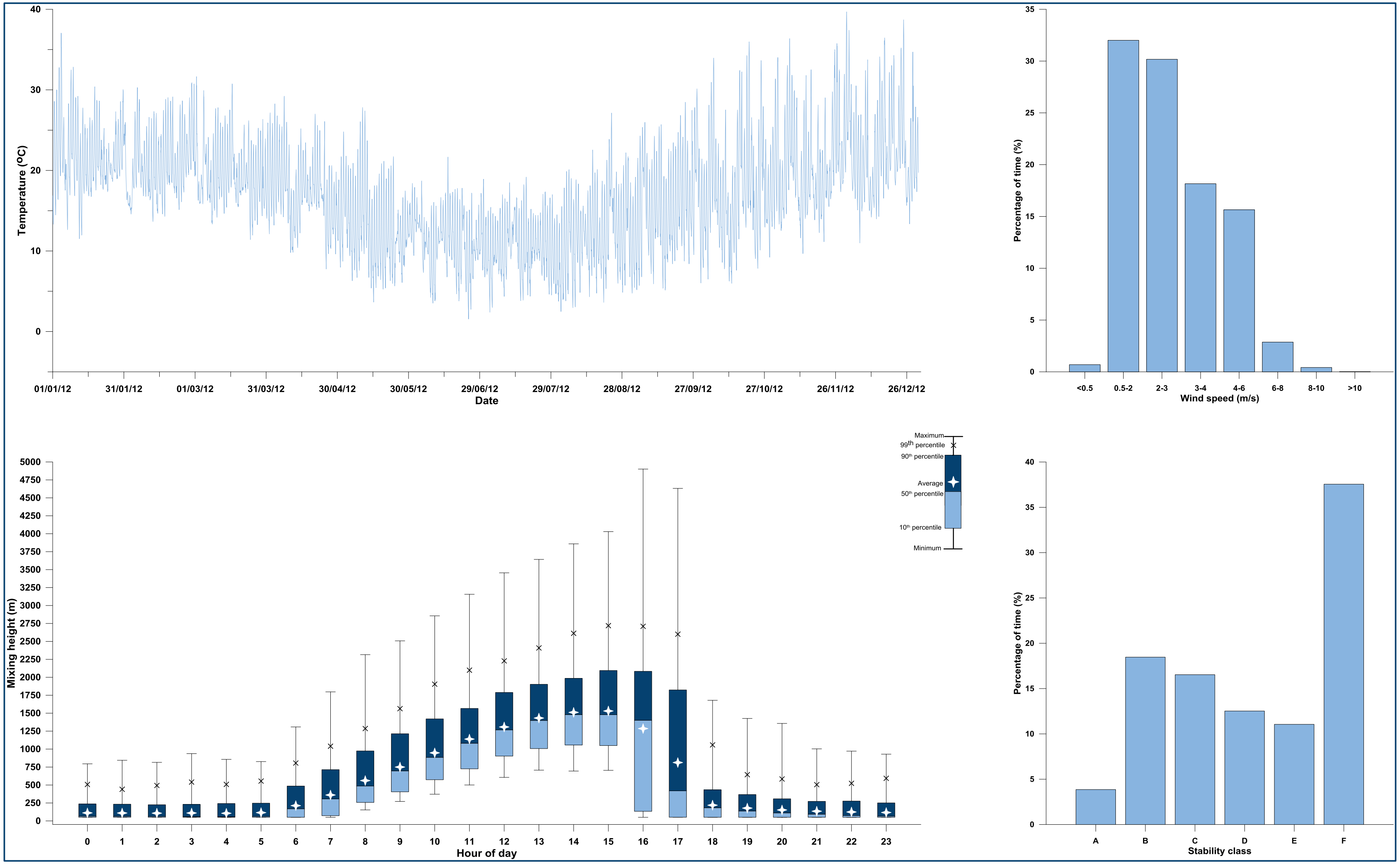

Figure 7-3: Meteorological analysis of CALMET extract (Cell ref 4650)

7.2.2 Dispersion modelling

CALPUFF modelling is based on the application of three particle size categories fine particulates, coarse matter and rest. The distribution of particles for each particle size category was derived from measurements in the **SPCC (1986)** study and is presented in **Table 7-2**.

Emissions from each activity in **Table 5-1** were represented by a series of volume sources and included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source. It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

Table 7-2: Distribution of particles

Particle category	Size range	Distribution [1]
Fine particulates	0 to 2.5 µm	4.68% of TSP
Coarse matter	2.5 to 10 µm	34.4% of TSP
Rest	10 to 30 µm	60.92% of TSP

[1] Particle distribution sourced from **SPCC (1986)**

Each particle-size category is modelled separately and later combined to predict short term and long term average concentrations for $PM_{2.5}$, PM_{10}, and TSP. Dust deposition was predicted using the proven dry deposition algorithm within the CALPUFF model. Particle deposition is expressed in terms of atmospheric resistance through the surface layer, deposition layer resistance and gravitational settling (**Slinn and Slinn, 1980** and **Pleim et al., 1984**). Gravitational settling is a function of the particle size and density, simulated for spheres by the Stokes equation (**Gregory, 1973**).

CALPUFF is capable of tracking the mass balance of particles emitted into the modelling domain. For each hour CALPUFF tracks the mass emitted, the amount deposited, the amounts remaining in the surface mixed layer or the air above the mixed layer, and the amount advected out of the modelling domain. The versatility to address both dispersion and deposition algorithms in CALPUFF, combined with the 3D meteorological and land use field generally result in a more accurate model prediction compared to other Gaussian plume models (**Pfender et al 2006**).

8 ACCOUNTING FOR BACKGROUND DUST LEVELS

Other significant dust generating sources surrounding the proposal were explicitly included in the model, including MTO, Bulga, Wambo, Hunter Valley Operations and Rix's Creek coal mines. These mining operations are the nearest significant operations and variously contribute to particulate matter concentrations near the proposal. **Section 5** outlines how dust emissions from these sources have been accounted for in the modelling to assess cumulative effects.

Other dust generating activities in the surrounding area would also contribute to existing dust levels and an allowance for this contribution as well as contributions from other non-modelled dust sources is included in the assessment.

The contribution to the prevailing background dust levels of other non-modelled dust sources was estimated by modelling the past (known) mining activities (including MTO, Bulga, Wambo, Hunter Valley Operations and Rix's Creek coal mines) during January 2012 to December 2012 and comparing model predictions with the actual measured data from the corresponding monitoring stations. The average difference between the measured and predicted PM_{10}, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources, and was added to the future predicted values to account for the background dust levels (not already in the model and due to the numerous non-modelled dust sources).

This approach is preferable to modelling the proposal alone and adding a single constant background level at all points across the modelling domain to estimate cumulative impacts. This is because the approach includes modelling of other major sources (ie mines) that more reliably represent the higher dust levels near such sources, and also accounts for the seasonal and time varying changes in the background levels that arise from these major dust sources. In addition, to account for any underestimation from not including every source (as it's not possible to do that reasonably), the relatively smaller contribution arising from the other non-modelled dust sources, as determined above, was added to the results to obtain the most accurate predictions of future cumulative impacts across the modelled domain.

Using the approach described above, the estimated annual average contribution from other non-modelled dust sources in the surrounding area was found to be:

- PM_{10} – 6.9µg/m^3;
- TSP – 23.1µg/m^3; and,
- Deposited dust – 1.7g/m^2/month.

It is important that the above values are not confused with measured background levels, background levels excluding only the proposal, or the change in existing levels as a result of the proposal. The values above are not background levels in that sense, but are the residual, small amount of the background dust that is not accounted for directly in the air dispersion modelling.

To account for background levels when assessing total (cumulative) 24-hour average PM_{10} impacts, the mine only incremental levels are added to the total measured ambient dust levels (per the NSW EPA contemporaneous assessment guidance). Further details regarding the total cumulative 24-hour average PM_{10} impacts are provided in **Section 8.5**.

Predicted incremental (proposal alone) and total (cumulative) concentrations and dust deposition levels for short and long term averaging periods are presented in tabular format as well as contour plots in the following section of this report.

9 DISPERSION MODELLING RESULTS

The dispersion model predictions for each of the indicative mine plan years are presented in this section. The results show the estimated maximum 24-hour average and annual average $PM_{2.5}$ concentrations, maximum 24-hour and annual average PM_{10} concentrations, annual average TSP concentrations and annual average dust (insoluble solids) deposition (DD) rates for the proposal operating in isolation (the incremental impact) and with other sources (the total (cumulative) impact).

It is important to note that when assessing impacts for a maximum 24-hour average PM_{10} concentration; the predictions show the highest modelled predicted 24-hour average PM_{10} concentrations that occur at each point within the modelling domain for the worst day (a 24-hour period) over the one year modelling period. When assessing the total (cumulative) 24-hour average PM_{10} impacts based on model predictions, challenges arise as the predicted impacts are often overestimated by the model's inability to consider spatial and temporal variability in reality. Furthermore, the difficulties associated with identification and quantification of emissions from non-modelled sources over the 24-hour period result in additional complications. The potential 24-hour average PM_{10} impacts need to be calculated differently to annual average impacts and therefore the predicted total (cumulative) impacts for maximum 24-hour average PM_{10} concentrations have been addressed specifically in **Section 8.5**.

Each of the potential assessment locations shown in **Figure 2-1** and listed in **Appendix A** were assessed individually as discrete receptors with the predicted results presented in tabular form for each of the indicative mine plan years.

For sources not explicitly included in the model, and to fully account for all cumulative dust levels, the unaccounted fractions of background dust levels (which arise from the other non-modelled sources) as described in **Section 7**, were added to the model predictions with the results presented in the following sections for each of the indicative mine plan years.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix E**.

9.1 Year 3 results

Table 9-1 presents the model predictions at each of the assessment locations. The values presented in bold indicate predicted values above the relevant criteria. The assessment locations highlighted in grey are identified as mine-owned assessment locations, and those highlighted in orange are privately-owned assessment locations already in the acquisition zone for other mine operations.

Figure E-1 to **Figure E-9** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in Year 3.

Table 9-1: Modelling predictions for Year 3 of the proposal

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
1	1	0	5	0	1	0.01	10	28	1.80
2	1	0	5	0	1	0.01	10	29	1.81
3	1	0	5	0	1	0.01	10	29	1.83
4	1	0	5	0	1	0.01	10	29	1.83
5	1	0	5	0	1	0.01	10	29	1.83
6	1	0	5	0	1	0.01	10	29	1.83
7	1	0	5	0	1	0.01	10	29	1.84
8	1	0	5	0	1	0.01	11	29	1.86
9	1	0	5	0	1	0.01	10	29	1.86
10	1	0	6	1	1	0.02	11	30	1.85
11**	2	0	14	2	4	0.13	14	36	2.03
12	1	0	7	1	1	0.01	11	31	1.92
13	1	0	7	1	1	0.02	12	31	1.89
14	2	0	8	1	1	0.01	12	31	1.94
15	2	0	8	1	1	0.01	12	31	1.95
16	2	0	8	1	1	0.02	12	32	1.92
17	2	0	9	1	2	0.03	12	32	1.92
18	2	0	8	1	1	0.01	12	32	1.96
19	2	0	9	1	2	0.03	12	33	1.93
20	2	0	8	1	1	0.01	12	32	1.97
21	2	0	8	1	1	0.02	12	33	1.94
22	1	0	8	1	1	0.01	12	32	1.97
23	1	0	7	1	1	0.01	12	32	1.95
24	2	0	9	1	2	0.03	13	33	1.95
25	2	0	13	2	3	0.07	14	34	1.98
26	1	0	8	1	1	0.01	12	32	1.98
27	2	0	11	1	2	0.05	13	33	1.96
28	1	0	7	0	1	0.01	11	31	1.91
29	2	0	11	1	2	0.05	13	34	1.96
30	2	0	11	1	1	0.02	13	33	1.97
31	2	0	10	1	1	0.02	13	34	1.97
32	2	0	10	1	2	0.03	13	34	1.96
33	2	0	10	1	1	0.02	13	33	1.99
34	2	0	13	2	3	0.07	14	34	1.99
35	2	0	11	1	1	0.02	13	34	1.98
36	1	0	8	1	1	0.01	12	33	1.98
37	2	0	11	1	2	0.04	13	34	1.97
38	1	0	8	1	1	0.02	13	33	1.99
39	1	0	9	1	1	0.02	13	33	1.99
40	2	0	9	1	1	0.02	13	34	2.00
41	1	0	7	0	1	0.01	11	31	1.91
42	2	0	11	1	2	0.03	14	35	1.99
43	1	0	8	1	1	0.02	13	33	2.00

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
44	1	0	8	1	1	0.02	13	34	2.00
45	1	0	8	1	1	0.01	12	32	1.97
46	1	0	9	1	1	0.02	13	34	2.01
47	1	0	9	1	1	0.02	13	34	2.01
48	2	0	9	1	1	0.02	14	35	2.02
49	2	0	9	1	1	0.02	13	34	2.01
50	1	0	9	1	1	0.02	13	34	2.01
51	3	0	19	3	5	0.12	16	39	2.10
52	1	0	8	1	1	0.01	13	33	1.99
53	2	0	9	1	1	0.02	13	34	2.01
54	1	0	7	0	1	0.01	11	31	1.90
55	2	0	9	1	1	0.02	14	35	2.03
56	2	0	9	1	1	0.02	13	34	2.01
57	2	0	9	1	1	0.02	13	35	2.02
58	2	0	10	1	1	0.02	14	36	2.03
59	2	0	9	1	1	0.02	14	35	2.02
60	2	0	9	1	1	0.02	14	35	2.02
61	1	0	7	0	1	0.01	11	31	1.90
62	2	0	9	1	1	0.02	14	35	2.03
63	2	0	10	1	1	0.02	14	36	2.04
64	2	0	10	1	1	0.02	14	36	2.04
65	2	0	10	1	1	0.02	14	36	2.04
66	2	0	10	1	1	0.02	14	35	2.03
67	1	0	5	0	1	0.01	10	28	1.81
68	2	0	10	1	1	0.02	14	36	2.05
69	2	0	10	1	1	0.02	14	35	2.04
70	1	0	5	0	1	0.01	10	28	1.81
71	2	0	10	1	1	0.02	14	36	2.04
72	2	0	10	1	1	0.02	14	36	2.04
73	2	0	9	1	1	0.02	14	35	2.02
74	1	0	7	0	1	0.01	12	31	1.91
75	2	0	10	1	1	0.02	14	36	2.04
76	1	0	8	1	1	0.01	12	33	1.97
77	4	1	32	8	14	0.56	**32**	69	2.93
78	5	1	44	8	15	0.92	**32**	70	3.43
79**	4	1	31	8	14	0.54	**32**	68	2.90
80	1	0	5	0	1	0.01	11	29	1.84
81	2	0	14	1	2	0.04	17	41	2.14
82	1	0	8	1	1	0.01	12	32	1.94
83**	4	1	31	8	14	0.50	**32**	68	2.87
84	1	0	6	0	1	0.01	11	30	1.86
86	2	0	10	1	1	0.02	15	36	2.05
87	2	0	14	1	2	0.03	17	42	2.17
89	1	0	6	0	1	0.01	11	30	1.86

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
90	4	1	32	8	15	0.54	30	65	2.90
91**	4	1	34	9	16	0.59	30	65	2.93
92**	1	0	6	0	1	0.01	11	31	1.88
93	5	1	37	9	18	0.74	30	65	3.06
94**	4	1	34	9	16	0.58	30	64	2.93
95	2	0	11	1	1	0.02	16	39	2.11
96**	4	1	36	10	18	0.71	30	65	3.04
97	3	0	18	1	2	0.03	19	45	2.25
98	3	0	16	1	2	0.03	19	45	2.25
99**	5	1	39	11	21	0.90	30	66	3.22
100	3	0	21	2	3	0.05	19	45	2.21
101	3	0	20	2	3	0.04	20	46	2.28
102	5	1	41	12	22	0.97	**31**	66	3.29
103**	1	0	8	1	1	0.02	14	35	2.00
104	3	0	20	2	3	0.04	22	49	2.38
105	8	1	**58**	10	20	0.67	30	65	3.07
106	4	0	26	2	4	0.05	23	52	2.45
107	3	0	22	2	3	0.04	25	56	2.59
108	4	0	34	3	6	0.09	26	57	2.60
109**	21	6	**162**	44	84	**3.01**	**61**	**125**	**5.29**
110	4	0	27	2	4	0.06	28	63	2.73
111	1	0	7	0	1	0.01	10	28	1.83
112	5	0	37	3	5	0.08	**37**	79	3.16
113**	2	0	8	1	1	0.01	11	31	1.95
114	8	1	**64**	5	9	0.25	26	55	2.79
115**	2	0	12	1	1	0.02	19	45	2.45
116	4	1	29	4	8	0.18	21	47	2.41
117	2	0	16	3	5	0.11	20	46	2.57
118	3	0	21	3	5	0.12	20	46	2.52
118	3	0	21	3	5	0.12	20	46	2.52
119	3	1	24	4	7	0.16	20	45	2.40
120	2	0	18	3	4	0.09	18	41	2.37
121	3	0	20	3	5	0.09	18	42	2.41
122	2	0	18	2	4	0.08	17	40	2.33
123	3	0	21	3	4	0.09	18	41	2.36
124	2	0	19	2	4	0.08	17	40	2.31
125	3	1	24	6	10	0.19	20	46	2.29
126	5	1	37	10	18	0.28	24	53	2.35
127	2	0	19	3	5	0.07	17	39	2.13
128	4	1	33	6	11	0.18	21	46	2.25
129	4	1	31	5	8	0.14	19	43	2.19
130	4	1	29	4	7	0.12	18	41	2.17
131	5	1	42	10	17	0.32	24	52	2.35
133	3	0	21	3	4	0.07	15	37	2.07

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
134	3	0	28	4	6	0.11	17	40	2.14
135	6	1	44	11	20	0.52	27	58	2.61
136	6	1	42	10	19	0.50	26	57	2.58
137	3	0	26	3	6	0.10	17	39	2.11
138	5	1	40	10	19	0.45	25	56	2.51
139	3	0	26	4	6	0.11	17	40	2.13
140	5	1	39	9	17	0.45	25	55	2.54
141	3	0	20	2	4	0.06	15	36	2.02
142	3	0	25	3	5	0.09	16	38	2.10
143	3	0	23	3	5	0.08	16	38	2.08
144	4	1	29	6	10	0.31	22	49	2.39
145**	6	1	47	6	10	0.31	**36**	76	3.08
146	4	1	28	5	10	0.29	21	48	2.36
147	2	0	17	3	5	0.10	16	38	2.08
148	4	1	24	4	8	0.23	20	45	2.27
149	3	1	22	4	8	0.24	20	45	2.30
150	3	1	23	4	7	0.20	19	43	2.21
151**	4	1	31	5	10	0.33	24	53	2.53
152	2	0	16	2	4	0.08	15	37	2.05
153	3	1	21	4	7	0.20	18	42	2.21
154**	3	1	22	4	7	0.19	18	42	2.19
155	2	0	15	2	3	0.07	15	35	2.02
156	2	0	15	2	3	0.07	14	35	2.01
157	2	0	14	2	3	0.06	14	35	2.00
158	5	0	34	3	5	0.14	27	58	3.59
160	2	0	14	2	4	0.08	18	42	2.47
161	2	0	12	2	4	0.08	17	40	2.32
162	2	0	12	2	4	0.08	17	40	2.34
163	2	0	12	2	3	0.07	17	39	2.24
165	3	1	28	4	7	0.17	21	46	2.42
167	2	0	17	2	3	0.05	14	34	1.98
168	2	0	16	2	3	0.05	14	34	1.97
169	3	0	20	2	4	0.06	15	36	2.02
170	2	0	18	2	3	0.06	14	35	1.99
172	3	0	22	3	4	0.08	15	37	2.06
173	3	0	20	3	4	0.07	15	36	2.05
174	2	0	17	2	3	0.06	14	35	2.01
175	2	0	17	2	3	0.06	14	35	2.00
176	2	0	16	2	3	0.06	14	34	1.98
177	2	0	15	2	3	0.05	14	34	1.97
178	2	0	13	1	2	0.05	13	33	1.95
179	2	0	14	1	2	0.05	13	33	1.94
180	2	0	13	2	3	0.06	14	35	2.00
181	2	0	14	2	3	0.07	15	36	2.02

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
182	2	0	13	2	3	0.07	14	35	2.00
183	2	0	14	2	3	0.08	15	36	2.03
184	2	0	12	2	3	0.07	14	35	2.01
185	2	0	12	2	3	0.08	14	35	2.02
186	2	0	13	2	3	0.08	15	36	2.03
187	2	0	12	2	3	0.08	15	36	2.03
188	2	0	16	2	4	0.09	15	36	2.02
189**	3	0	19	3	6	0.15	17	40	2.12
190	3	1	23	4	7	0.20	19	43	2.21
191	2	0	13	2	4	0.09	15	37	2.05
192	2	0	14	3	5	0.10	16	38	2.07
193	1	0	4	0	0	0.01	8	25	1.74
194**	1	0	6	0	1	0.01	9	26	1.77
195**	1	0	7	0	1	0.01	9	27	1.79
196**	1	0	7	0	1	0.01	9	27	1.77
197	1	0	6	0	1	0.01	9	26	1.76
198**	1	0	5	0	0	0.01	8	26	1.75
199	1	0	3	0	0	0.01	8	24	1.72
200	1	0	3	0	0	0.01	8	25	1.73
201	1	0	4	0	0	0.01	8	25	1.73
202	1	0	4	0	0	0.01	8	25	1.73
203	1	0	4	0	0	0.01	8	25	1.73
204	1	0	4	0	0	0.01	8	25	1.73
205	1	0	4	0	0	0.01	8	25	1.73
206	1	0	4	0	0	0.01	8	25	1.73
207	1	0	4	0	0	0.01	8	25	1.73
208	1	0	4	0	0	0.01	8	25	1.74
209**	3	0	21	3	5	0.15	**32**	68	2.84
210	2	0	10	1	1	0.02	14	35	2.03
211	2	0	10	1	1	0.02	14	36	2.05
215	2	0	11	1	1	0.02	13	34	1.98
217	1	0	6	1	1	0.01	11	30	1.89
218	1	0	6	1	1	0.01	10	29	1.82
219	1	0	5	0	1	0.01	10	29	1.81
220	1	0	5	0	1	0.01	10	29	1.83
221	1	0	5	0	1	0.01	10	28	1.80
222	1	0	5	0	1	0.01	10	28	1.81
223	1	0	5	0	1	0.01	10	28	1.83
224	1	0	5	0	1	0.01	10	29	1.84
225	1	0	6	0	1	0.01	11	30	1.89
226	1	0	6	0	1	0.01	11	30	1.91
227	1	0	6	0	1	0.01	11	30	1.91
228	1	0	6	0	1	0.01	11	30	1.92
229	1	0	7	1	1	0.01	11	31	1.94

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
230	1	0	6	0	1	0.01	11	31	1.93
231	1	0	7	1	1	0.01	12	31	1.94
234	1	0	7	0	1	0.01	11	30	1.88
235	1	0	6	0	1	0.01	11	30	1.87
236	1	0	7	0	1	0.01	12	31	1.91
237	1	0	6	0	1	0.01	11	30	1.86
238	1	0	6	0	1	0.01	11	30	1.87
243	1	0	5	0	1	0.01	10	29	1.83
244	2	0	18	2	4	0.07	16	38	2.19
245	2	0	16	2	4	0.07	16	38	2.19
246	2	0	17	2	3	0.07	16	38	2.14
247	2	0	17	2	3	0.06	16	38	2.13
248	2	0	16	2	3	0.06	14	34	1.99
249	2	0	14	2	3	0.05	14	34	1.96
250	1	0	11	1	2	0.04	13	33	1.93
251	2	0	12	1	2	0.04	13	32	1.92
252	1	0	7	1	1	0.01	12	32	1.93
253	1	0	7	1	1	0.01	12	31	1.95
254	1	0	7	0	1	0.01	11	31	1.90
255	2	0	9	1	1	0.02	12	33	1.93
256	2	0	13	2	3	0.07	16	38	2.21
257	2	0	17	2	4	0.07	16	38	2.16
258	2	0	12	2	3	0.07	17	39	2.24
259	3	0	23	3	6	0.12	20	45	2.50
260	2	0	12	2	4	0.08	17	40	2.34
261	2	0	13	2	4	0.08	18	41	2.42
262	5	1	36	10	17	0.26	24	52	2.34
263	2	0	13	2	4	0.09	15	37	2.05
264	6	2	44	12	23	1.11	**31**	67	3.44
265	2	0	16	3	5	0.11	20	46	2.56
266	2	0	10	1	2	0.06	10	29	1.88
267	1	0	8	1	1	0.03	10	28	1.83
268	1	0	6	1	1	0.03	9	27	1.80
269**	3	0	18	2	3	0.11	13	32	1.97
270**	2	0	15	3	5	0.15	15	37	2.05
271**	2	0	15	3	6	0.16	**44**	88	3.00
903	1	0	5	0	1	0.01	10	29	1.82
904	1	0	4	0	0	0.01	9	27	1.77
905	1	0	3	0	0	0.01	9	26	1.75
909	1	0	5	0	1	0.01	10	28	1.80
911	1	0	4	0	0	0.01	9	26	1.76
915	4	1	30	6	11	0.34	22	50	2.42
917	1	0	5	0	1	0.01	10	28	1.80
918	1	0	5	0	1	0.01	10	28	1.81

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
919	1	0	8	1	1	0.01	12	32	1.96
920	2	0	9	1	1	0.02	14	35	2.03
921	1	0	7	0	1	0.01	11	30	1.90
922	1	0	6	0	1	0.01	10	29	1.85
923	1	0	4	0	0	0.01	8	25	1.74
926	1	0	4	0	0	0.01	8	26	1.75
927a	1	0	4	0	0	0.01	9	27	1.77
927b	1	0	4	0	0	0.01	9	27	1.77
927c	1	0	4	0	1	0.01	9	27	1.78
927d	1	0	4	0	0	0.01	8	26	1.75
927e	1	0	4	0	0	0.01	9	26	1.75
927f	1	0	4	0	0	0.01	9	26	1.75
927g	1	0	3	0	0	0.01	8	25	1.73
927h	1	0	3	0	0	0.01	8	25	1.74
927i	1	0	3	0	0	0.01	8	25	1.74
927j	1	0	3	0	0	0.01	8	25	1.74
928	1	0	4	0	1	0.01	9	27	1.78
929	1	0	5	0	1	0.01	10	28	1.80
932	2	0	16	3	5	0.12	15	36	2.02
936	1	0	5	0	1	0.01	9	27	1.79
937a	3	0	20	2	4	0.08	15	37	2.05
937b	2	0	19	2	4	0.07	15	36	2.03
937c	2	0	17	2	3	0.06	14	35	2.01
937d	2	0	15	2	4	0.08	15	36	2.03
937e	2	0	15	2	4	0.07	15	36	2.03
941**	5	1	41	12	22	0.97	**31**	66	3.30

*Advisory NEPM reporting standard applicable to the population as a whole

**Other mine owned property

9.1.1 Predicted maximum 24-hour and annual average $PM_{2.5}$ concentrations

Figure E-1 and **Figure E-2** show the predicted maximum 24-hour average and annual average $PM_{2.5}$ concentrations for Year 3 due to emissions from the proposal. The results in **Table 9-1** indicate that all assessment locations are predicted to experience a maximum 24-hour average and annual average concentration below the advisory reporting standards of 25µg/m³ and 8µg/m³, respectively in Year 3.

9.1.2 Predicted maximum 24-hour and annual average PM_{10} concentrations

Figure E-3 shows the predicted maximum 24-hour average PM_{10} concentrations for Year 3 due to emissions from the proposal. The results in **Table 9-1** indicate that assessment locations 105, 109 and 114 are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m³ in Year 3. All of these assessment locations are mine owned properties.

An analysis of the number of days that the P&I acquisition criterion of 50µg/m^3 would be exceeded at these assessment locations is presented in **Table 9-2**. The analysis indicates that assessment location 109 would experience levels systemically above the criterion (eg on more than five days).

Table 9-2: Analysis of Year 3 – maximum 24-hour average PM_{10} concentrations

Assessment location ID	Number of days over 50µg/m^3
105	2
109*	**153**
114	1

*Other mine owned property

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 8.5**.

Figure E-4 shows the predicted annual average PM_{10} concentrations for Year 3 due to emissions from the proposal. **Figure E-5** shows the predicted total impact from the proposal and other sources. The results in **Table 9-1** indicate that assessment locations 77, 78, 79, 83, 102, 109, 112, 145, 209, 264, 271 and 941 are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 in Year 3.

It is noted that assessment locations 209 and 271 are largely unaffected by activity from the proposal. These locations would be influenced by other dust sources in the area as indicated by the low incremental predictions due to the proposal in **Table 9-1**.

9.1.3 Predicted annual average TSP concentrations

Figure E-6 shows the predicted annual average TSP concentrations for Year 3 due to emissions from the proposal. **Figure E-7** shows the predicted total impact from the proposal and other sources. The results in **Table 9-1** indicate that all assessment locations are predicted to experience annual average TSP concentrations below the relevant criterion of 90µg/m^3 in Year 3, with the exception of assessment location 109.

9.1.4 Predicted annual average dust deposition levels

Figure E-8 shows the predicted annual average dust deposition levels for Year 3 due to emissions from the proposal. **Figure E-9** shows the predicted total impact from the proposal and other sources.

The results in **Table 9-1** indicate that all of the assessment locations with the exception of assessment location 109 are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month in Year 3. All of the assessment locations with the exception of assessment location 109 are predicted to experience total annual average dust deposition levels below the relevant criterion of 4g/m^2/month in Year 3 from the proposal and other sources.

9.2 Year 9 results

Table 9-3 presents the model predictions at each of the assessment locations, the values presented in bold indicate predicted values above the relevant criteria. The assessment locations highlighted in grey are identified as mine-owned assessment locations, and those highlighted in orange are privately-owned assessment locations already in the acquisition zone for other mine operations.

Figure E-10 to **Figure E-18** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in Year 9.

Table 9-3: Modelling predictions for Year 9 of the proposal

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
1	1	0	7	1	1	0.02	10	28	1.79
2	1	0	7	1	1	0.02	10	28	1.79
3	2	0	7	1	1	0.02	10	28	1.81
4	2	0	7	1	1	0.02	10	28	1.81
5	2	0	7	1	1	0.02	10	28	1.81
6	2	0	8	1	1	0.02	10	28	1.81
7	2	0	7	1	1	0.02	10	28	1.81
8	2	0	8	1	1	0.02	10	29	1.83
9	2	0	8	1	1	0.02	10	28	1.83
10	2	0	8	1	2	0.03	11	29	1.83
11**	3	1	21	4	7	0.20	15	37	2.06
12	2	0	11	1	1	0.02	11	30	1.88
13	2	0	10	1	2	0.04	11	31	1.87
14	2	0	12	1	1	0.02	11	30	1.89
15	2	0	11	1	1	0.02	11	30	1.90
16	3	0	14	1	2	0.04	12	31	1.89
17	2	0	11	2	3	0.06	12	32	1.91
18	2	0	11	1	1	0.02	11	30	1.91
19	2	0	13	2	3	0.07	12	33	1.92
20	2	0	11	1	1	0.02	11	31	1.92
21	3	0	15	1	2	0.04	12	32	1.91
22	2	0	10	1	1	0.02	11	31	1.92
23	2	0	10	1	1	0.02	11	30	1.90
24	2	0	14	2	3	0.06	13	33	1.93
25	3	0	19	3	5	0.14	14	35	2.01
26	2	0	10	1	1	0.02	12	31	1.92
27	2	0	15	2	4	0.10	13	34	1.96
28	2	0	9	1	1	0.02	11	30	1.87
29	3	0	15	2	4	0.11	13	34	1.97
30	3	0	16	1	2	0.04	12	32	1.93
31	3	0	16	1	2	0.04	12	33	1.93
32	2	0	14	2	3	0.07	13	34	1.95
33	2	0	13	1	2	0.03	12	32	1.93

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
34	3	0	18	3	5	0.14	14	35	2.01
35	3	0	16	1	2	0.04	13	33	1.94
36	2	0	11	1	1	0.02	12	31	1.93
37	2	0	15	2	4	0.10	13	34	1.97
38	2	0	11	1	2	0.02	12	31	1.93
39	2	0	11	1	2	0.03	12	32	1.93
40	2	0	12	1	2	0.03	12	32	1.94
41	2	0	9	1	1	0.02	11	30	1.87
42	3	0	16	2	3	0.05	13	34	1.96
43	2	0	12	1	2	0.03	12	32	1.94
44	2	0	12	1	2	0.03	12	32	1.94
45	2	0	11	1	1	0.02	11	31	1.91
46	2	0	12	1	2	0.03	12	32	1.94
47	2	0	13	1	2	0.03	12	33	1.95
48	2	0	13	1	2	0.03	13	33	1.95
49	2	0	13	1	2	0.03	13	33	1.95
50	2	0	13	1	2	0.03	12	32	1.94
51	5	1	29	5	8	0.24	17	40	2.16
52	2	0	12	1	1	0.02	12	32	1.93
53	2	0	13	1	2	0.03	12	33	1.95
54	2	0	9	1	1	0.02	11	30	1.87
55	2	0	14	1	2	0.03	13	33	1.96
56	2	0	13	1	2	0.03	12	33	1.95
57	2	0	13	1	2	0.03	13	33	1.95
58	2	0	14	1	2	0.03	13	34	1.97
59	2	0	13	1	2	0.03	13	33	1.95
60	2	0	14	1	2	0.03	13	33	1.95
61	2	0	9	1	1	0.02	11	30	1.87
62	2	0	14	1	2	0.03	13	33	1.96
63	2	0	15	1	2	0.03	13	34	1.97
64	2	0	15	1	2	0.03	13	34	1.96
65	2	0	15	1	2	0.03	13	34	1.97
66	2	0	14	1	2	0.03	13	34	1.96
67	1	0	6	1	1	0.01	10	28	1.80
68	2	0	15	1	2	0.03	13	34	1.97
69	2	0	14	1	2	0.03	13	34	1.96
70	1	0	6	1	1	0.01	10	28	1.79
71	2	0	15	1	2	0.03	13	34	1.97
72	2	0	15	1	2	0.03	13	34	1.97
73	2	0	14	1	2	0.03	13	33	1.95
74	2	0	10	1	1	0.02	11	30	1.88
75	2	0	15	1	2	0.03	13	34	1.97
76	2	0	11	1	1	0.02	12	31	1.91
77	9	2	**59**	12	22	0.82	**36**	75	3.15

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
78	14	4	**105**	32	57	**2.42**	**55**	**110**	**4.86**
79**	8	1	**55**	11	21	0.77	**35**	73	3.09
80	1	0	7	1	1	0.02	10	29	1.82
81	4	0	27	3	5	0.08	16	40	2.08
82	2	0	10	1	1	0.02	12	31	1.90
83**	8	1	**55**	11	19	0.71	**34**	71	3.03
84	1	0	8	1	1	0.02	11	29	1.84
86	2	0	15	1	2	0.03	13	34	1.98
87	4	0	25	2	4	0.06	16	39	2.08
89	2	0	8	1	1	0.02	11	29	1.84
90	8	1	**64**	11	20	0.76	**32**	68	3.06
91**	8	1	**64**	11	21	0.83	**32**	69	3.12
92**	2	0	8	1	1	0.02	11	30	1.85
93	9	2	**71**	13	24	1.02	**33**	69	3.30
94**	9	1	**68**	11	20	0.79	**31**	67	3.08
95	3	0	18	1	2	0.04	15	37	2.02
96**	9	2	**73**	12	23	0.96	**31**	67	3.23
97	5	0	31	3	5	0.07	18	42	2.14
98	4	0	28	2	4	0.06	18	42	2.12
99**	10	2	**80**	13	25	1.17	**32**	68	3.44
100	5	1	38	4	7	0.11	19	44	2.15
101	5	0	34	3	6	0.08	19	44	2.17
102	11	2	**82**	13	25	1.20	**31**	67	3.46
103**	2	0	11	1	2	0.03	13	33	1.94
104	5	0	37	3	5	0.08	20	46	2.22
105	8	1	**62**	10	18	0.67	28	61	2.94
106	6	1	49	5	8	0.12	22	50	2.30
107	5	0	38	4	6	0.09	22	50	2.36
108	10	1	**76**	11	19	0.31	28	61	2.52
109**	20	3	**165**	20	38	1.51	**35**	75	3.64
110	8	1	**60**	5	9	0.13	25	56	2.48
111	2	0	12	1	1	0.02	10	28	1.83
112	19	1	**143**	10	18	0.28	**34**	72	2.82
113**	3	0	15	1	1	0.02	11	30	1.94
114	5	0	34	4	7	0.18	22	49	2.57
115**	4	0	23	1	2	0.03	18	42	2.33
116	3	0	23	4	7	0.14	20	45	2.32
117	2	0	15	2	4	0.09	19	44	2.44
118	2	0	16	3	5	0.09	19	44	2.40
118	2	0	16	3	5	0.09	19	44	2.40
119	3	0	22	3	6	0.12	19	44	2.30
120	2	0	13	2	3	0.06	17	40	2.27
121	2	0	14	2	4	0.07	18	41	2.31
122	2	0	13	2	3	0.06	17	39	2.24

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
123	2	0	14	2	4	0.07	17	40	2.27
124	2	0	13	2	3	0.06	17	39	2.23
125	3	1	27	4	8	0.15	20	44	2.20
126	4	1	28	8	13	0.22	23	49	2.26
127	3	0	20	2	4	0.06	17	39	2.08
128	3	1	27	5	8	0.14	19	44	2.17
129	3	0	26	4	6	0.11	18	41	2.13
130	3	0	24	3	6	0.10	17	40	2.10
131	6	1	44	9	15	0.26	24	53	2.28
133	2	0	19	2	3	0.06	16	37	2.03
134	3	0	23	3	5	0.09	17	39	2.08
135	5	1	36	9	16	0.46	30	62	2.59
136	5	1	35	9	16	0.44	29	60	2.56
137	3	0	22	3	5	0.09	16	38	2.06
138	5	1	40	9	16	0.40	27	57	2.47
139	3	0	22	3	5	0.09	16	39	2.07
140	4	1	32	8	14	0.39	27	57	2.50
141	2	0	17	2	3	0.05	16	36	1.99
142	3	0	21	3	4	0.08	16	37	2.05
143	3	0	20	2	4	0.08	16	37	2.03
144	4	1	24	5	9	0.27	21	46	2.30
145**	5	1	37	6	11	0.34	**41**	85	3.12
146	4	1	23	5	8	0.25	20	45	2.26
147	2	0	16	3	4	0.09	16	37	2.02
148	3	1	20	4	7	0.19	19	43	2.18
149	3	1	19	4	7	0.21	19	44	2.22
150	3	0	19	4	6	0.17	18	41	2.13
151**	3	1	21	5	8	0.26	23	51	2.42
152	2	0	15	2	4	0.08	15	36	2.00
153	3	0	18	4	6	0.17	18	41	2.14
154**	3	0	18	3	6	0.16	17	40	2.12
155	2	0	16	2	3	0.07	14	35	1.98
156	2	0	16	2	3	0.06	14	34	1.97
157	2	0	15	2	3	0.06	14	34	1.96
158	3	0	20	2	4	0.10	24	53	3.25
160	2	0	13	2	3	0.07	17	40	2.36
161	2	0	13	2	3	0.06	17	39	2.25
162	2	0	13	2	3	0.06	17	39	2.26
163	2	0	12	2	3	0.06	17	38	2.19
165	3	0	21	3	6	0.13	19	44	2.32
167	2	0	16	2	3	0.05	15	35	1.96
168	2	0	15	1	2	0.05	15	35	1.95
169	2	0	18	2	3	0.06	15	36	1.99
170	2	0	16	2	3	0.05	15	36	1.97

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
172	2	0	19	2	4	0.07	15	36	2.02
173	2	0	18	2	4	0.07	15	36	2.01
174	2	0	16	2	3	0.06	14	35	1.97
175	2	0	16	2	3	0.06	14	35	1.97
176	2	0	15	2	3	0.05	14	34	1.96
177	2	0	17	2	3	0.05	14	34	1.95
178	2	0	15	1	2	0.05	14	35	1.94
179	2	0	15	1	2	0.05	14	34	1.93
180	2	0	13	2	3	0.06	14	34	1.96
181	2	0	13	2	3	0.07	14	35	1.98
182	2	0	12	2	3	0.06	14	34	1.97
183	2	0	13	2	3	0.07	14	35	1.99
184	1	0	11	2	3	0.07	14	34	1.97
185	2	0	12	2	3	0.07	14	35	1.98
186	2	0	12	2	3	0.08	14	35	1.99
187	2	0	12	2	3	0.08	14	35	1.99
188	2	0	15	2	4	0.09	14	35	1.98
189**	3	0	18	3	5	0.13	16	38	2.06
190	3	0	19	4	6	0.17	18	41	2.13
191	2	0	13	2	4	0.08	15	36	2.00
192	2	0	16	2	4	0.10	15	37	2.02
193	1	0	7	0	1	0.01	8	25	1.74
194**	2	0	10	1	1	0.02	9	26	1.78
195**	2	0	12	1	1	0.02	9	27	1.80
196**	2	0	11	1	1	0.02	9	27	1.78
197	2	0	9	1	1	0.02	9	26	1.76
198**	1	0	8	0	1	0.01	8	26	1.75
199	1	0	5	0	0	0.01	8	25	1.72
200	1	0	5	0	1	0.01	8	25	1.73
201	1	0	5	0	1	0.01	8	25	1.73
202	1	0	5	0	1	0.01	8	25	1.73
203	1	0	5	0	0	0.01	8	25	1.73
204	1	0	6	0	1	0.01	8	25	1.73
205	1	0	6	0	1	0.01	8	25	1.73
206	1	0	6	0	1	0.01	8	25	1.73
207	1	0	6	0	1	0.01	8	25	1.73
208	1	0	6	0	1	0.01	8	25	1.74
209**	4	1	33	5	8	0.22	**35**	72	2.92
210	2	0	14	1	2	0.03	13	34	1.96
211	2	0	15	1	2	0.03	13	34	1.97
215	3	0	16	1	2	0.04	12	32	1.93
217	2	0	10	1	1	0.02	11	29	1.86
218	1	0	8	1	1	0.02	10	29	1.81
219	1	0	8	1	1	0.02	10	28	1.80

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
220	2	0	7	1	1	0.02	10	28	1.80
221	1	0	7	1	1	0.01	9	27	1.79
222	1	0	7	0	1	0.01	9	27	1.79
223	1	0	7	1	1	0.01	10	28	1.81
224	1	0	7	1	1	0.01	10	28	1.82
225	2	0	8	1	1	0.02	10	29	1.86
226	2	0	9	1	1	0.02	10	29	1.87
227	2	0	9	1	1	0.02	11	29	1.87
228	2	0	9	1	1	0.02	11	29	1.88
229	2	0	9	1	1	0.02	11	30	1.89
230	2	0	10	1	1	0.02	11	30	1.89
231	2	0	10	1	1	0.02	11	30	1.90
234	1	0	9	1	1	0.02	11	29	1.85
235	1	0	8	1	1	0.02	10	29	1.84
236	2	0	9	1	1	0.02	11	30	1.87
237	1	0	8	1	1	0.02	10	29	1.83
238	1	0	8	1	1	0.02	11	29	1.85
243	1	0	8	1	1	0.02	10	29	1.82
244	2	0	12	2	3	0.05	17	38	2.13
245	1	0	12	2	3	0.05	17	38	2.14
246	1	0	12	2	3	0.05	16	38	2.10
247	2	0	12	2	3	0.05	17	38	2.10
248	2	0	17	2	3	0.06	14	34	1.96
249	2	0	16	2	3	0.05	14	35	1.95
250	2	0	13	1	2	0.04	15	35	1.94
251	2	0	12	1	2	0.04	14	34	1.92
252	2	0	10	1	1	0.02	11	31	1.89
253	2	0	10	1	1	0.02	11	30	1.90
254	2	0	9	1	1	0.02	11	30	1.86
255	3	0	15	1	2	0.04	12	32	1.91
256	2	0	13	2	3	0.05	16	38	2.16
257	2	0	12	2	3	0.05	17	38	2.12
258	2	0	12	2	3	0.06	16	38	2.18
259	2	0	16	3	5	0.09	19	43	2.37
260	2	0	12	2	3	0.06	17	39	2.26
261	2	0	12	2	3	0.06	17	40	2.32
262	4	1	28	7	12	0.21	22	48	2.25
263	2	0	13	2	4	0.09	15	36	2.01
264	11	2	**86**	14	26	1.33	**32**	68	3.58
265	2	0	15	2	4	0.09	19	44	2.43
266	3	0	14	2	3	0.09	11	29	1.89
267	2	0	11	1	2	0.06	10	28	1.84
268	2	0	10	1	2	0.04	10	28	1.80
269**	4	0	25	3	5	0.16	13	33	1.99

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
270**	4	1	24	4	7	0.22	15	38	2.08
271**	3	1	24	5	10	0.27	**46**	**92**	3.08
903	1	0	7	1	1	0.02	10	28	1.81
904	1	0	5	0	1	0.01	9	26	1.77
905	1	0	4	0	1	0.01	8	26	1.75
909	1	0	7	1	1	0.01	9	27	1.79
911	1	0	5	0	1	0.01	9	26	1.76
915	4	1	24	5	9	0.29	21	47	2.33
917	1	0	7	1	1	0.01	10	28	1.79
918	1	0	7	1	1	0.01	10	28	1.80
919	2	0	11	1	1	0.02	11	31	1.91
920	2	0	14	1	2	0.03	13	33	1.96
921	2	0	9	1	1	0.02	11	29	1.86
922	1	0	8	1	1	0.02	10	28	1.83
923	1	0	5	0	1	0.01	8	25	1.75
926	1	0	7	0	1	0.01	8	26	1.75
927a	1	0	6	0	1	0.01	9	27	1.77
927b	1	0	6	0	1	0.01	9	26	1.77
927c	1	0	6	0	1	0.01	9	27	1.77
927d	1	0	5	0	1	0.01	8	25	1.75
927e	1	0	5	0	1	0.01	8	26	1.75
927f	1	0	6	0	1	0.01	8	26	1.75
927g	1	0	4	0	1	0.01	8	25	1.73
927h	1	0	4	0	1	0.01	8	25	1.74
927i	1	0	5	0	1	0.01	8	25	1.74
927j	1	0	5	0	1	0.01	8	25	1.74
928	1	0	6	0	1	0.01	9	27	1.78
929	1	0	6	1	1	0.01	9	27	1.79
932	2	0	15	2	4	0.11	14	35	1.99
936	1	0	6	0	1	0.01	9	27	1.78
937a	2	0	19	2	4	0.07	15	36	2.00
937b	2	0	18	2	3	0.07	15	35	1.99
937c	2	0	17	2	3	0.06	14	35	1.97
937d	2	0	17	2	3	0.07	15	35	1.99
937e	2	0	16	2	3	0.07	14	35	1.99
941**	11	2	**82**	13	25	1.20	**31**	67	3.46

*Advisory NEPM reporting standard applicable to the population as a whole
**Other mine owned property

9.2.1 Predicted maximum 24-hour and annual average $PM_{2.5}$ concentrations

Figure E-10 and **Figure E-11** show the predicted maximum 24-hour average and annual average $PM_{2.5}$ concentrations for Year 9 due to emissions from the proposal. The results in **Table 9-3** indicate that all assessment locations are predicted to experience a maximum 24-hour average and annual average concentrations below the advisory reporting standards of 25µg/m³ and 8µg/m³, respectively in Year 9.

9.2.2 Predicted maximum 24-hour and annual average PM_{10} concentrations

Figure E-12 shows the predicted maximum 24-hour average PM_{10} concentrations for Year 9 due to emissions from the proposal. The results in **Table 9-3** indicate that assessment locations 77, 78, 79, 83, 90, 91, 93, 94, 96, 99, 102, 105, 108, 109, 110, 112, 264 and 941 are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m^3 in Year 9. Of these 18 assessment locations, 15 are mine owned and two are privately owned properties that are already in the acquisition zone under the current development consent.

An analysis of the number of days that the P&I acquisition criterion of 50µg/m^3 would be exceeded at these assessment locations is presented in **Table 9-4**. The analysis indicates that assessment locations 78, 96, 99, 102, 108, 109, 112, 264 and 941 would experience levels systemically above the criterion (eg on more than five days).

Table 9-4: Analysis of Year 9 – maximum 24-hour average PM_{10} concentrations

Assessment location ID	Number of days over 50µg/m^3
77	2
78	**68**
79*	2
83*	2
90	2
91*	3
93	5
94*	3
96*	**6**
99*	**7**
102	**8**
105	3
108	**14**
109*	**27**
110	2
112	**16**
264	**10**
941*	**9**

*Other mine owned property

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 8.5**.

Figure E-13 shows the predicted annual average PM_{10} concentrations for Year 9 due to emissions from the proposal. **Figure E-14** shows the predicted total impact from the proposal and other sources. The results in **Table 9-3** indicate that assessment locations 77, 78, 79, 83, 90, 91, 93, 94, 96, 99, 102, 109, 112, 145, 209, 264, 271 and 941 are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 in Year 9.

It is noted that assessment locations 145, 209 and 271 are largely unaffected by activity from the proposal. These locations would be influenced by other dust sources in the area as indicated by the incremental predictions due to the proposal in **Table 9-3**.

9.2.3 Predicted annual average TSP concentrations

Figure E-15 shows the predicted annual average TSP concentrations for Year 9 due to emissions from the proposal. **Figure E-16** shows the predicted total impact from the proposal and other sources. The results in **Table 9-3** indicate that assessment locations 78 and 271 are predicted to experience annual average TSP concentrations above the relevant criterion of 90µg/m^3 in Year 9.

It is noted that assessment location 271 is largely unaffected by activity from the proposal. This location would be influenced by other dust sources in the area as indicated by the incremental predictions due to the proposal in **Table 9-3**.

9.2.4 Predicted annual average dust deposition levels

Figure E-17 shows the predicted annual average dust deposition levels for Year 9 due to emissions from the proposal. **Figure E-18** shows the predicted total impact from the proposal and other sources.

The results in **Table 9-3** indicate that all assessment locations with the exception of assessment location 78 are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month in Year 9. Assessment location 78 is also the only assessment location predicted to experience total annual average dust deposition levels above the relevant criterion of 4g/m^2/month in Year 9 from the proposal and other sources.

9.3 Year 14 results

Table 9-5 presents the model predictions at each of the assessment locations, the values presented in bold indicate predicted values above the relevant criteria. The assessment locations highlighted in grey are identified as mine-owned assessment locations, and those highlighted in orange are privately-owned assessment locations already in the acquisition zone for other mine operations.

Figure E-19 to **Figure E-27** in **Appendix E** present isopleth diagrams of the predicted modelling results for each of the assessed pollutants in Year 14.

Table 9-5: Modelling predictions for Year 14 of the proposal

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
1	1	0	8	1	1	0.02	9	27	1.77
2	2	0	8	1	1	0.02	9	27	1.78
3	2	0	9	1	1	0.02	9	27	1.79
4	2	0	9	1	1	0.02	9	27	1.79
5	2	0	9	1	1	0.02	9	27	1.79
6	2	0	9	1	1	0.02	9	27	1.79
7	2	0	9	1	1	0.02	9	27	1.80
8	2	0	10	1	1	0.02	10	28	1.81
9	2	0	9	1	1	0.02	10	28	1.81
10	2	0	9	1	2	0.03	10	28	1.81
11**	4	1	22	5	8	0.26	14	36	2.06

Assessment location ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
12	3	0	13	1	2	0.03	10	29	1.85
13	2	0	13	2	3	0.05	11	29	1.84
14	3	0	15	1	2	0.03	10	29	1.86
15	3	0	13	1	2	0.03	10	29	1.87
16	3	0	16	2	3	0.05	11	30	1.85
17	2	0	14	2	4	0.08	11	30	1.86
18	3	0	14	1	2	0.03	10	29	1.87
19	2	0	14	2	4	0.09	11	31	1.87
20	2	0	13	1	2	0.03	11	29	1.88
21	3	0	17	2	3	0.05	11	30	1.86
22	2	0	13	1	2	0.03	11	29	1.88
23	2	0	13	1	2	0.03	10	29	1.88
24	3	0	16	2	4	0.08	12	31	1.87
25	4	0	23	4	7	0.19	13	34	1.97
26	2	0	13	1	2	0.03	11	30	1.89
27	3	0	17	3	5	0.13	12	32	1.92
28	2	0	11	1	1	0.02	10	29	1.86
29	3	0	18	3	5	0.14	12	32	1.92
30	3	0	19	2	3	0.05	11	30	1.88
31	3	0	19	2	3	0.06	11	31	1.87
32	3	0	16	2	4	0.10	12	31	1.89
33	3	0	16	1	2	0.04	11	30	1.89
34	4	0	22	3	6	0.18	13	33	1.97
35	3	0	19	2	3	0.05	11	31	1.88
36	2	0	14	1	2	0.03	11	30	1.89
37	3	0	17	3	5	0.13	12	32	1.92
38	2	0	14	1	2	0.03	11	30	1.89
39	2	0	14	1	2	0.04	11	30	1.89
40	3	0	15	1	2	0.04	11	30	1.90
41	2	0	11	1	1	0.02	10	29	1.86
42	4	0	21	2	4	0.07	12	32	1.88
43	3	0	15	1	2	0.04	11	30	1.90
44	3	0	15	1	2	0.04	11	30	1.90
45	2	0	14	1	2	0.03	11	30	1.89
46	3	0	16	1	2	0.04	11	31	1.90
47	3	0	16	1	2	0.04	11	31	1.90
48	3	0	17	2	3	0.04	12	31	1.90
49	3	0	16	1	2	0.04	12	31	1.90
50	3	0	16	1	2	0.04	11	31	1.90
51	5	1	36	5	10	0.31	15	38	2.12
52	3	0	15	1	2	0.03	11	31	1.90
53	3	0	16	1	2	0.04	12	31	1.90
54	2	0	11	1	1	0.02	10	29	1.87
55	3	0	18	2	3	0.04	12	31	1.91

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
56	3	0	17	1	2	0.04	12	31	1.91
57	3	0	17	1	2	0.04	12	31	1.91
58	3	0	19	2	3	0.05	12	32	1.91
59	3	0	17	1	2	0.04	12	31	1.91
60	3	0	18	1	2	0.04	12	31	1.91
61	2	0	11	1	1	0.02	11	29	1.87
62	3	0	18	2	3	0.04	12	32	1.91
63	3	0	19	2	3	0.04	12	32	1.91
64	3	0	19	2	3	0.04	12	32	1.91
65	3	0	19	2	3	0.04	12	32	1.91
66	3	0	19	2	3	0.04	12	32	1.91
67	2	0	8	1	1	0.02	10	28	1.81
68	3	0	20	2	3	0.04	12	32	1.92
69	3	0	19	2	3	0.04	12	32	1.92
70	2	0	8	1	1	0.02	10	28	1.81
71	3	0	19	2	3	0.04	12	32	1.92
72	3	0	19	2	3	0.04	12	32	1.92
73	3	0	18	1	2	0.04	12	32	1.92
74	2	0	11	1	2	0.03	11	30	1.88
75	3	0	19	2	3	0.04	12	32	1.93
76	2	0	14	1	2	0.03	11	31	1.91
77	10	2	**78**	13	24	0.94	**35**	75	3.19
78	20	4	**147**	35	66	**2.79**	**57**	**117**	**5.15**
79**	10	2	**77**	12	22	0.85	**34**	72	3.10
80	2	0	10	1	1	0.02	10	29	1.83
81	5	0	34	4	6	0.11	14	35	1.94
82	2	0	12	1	2	0.03	11	31	1.90
83**	10	1	**74**	10	19	0.74	**33**	69	2.99
84	2	0	10	1	1	0.02	11	30	1.85
86	3	0	20	2	3	0.04	12	33	1.93
87	5	0	32	3	5	0.08	14	35	1.94
89	2	0	11	1	1	0.02	11	30	1.85
90	9	1	**72**	9	17	0.69	29	63	2.92
91**	10	1	**76**	10	19	0.78	30	65	2.99
92**	2	0	11	1	1	0.03	11	30	1.87
93	11	1	**83**	11	21	0.92	30	65	3.10
94**	10	1	**78**	9	17	0.68	28	61	2.89
95	4	0	23	2	3	0.05	13	34	1.95
96**	11	1	**86**	10	18	0.80	28	61	2.98
97	6	1	44	4	7	0.11	15	37	1.97
98	6	0	42	3	6	0.09	15	37	1.97
99**	12	1	**95**	10	20	0.92	28	61	3.07
100	7	1	**53**	5	9	0.15	16	39	1.99
101	7	1	**51**	5	9	0.13	16	39	1.99

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
102	12	1	**96**	10	19	0.88	26	59	3.03
103**	3	0	16	1	2	0.04	13	33	1.94
104	8	1	**58**	5	8	0.13	17	40	2.01
105	10	1	**78**	6	12	0.47	23	52	2.68
106	11	1	**83**	8	15	0.21	20	46	2.08
107	8	1	**62**	6	11	0.17	19	43	2.07
108	20	2	**160**	18	34	0.57	30	65	2.43
109**	12	1	**92**	9	18	0.78	23	52	2.81
110	13	1	**95**	10	19	0.29	23	51	2.19
111	3	0	16	1	1	0.03	10	28	1.86
112	**40**	4	**313**	29	57	0.97	**43**	90	2.88
113**	4	0	22	1	2	0.03	11	31	2.01
114	3	0	20	3	5	0.12	20	45	2.46
115**	5	0	34	2	3	0.05	18	43	2.46
116	3	0	21	3	5	0.11	17	40	2.22
117	2	0	13	2	3	0.07	17	40	2.36
118	2	0	14	2	4	0.08	17	40	2.31
118	2	0	14	2	4	0.08	17	40	2.31
119	3	0	21	3	5	0.10	16	39	2.21
120	2	0	12	2	3	0.06	15	36	2.21
121	2	0	13	2	3	0.06	15	37	2.24
122	2	0	12	2	3	0.05	14	35	2.17
123	2	0	12	2	3	0.06	15	36	2.20
124	2	0	12	2	3	0.05	14	35	2.16
125	3	1	22	4	7	0.13	16	39	2.11
126	3	1	25	7	12	0.21	19	43	2.16
127	2	0	15	2	3	0.05	14	34	2.01
128	3	1	23	4	7	0.13	16	38	2.09
129	3	0	22	3	6	0.10	15	36	2.05
130	3	0	21	3	5	0.09	14	35	2.04
131	6	1	45	9	16	0.26	20	46	2.16
133	2	0	17	2	3	0.05	13	32	1.97
134	3	0	20	3	5	0.09	14	34	2.02
135	5	1	32	8	15	0.41	21	47	2.34
136	4	1	30	8	14	0.39	20	46	2.31
137	2	0	19	2	4	0.08	13	34	2.00
138	4	1	34	8	15	0.37	20	46	2.27
139	2	0	19	3	5	0.09	14	34	2.01
140	4	1	29	7	12	0.35	19	44	2.27
141	2	0	16	1	3	0.05	12	32	1.94
142	2	0	19	2	4	0.07	13	33	1.99
143	2	0	18	2	4	0.07	13	33	1.98
144	3	1	22	5	8	0.24	16	39	2.12
145**	4	1	30	6	11	0.35	22	50	2.37

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
146	3	1	21	4	8	0.22	16	38	2.09
147	2	0	12	2	4	0.08	13	33	1.95
148	3	0	19	4	6	0.17	14	36	2.03
149	3	0	18	3	6	0.18	14	36	2.04
150	3	0	18	3	6	0.15	14	35	2.00
151**	2	1	20	4	7	0.22	15	37	2.10
152	1	0	12	2	3	0.07	12	32	1.94
153	3	0	17	3	5	0.15	14	34	2.00
154**	3	0	17	3	5	0.14	14	34	1.99
155	2	0	14	2	3	0.06	12	31	1.92
156	2	0	14	2	3	0.06	12	31	1.92
157	2	0	14	2	3	0.06	12	31	1.91
158	2	0	12	2	3	0.07	22	50	3.15
160	2	0	10	2	3	0.05	15	37	2.29
161	2	0	10	1	2	0.05	14	35	2.18
162	2	0	10	1	2	0.05	14	35	2.19
163	1	0	10	1	2	0.05	14	34	2.11
165	2	0	19	3	5	0.10	17	40	2.22
167	2	0	14	1	2	0.04	12	31	1.91
168	2	0	13	1	2	0.04	12	31	1.90
169	2	0	16	2	3	0.05	12	31	1.94
170	2	0	14	1	2	0.05	12	31	1.92
172	2	0	17	2	3	0.06	13	32	1.96
173	2	0	16	2	3	0.06	12	32	1.96
174	2	0	15	2	3	0.06	12	31	1.93
175	2	0	15	2	3	0.05	12	31	1.92
176	2	0	14	1	2	0.05	12	31	1.91
177	2	0	15	1	2	0.05	11	31	1.90
178	2	0	14	1	2	0.04	11	30	1.89
179	2	0	13	1	2	0.04	11	30	1.88
180	1	0	10	1	2	0.06	12	31	1.91
181	1	0	11	2	3	0.06	12	31	1.92
182	1	0	10	1	2	0.06	12	31	1.92
183	1	0	11	2	3	0.06	12	31	1.93
184	1	0	9	2	3	0.06	12	31	1.92
185	1	0	10	2	3	0.06	12	31	1.93
186	1	0	10	2	3	0.07	12	31	1.93
187	2	0	11	2	3	0.07	12	31	1.93
188	2	0	13	2	3	0.08	12	32	1.92
189**	3	0	16	3	5	0.12	13	33	1.96
190	3	0	18	3	6	0.15	14	35	2.00
191	2	0	11	2	3	0.07	12	32	1.94
192	2	0	14	2	4	0.08	13	32	1.94
193	2	0	9	1	1	0.02	8	25	1.75

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
194**	2	0	13	1	1	0.02	9	26	1.78
195**	3	0	15	1	1	0.02	9	27	1.80
196**	2	0	14	1	1	0.02	9	27	1.79
197	2	0	12	1	1	0.02	9	26	1.76
198**	2	0	10	1	1	0.02	8	26	1.75
199	1	0	6	0	1	0.01	8	24	1.72
200	1	0	7	0	1	0.01	8	25	1.73
201	1	0	7	0	1	0.01	8	25	1.73
202	1	0	6	0	1	0.01	8	25	1.73
203	1	0	6	0	1	0.01	8	25	1.73
204	1	0	7	0	1	0.01	8	25	1.73
205	1	0	7	0	1	0.01	8	25	1.73
206	1	0	7	0	1	0.01	8	25	1.73
207	1	0	7	0	1	0.01	8	25	1.73
208	2	0	8	0	1	0.01	8	25	1.74
209**	5	1	42	6	10	0.27	26	55	2.38
210	3	0	19	2	3	0.04	12	32	1.91
211	3	0	20	2	3	0.04	12	32	1.92
215	3	0	19	2	3	0.05	11	31	1.88
217	2	0	12	1	2	0.03	10	28	1.83
218	2	0	8	1	2	0.03	10	28	1.79
219	1	0	8	1	2	0.03	9	27	1.78
220	2	0	9	1	1	0.02	9	27	1.79
221	2	0	8	1	1	0.02	9	27	1.78
222	2	0	9	1	1	0.02	9	27	1.78
223	2	0	9	1	1	0.02	9	27	1.79
224	2	0	10	1	1	0.02	9	27	1.80
225	2	0	10	1	1	0.02	10	28	1.83
226	2	0	11	1	1	0.02	10	28	1.84
227	2	0	11	1	1	0.02	10	28	1.85
228	2	0	12	1	1	0.02	10	28	1.85
229	2	0	12	1	2	0.03	10	29	1.86
230	2	0	12	1	2	0.03	10	29	1.86
231	2	0	13	1	2	0.03	10	29	1.87
234	2	0	10	1	1	0.02	10	29	1.86
235	2	0	10	1	1	0.02	10	29	1.85
236	2	0	11	1	2	0.03	11	30	1.88
237	2	0	9	1	1	0.02	10	29	1.84
238	2	0	9	1	1	0.02	10	29	1.85
243	2	0	10	1	1	0.02	10	29	1.83
244	1	0	11	1	2	0.05	13	34	2.06
245	1	0	11	1	2	0.05	14	34	2.07
246	1	0	11	1	2	0.04	13	33	2.03
247	1	0	11	1	2	0.04	13	33	2.02

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
248	2	0	15	2	3	0.05	12	31	1.91
249	2	0	14	1	2	0.05	11	30	1.90
250	1	0	12	1	2	0.04	11	30	1.87
251	1	0	11	1	2	0.04	11	29	1.86
252	2	0	11	1	2	0.03	11	31	1.89
253	2	0	12	1	2	0.03	10	29	1.87
254	2	0	10	1	1	0.03	11	30	1.87
255	3	0	17	2	3	0.06	11	30	1.86
256	1	0	9	1	2	0.05	14	34	2.08
257	1	0	11	1	2	0.05	13	34	2.05
258	1	0	10	1	2	0.05	14	34	2.11
259	2	0	14	2	4	0.08	16	39	2.29
260	2	0	11	2	3	0.05	14	35	2.19
261	2	0	11	2	3	0.05	15	36	2.25
262	3	1	25	7	11	0.19	18	42	2.15
263	2	0	12	2	3	0.08	12	32	1.94
264	12	1	**99**	10	19	0.94	26	58	3.08
265	2	0	13	2	3	0.07	17	40	2.35
266	3	0	16	2	4	0.11	10	29	1.87
267	2	0	12	2	3	0.07	10	28	1.82
268	2	0	11	1	2	0.05	9	27	1.79
269**	5	0	27	4	6	0.21	13	33	1.98
270**	4	1	27	5	9	0.29	15	37	2.09
271**	4	1	35	6	11	0.30	**46**	**92**	3.09
903	2	0	10	1	1	0.02	10	29	1.83
904	1	0	7	1	1	0.01	9	27	1.77
905	1	0	5	0	1	0.01	8	26	1.75
909	2	0	9	1	1	0.02	10	28	1.80
911	1	0	5	0	1	0.01	9	26	1.76
915	4	1	23	5	8	0.26	16	39	2.14
917	2	0	9	1	1	0.02	10	28	1.81
918	2	0	9	1	1	0.02	10	28	1.81
919	2	0	13	1	2	0.03	11	30	1.89
920	3	0	18	2	3	0.04	12	32	1.91
921	2	0	11	1	1	0.02	10	29	1.86
922	2	0	9	1	1	0.02	10	28	1.83
923	1	0	7	0	1	0.01	8	25	1.75
926	2	0	8	1	1	0.01	8	26	1.75
927a	1	0	7	1	1	0.02	9	27	1.78
927b	1	0	7	1	1	0.02	9	27	1.77
927c	2	0	8	1	1	0.02	9	27	1.78
927d	1	0	7	0	1	0.01	8	25	1.75
927e	1	0	7	1	1	0.01	8	26	1.75
927f	1	0	7	1	1	0.01	8	26	1.76

Assessment location ID	PM2.5 (µg/m³)		PM10 (µg/m³)		TSP (µg/m³)	DD (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Incremental impact						Total impact		
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Advisory*		Air quality impact criteria						
	25	8	50	-	-	2	30	90	4
927g	1	0	5	0	1	0.01	8	25	1.74
927h	1	0	6	0	1	0.01	8	25	1.74
927i	1	0	6	0	1	0.01	8	25	1.74
927j	1	0	6	0	1	0.01	8	25	1.75
928	2	0	8	1	1	0.02	9	27	1.78
929	2	0	8	1	1	0.02	10	28	1.80
932	2	0	13	2	4	0.10	12	32	1.93
936	2	0	8	1	1	0.02	9	27	1.79
937a	2	0	17	2	3	0.07	12	32	1.95
937b	2	0	17	2	3	0.06	12	32	1.94
937c	2	0	16	2	3	0.06	12	31	1.92
937d	2	0	14	2	3	0.06	12	32	1.93
937e	2	0	14	2	3	0.06	12	32	1.93
941**	12	1	**96**	10	18	0.88	26	58	3.03

*Advisory NEPM reporting standard applicable to the population as a whole
**Other mine owned property

9.3.1 Predicted maximum 24-hour and annual average $PM_{2.5}$ concentrations

Figure E-19 and **Figure E-20** show the predicted maximum 24-hour average and annual average $PM_{2.5}$ concentrations for Year 14 due to emissions from the proposal. The results in **Table 9-5** indicate that all assessment locations with the exception of assessment location 112 is predicted to experience a maximum 24-hour average concentration below the advisory reporting standard of 25µg/m³ in Year 14. All assessment locations are predicted to experience annual average concentrations below the advisory reporting standard of 8µg/m³ in Year 14.

9.3.2 Predicted maximum 24-hour and annual average PM_{10} concentrations

Figure E-21 shows the predicted maximum 24-hour average PM_{10} concentrations for Year 14 due to emissions from the proposal. The results in **Table 9-5** indicate that assessment locations 77, 78, 79, 83, 90, 91, 93, 94, 96, 99, 100, 101, 102, 104, 105, 106, 107, 108, 109, 110, 112, 264 and 941 are predicted to experience maximum 24-hour average PM_{10} concentrations above the relevant criterion of 50µg/m³ in Year 14. Of these 23 assessment locations, 20 are mine owned and two are privately owned properties that are already in the acquisition zone under the current development consent.

An analysis of the number of days that the P&I acquisition criterion of 50µg/m³ would be exceeded at these locations is presented in **Table 9-6**. The analysis indicates that assessment locations 77, 78, 106, 108, 110 and 112 would experience levels systemically above the criterion (e.g. on more than five days).

Table 9-6: Analysis of Year 14 – maximum 24-hour average PM_{10} concentrations

Assessment location ID	Number of days over 50µg/m³
77	**7**
78	**94**
79*	4
83*	3

90	3
91*	3
93	4
94*	3
96*	3
99*	3
100	1
101	1
102	3
104	2
105	1
106	**16**
107	5
108	**42**
109*	2
110	**21**
112	**79**
264	3
941*	3

*Other mine owned property

Results for the total (cumulative) impact for maximum 24-hour average PM_{10} concentrations are discussed in **Section 8.5**.

Figure E-22 shows the predicted annual average PM_{10} concentrations for Year 14 due to emissions from the proposal. **Figure E-23** shows the predicted total impact from the proposal and other sources. The results in **Table 9-5** indicate that assessment locations 77, 78, 79, 83, 112 and 271 are predicted to experience annual average PM_{10} concentrations above the relevant criterion of 30µg/m^3 in Year 14. Of these six assessment locations, five are mine owned and one is a privately owned property that is already in the acquisition zone under the current development consent.

It is noted that assessment location 271 is largely unaffected by activity from the proposal. This location would be influenced by other dust sources in the area as indicated by the incremental predictions due to the proposal in **Table 9-5**.

9.3.3 Predicted annual average TSP concentrations

Figure E-24 shows the predicted annual average TSP concentrations for Year 14 due to emissions from the proposal. **Figure E-25** shows the predicted total impact from the proposal and other sources. The results in **Table 9-5** indicate that all assessment locations with the exception of assessment locations 78 and 271 are predicted to experience annual average TSP concentrations below the relevant criterion of 90µg/m^3 in Year 14.

It is noted that assessment location 271 is largely unaffected by activity from the proposal. This location would be influenced by other dust sources in the area as indicated by the incremental predictions due to the proposal in **Table 9-5**.

9.3.4 Predicted annual average dust deposition levels

Figure E-26 shows the predicted annual average dust deposition levels for Year 14 due to emissions from the proposal. **Figure E-27** shows the predicted total impact from the proposal and other sources.

The results in **Table 9-5** indicate that all assessment locations with the exception of assessment location 78 are predicted to experience incremental annual average dust deposition levels below the relevant criterion of 2g/m^2/month in Year 14. Assessment location 78 is also the only assessment location predicted to experience total annual average dust deposition levels above the relevant criterion of 4g/m^2/month in Year 14 from the proposal and other sources.

9.4 Summary of results

Table 9-7 summarises the assessment locations where impacts are predicted to exceed relevant assessment criteria. The assessment locations highlighted in grey are identified as mine-owned assessment locations, and those highlighted in orange are privately-owned assessment locations already in the acquisition zone for other mine operations.

Cumulative 24-hour PM_{10} impacts are assessed specifically in **Section 9.5**.

As shown, all assessment locations where predicted impacts exceed assessment criteria are mine-owned properties with the exception of assessment location 77, 102 and 246 which are privately-owned. Assessment locations 77 and 102 are in the acquisition zone for other mine operations.

It is noted that assessment locations 145, 209 and 271 are largely unaffected by activity from the proposal. These locations would be influenced by other dust sources in the area.

There is only one receptor, Receptor 112, which is predicted to experience 24-hour average $PM_{2.5}$ concentrations above the advisory reporting standard of 25µg/m^3 in Year 14.

Table 9-7: Summary of modelled predictions where predicted impacts exceed assessment criteria

Assessment location ID	PM_{10}			TSP	DD	
	Incremental 24-hour average		Total annual average	Total annual average	Incremental annual average	Total annual average
	Criterion 50µg/m^3		Criterion 30µg/m^3	Criterion 90µg/m^3	Criterion 2g/m^2/month	Criterion 4g/m^2/month
	Year of impact (level of impact - µg/m^3)	No. of days above 50µg/m^3	Year of impact (level of impact - µg/m^3)		Year of impact (level of impact - g/m^2/month)	
77	Year 9 (59) Year 14 (78)	2 7	Year 3 (32) Year 9 (36) Year 14 (35)			
78	Year 9 (105) Year 14 (147)	68 94	Year 3 (32) Year 9 (55) Year 14 (57)	Year 9 (110) Year 14 (117)	Year 9 (2.4) Year 14 (2.8)	Year 9 (4.9) Year 14 (5.2)
79*	Year 9 (55) Year 14 (77)	2 4	Year 3 (32) Year 9 (35) Year 14 (34)			
83*	Year 9 (55) Year 14 (74)	2 3	Year 3 (32) Year 9 (34) Year 14 (33)			
90	Year 9 (64) Year 14 (72)	2 3	Year 9 (32)			
91*	Year 9 (64)	3	Year 9 (32)			

Assessment location ID	PM10			TSP	DD	
	Incremental 24-hour average		Total annual average	Total annual average	Incremental annual average	Total annual average
	Criterion 50µg/m³		Criterion 30µg/m³	Criterion 90µg/m³	Criterion 2g/m²/month	Criterion 4g/m²/month
	Year of impact (level of impact - µg/m³)	No. of days above 50µg/m³	Year of impact (level of impact - µg/m³)		Year of impact (level of impact - g/m²/month)	
	Year 14 (76)	3				
93	Year 9 (71) Year 14 (83)	5 4	Year 9 (33)			
94*	Year 9 (68) Year 14 (78)	3 3	Year 9 (31)			
96*	Year 9 (73) Year 14 (86)	6 3	Year 9 (31)			
99*	Year 9 (80) Year 14 (95)	7 3	Year 9 (32)			
100	Year 14 (53)	1				
101	Year 14 (51)	1				
102	Year 9 (82) Year 14 (96)	8 3	Year 3 (31) Year 9 (31)			
104	Year 14 (58)	2				
105	Year 3 (58) Year 9 (62) Year 14 (78)	2 3 1				
106	Year 14 (83)	16				
107	Year 14 (62)	5				
108	Year 9 (76) Year 14 (160)	14 42				
109*	Year 3 (162) Year 9 (165) Year 14 (92)	153 27 2	Year 3 (61) Year 9 (35)	Year 3 (125)	Year 3 (3.0)	Year 3 (5.3)
110	Year 9 (60) Year 14 (95)	2 21				
112	Year 9 (143) Year 14 (313)	16 79	Year 3 (37) Year 9 (34) Year 14 (43)			
114	Year 3 (64)	1				
145*			Year 3 (36) Year 9 (41)			
209*			Year 3 (32) Year 9 (35)			
264	Year 9 (86) Year 14 (99)	10 3	Year 3 (31) Year 9 (32)			
271*			Year 3 (44) Year 9 (46) Year 14 (46)	Year 9 (92) Year 14 (92)		
941*	Year 9 (82) Year 14 (96)	9 3	Year 9 (31)			

**Other mine owned property

9.5 Assessment of total (cumulative) 24-hour average PM_{10} concentrations

9.5.1 Introduction

The NSW EPA contemporaneous assessment method was applied to examine the potential maximum (cumulative) 24-hour average PM_{10} impacts for the proposal.

The analysis described in this section focusses on locations at which the data required to conduct this assessment are available and represent the assessment locations surrounding Warkworth Mine. The locations are five monitoring stations where suitable ambient monitoring data is available. The monitoring data collected at these sites cover the contemporaneous modelling period. The assessment of cumulative impacts uses the monitoring data from the closest monitor.

Figure 9-1 shows the location of each of these monitors in relation to Warkworth Mine and surrounding assessment locations.

Generally, these monitoring locations are representative of the most impacted receptors in the surrounding assessment locations as they are typically located closer to the mining activity and hence are likely to experience greater impacts. The predicted cumulative 24-hour average PM_{10} levels assessed at the monitor locations can therefore be considered a reasonable, conservative measure of the potential 24-hour average PM_{10} impacts that may arise across the representative assessment locations.

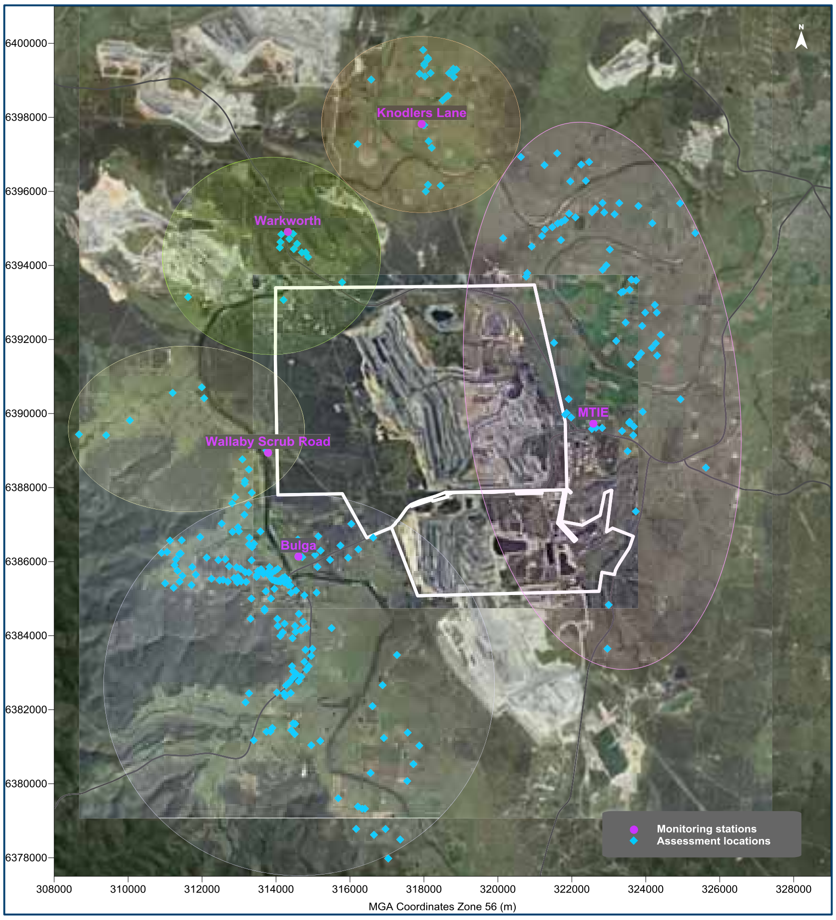

Figure 9-1: Locations available for contemporaneous cumulative impact assessment

9.5.2 Contemporaneous assessment per NSW EPA Approved Methods

An assessment of cumulative 24-hour average PM_{10} impacts was undertaken in accordance with the methods outlined in Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC**, **2005**). The "Level 2 assessment - Contemporaneous impact and background approach" was applied to assess potential impacts.

As shown in **Section 4**, maximum background levels have in the past reached levels near to the 24-hour average PM_{10} criterion level (depending on the monitoring location and time). As a result, the screening Level 1 NSW EPA approach of adding maximum background levels to maximum predicted proposal only levels would show levels above the criterion.

In such situations, the NSW EPA approach applies a more thorough Level 2 assessment whereby the measured background level on a given day is added contemporaneously with the corresponding proposal only level predicted using the same day's weather data. This method factors into the assessment the spatial and temporal variation in background levels affected by the weather and existing sources of dust in the area on a given day. However, even with a detailed Level 2 approach, any air dispersion modelling has limitations (as described in **Section 8**) in predicting short term impacts which may arise many years into the future, and these limitations need to be understood when interpreting the results.

Ambient (background) dust concentration data for January 2012 to December 2012 from the TEOM stations have been applied in the Level 2 contemporaneous 24-hour average PM_{10} assessment and represent the prevailing measured background levels in the vicinity of Warkworth Mine and surrounding assessment locations.

This period was chosen as it contains meteorological data that if representative for this area, and also as it contains the highest baseline PM_{10} levels measured in Bulga village, but does not contain the anomalous high peaks that occurred during the bushfire period in late 2013 or the relatively low levels that occurred in Bulga village in 2013. The use of this data is likely to result in a generally conservative estimate (ie an overestimate) of the potential cumulative air quality impacts which may be predicted to occur in this area.

As the existing mine was operational during 2012, it would have contributed to the measured levels of dust in the area on some occasions. Due to this it is important to account for these existing activities in the cumulative assessment. Modelling of the actual mining scenario for the 2012 period (in which the weather and background dust data were collected) was conducted to determine the existing contribution to the measured levels of dust. The results were applied in the cumulative assessment to minimise potential double counting of existing mine emissions (as they would occur in both the measured data and in the predicted levels), and thus to make a more reliable prediction of the likely cumulative total dust level.

As the proposal interacts with MTO, future MTO activities were included as part of the total cumulative assessment of likely future impacts.

Table 9-8 provides a summary of the findings of the contemporaneous assessment at each monitoring location. Detailed tables of the full assessment results are provided in **Appendix F**.

Table 9-8: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion depending on background level at monitoring sites

Location	Year 3	Year 9	Year 14
Bulga	0	0	0
Wallaby Scrub Road	0	0	0
Warkworth	1	6	4
Knodlers Lane	0	2	1
MTIE	0	3	0

The results in **Table 9-8** indicate that it is unlikely that cumulative impacts would arise at the assessment locations near the Bulga and Wallaby Scrub Road monitoring locations during the years assessed.

There is potential for cumulative impacts to arise near the Warkworth, Knodlers Lane and MTIE monitoring stations. The potential risk of cumulative impacts at the Knodlers Lane and MTIE monitors is relatively low with only two and three additional days, respectively, of predicted impact above the relevant criterion in Year 9 and only one day for Knodlers Lane in Year 14.

The potential risk of cumulative impacts near the Warkworth monitor is greater with one, six and four additional days predicted to exceed the relevant criterion in Year 3, 9 and 14, respectively. These impacts are as would be expected when analysing the predicted results and isopleth figures in **Appendix E**. The figures show that the prevailing winds would transport material along the mine pit and project dust northwards. As the mine progresses westwards, the impacts to the north of the mine move closer to Warkworth, as represented in the indicative mine plan years assessed.

9.6 Consideration of cumulative $PM_{2.5}$ impacts

There are currently no criteria applicable for $PM_{2.5}$ particulate impact assessment in NSW, however there are NEPM advisory reporting standards that apply to the exposure of the population as a whole. Care is taken by the various state governments to establish NEPM "performance monitoring sites", which are positioned away from "hot spots' such as industry, main roads and other sources of pollution. Compliance with the NEPM standards is assessed by monitoring at such sites, and therefore the NEPM criteria would not generally apply in the near proximity to coal mines, or near to other potentially large sources of particulate emissions.

Despite the absence of suitable criteria, this assessment quantifies the approximate levels of $PM_{2.5}$ that may arise as a result of the proposal.

There are no reliable $PM_{2.5}$ background monitoring data collected at the proposal with which to conduct an accurate technical assessment of impacts and therefore it is necessary to make an approximate assessment to consider 24-hour average $PM_{2.5}$ levels.

The lack of $PM_{2.5}$ data at the proposal is not unusual (such data is rare), but it is an impediment to making an accurate calculation of the likely total $PM_{2.5}$ level in the area. This is especially so in this case as it is known that particulate levels from coal mine emissions contain a relatively small fraction of $PM_{2.5}$ material (approximately 4.7% of TSP from mining – refer to **Section 3.1** and **Section 7.2.2**). This means that in the modelling, where all major mine sources of dust are accounted for, the residual, unaccounted portion of $PM_{2.5}$, for example due to non-mining sources such as wood smoke and other such sources may comprise a significant portion of total $PM_{2.5}$ levels in the environment.

In other words ambient $PM_{2.5}$ levels are likely to be governed by many minor non-mining background sources such as wood heaters and motor vehicles which cannot be reasonably modelled in small populations and rural areas, and there is little $PM_{2.5}$ monitoring data available with which to make a detailed assessment.

The nearest available $PM_{2.5}$ data is collected at the Upper Hunter Air Quality Monitoring Network station at Singleton. This data was examined in the absence of site specific data and is presented in **Figure 9-2**. The graph includes a moving average trend line on a 25 point basis and shows a trend of increasing $PM_{2.5}$ levels in the winter and reduced levels in the summer.

A peak in wintertime $PM_{2.5}$ levels in Singleton is shown. It is unlikely that this arises from mining activity as mining produces a relatively steady level of particulate emissions over the year. It can be reasonably inferred that the increase winter levels of $PM_{2.5}$ may be largely due to urban sources of fine particulate matter such as wood heaters, and that these sources appear to govern the population exposure to $PM_{2.5}$ in this area.

Examination of the available $PM_{2.5}$ measurement data for Singleton shows that during 2012, the annual average $PM_{2.5}$ level is approximately 8µg/m^3 and the 70th percentile 24-hour average maximum levels are approximately 9.6µg/m^3. Maximum 24-hour average levels are below 25 µg/m^3.

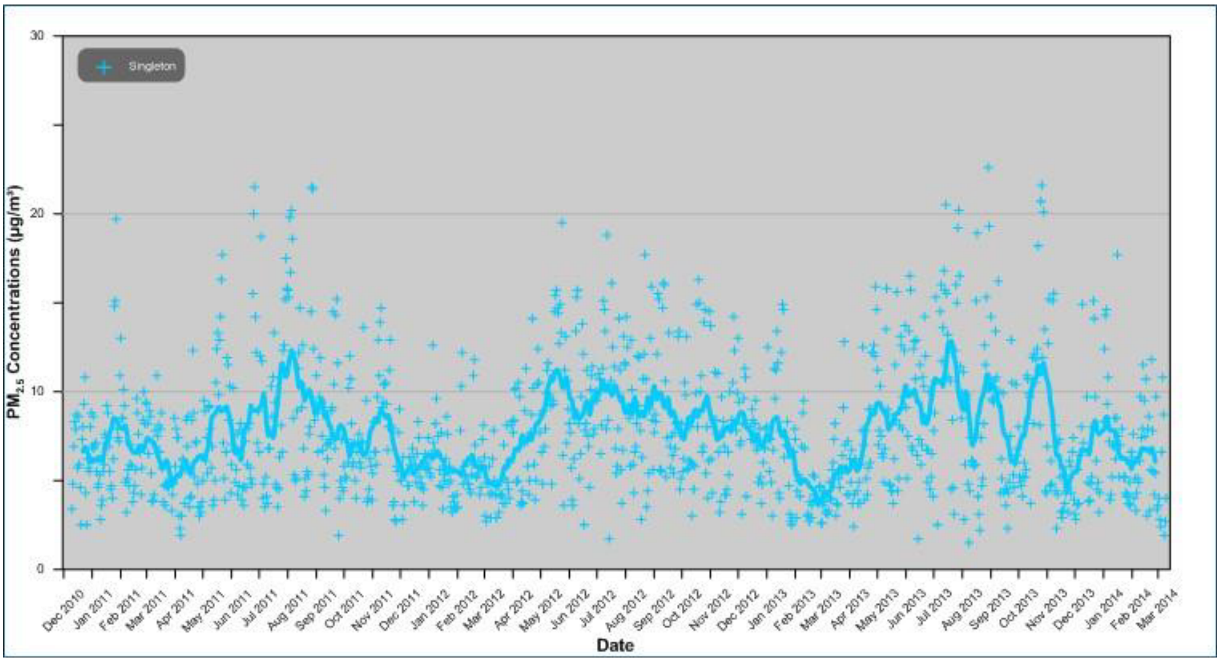

Figure 9-2: Measured $PM_{2.5}$ levels in Singleton

However, as the $PM_{2.5}$ levels in Singleton would be influenced by urban sources of fine particle emissions such as wood heaters, motor vehicles and other combustions sources potentially to a larger extent than the sparsely populated rural receptors surrounding the Warkworth Mine.

This is reflected in the recent CSIRO study (**CSIRO, 2013**) that characterises fine particulate matter in the Hunter Valley region. This study found that wood burning activities in winter make up an average of 62 per cent of the $PM_{2.5}$ in Muswellbrook and 38 per cent of the $PM_{2.5}$ in Singleton.

The monitoring data in Camberwell shows lower levels of $PM_{2.5}$ than are measured in Muswellbrook and Singleton, less of a winter peak, and the location is close to coal mining activity.

On the basis of the available information it would be reasonable to assume that the underlying background levels of $PM_{2.5}$ at the proposal site would be significantly lower than the levels in Singleton, given that wood heaters, people and cars are more widely spaced, and, therefore, the likely level has been estimated to be approximately 5µg/m^3 on an annual average basis and 9µg/m^3 on a 70th percentile 24-hour basis.

Examination of the incremental (mine alone) results for annual and 24-hour $PM_{2.5}$ shown in the tables in **Section 9**, reveals that if these levels were added to the assumed annual average background levels or the 70th percentile 24-hour maximum levels, then no assessment location (predicted to comply with the criteria for other pollutants) would experience $PM_{2.5}$ level above the NEPM advisory reporting standards.

Therefore, the indication is that $PM_{2.5}$ would not appear to be a limiting issue for air quality impacts from the proposal, and that air impacts, including $PM_{2.5}$, would be effectively managed through the existing framework for air quality impact assessment and regulation overseen by NSW EPA and P&I.

The recently released Upper Hunter Air Particles Action Plan (**NSW EPA, 2013**), by the NSW EPA provides additional information about air quality and the actions underway to improve air quality in the Upper Hunter. The action plan has a strong focus on reducing $PM_{2.5}$ levels in the region and outlines 18 actions of which include a dust stop program for coal mining operations, reducing emissions from diesel powered equipment and improving local government wood smoke management in the urban settlements. MTW is actively participating in these relevant actions to assist with the reduction in $PM_{2.5}$ levels from the operation.

10 ASSESSMENT OF DIESEL EMISSIONS

10.1 Preamble

It is generally considered that the quantity of emissions generated from diesel powered equipment used for mining activity is too low to generate any significant off-site concentrations. This is due to consideration of the relatively small individual sources, the generally large distance between the sources and assessment locations, and the generally widely spread distribution of sources across the mine site.

Recent analysis by NSW EPA indicates that a large amount of diesel fuel is used in mining and, consequently, that there may be potential for impacts to arise due to the emissions from diesel powered equipment used during operations.

It is noted that the available data do not indicate any likely issues in this regard. For example, NO_2 is a significant pollutant emitted from the combustion of diesel, yet NO_2 levels at the monitoring stations in the Hunter Valley are low relative to the criteria.

Also, fine particulate (ie $PM_{2.5}$) is a significant pollutant emitted from diesel combustion. However the recent CSIRO study (**CSIRO, 2013**) found that wood burning in winter made up an average of 62 per cent of the $PM_{2.5}$ in Muswellbrook and 38 per cent of the $PM_{2.5}$ in Singleton. Secondary sulphate and industry aged sea salt made the highest contribution during summer months, sulphate levels were found to be comparable to other Australian locations. Vehicle and industry sources comprised of approximately 8 per cent and 17 per cent in Muswellbrook and Singleton, respectively.

Whilst these data may not indicate any issue related to diesel combustion, it is recognised that the locations at which this data was collected are some distance away from coal mines. Thus an assessment of potential impacts from diesel combustion was conducted for the proposal to determine whether any risk may arise. It should be noted that emissions of fine particulate from diesel combustion in mining equipment is generally already included within the assessment of mine dust presented in **Section 8**.

10.2 Approach to assessment

10.2.1 Emission estimation

Emissions from diesel powered equipment were estimated on the basis of manufacturer's data. It is noted that manufacturer's equipment performance specifications were typically categorised on the basis of the US EPA federal tier standards of emissions for diesel equipment (**Dieselnet**, **2012**).

Emissions for certain plant included non-methane-hydrocarbon (NMHC) and NO_x emissions as a single value. For the purpose of this assessment it has been conservatively assumed that the total emission (NHMC and NO_x) comprises NO_2.

The various types of diesel powered mining equipment to be used under the proposal were identified (see **Table 10-1**). Plant hours of operation were based on assumed plant availability and utilisation rates for the specific equipment type, conservatively assuming that all operational plant operates at full power for 20 per cent of the time.

The emission rates used in the modelling are considered conservative and likely to overestimate actual emissions from mining equipment.

Table 10-1: Summary of diesel powered equipment and associated emissions

Equipment type	Number of equipment			CO (g/KWh)	NMHC + NOx / NOx (g/KWh)
	Year 3	Year 9	Year 14		
5500 Excavator	2	2	2	3.5	6.4
3600 Excavator	2	4	3	3.5	6.4
Loader	3	3	2	3.5	6.4
Dozer	17	20	22	3.5	3.5
RTD	2	2	3	3.5	6.4
Drill	4	5	5	3.5	6.4
Grader	4	4	4	3.5	4.0
Watercart	4	4	4	1.3	9.2
795 Truck	12	19	21	3.5	6.4
830E Truck	35	41	37	0.8	8.7
789 Truck	11	5	15	11.4	9.2

10.2.2 Dispersion modelling

Dispersion modelling of the diesel powered equipment was conducted for each indicative mine plan year. Modelled sources were described as point sources and incremental impacts due to the proposal were added to the ambient background level to assess potential impacts.

The NO_2 monitoring data presented in **Section 4** shows that the maximum measured 1-hour average NO_2 background level at the Singleton monitor during 2012 was 75.2µg/m^3. In lieu of any data for the site, per the Victorian EPA approach[1], the 70th percentile level of 41.4µg/m^3 obtained from the Singleton data was used as a constant background level contributing to the total cumulative impact predictions. The annual average NO_2 background level at the Singleton monitor during 2012 was 16.9µg/m^3.

It is noted that the background levels measured in Singleton are likely to be higher than the levels for the majority of assessment locations because there are many densely positioned sources of NO_X in Singleton, such as motor vehicles. The measured levels would also include some contribution of emissions arising from the existing operations and thus are considered to be even more conservative and likely to overestimate actual levels.

The conversion of NO_X to NO_2 was estimated using an empirical equation for estimating the oxidation rate of NO in power plant plumes developed by **Janssen et al. (1988)**. This method is outlined in the Approved Methods **(DEC 2005)** and is used to calculate the ratio of NO_2 to NO_X as determined by the atmospheric conditions and distance from the maximum recorded level to the source.

The separation distance from the sources to the maximum predicted 1-hour and annual average ground-level concentrations was taken to be the nominal distance from the centroid of all NOx sources to the nearest likely affected assessment locations. Applying conservative A and α constant values, the

[1]The Victorian Government's State Environment Protection Policy (Air Quality Management), **SEPP (2001)** states at Part B, 3(b) *"Proponents required to include background data where no appropriate hourly background data exists must add the 70th percentile of one year's observed hourly concentrations as a constant value to the predicted maximum concentration from the model simulation. In cases where a 24-hour averaging time is used in the model, the background data must be based on 24-hour averages. "*.

ratio of NO_2 to NO_X at receptors due to the diesel powered equipment was calculated to be approximately 15%.

10.3 Modelling predictions

Figure G-1 to **Figure G-6** in **Appendix G** present isopleth diagrams of the predicted modelling results for the assessed 1-hour average and annual average NO_2 concentrations.

Table 10-2 presents the model predictions at each of the assessment locations with background levels included. The values presented in bold red indicate predicted values above the relevant criteria.

Table 10-2: Predicted NO_2 concentrations (µg/m³) for each indicative mine plan year

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
1	51	17	55	17	56	17
2	52	17	55	17	57	17
3	53	17	57	17	59	17
4	53	17	57	17	59	17
5	53	17	58	17	59	17
6	54	17	58	17	59	17
7	53	17	57	17	58	17
8	54	17	59	17	60	17
9	53	17	57	17	59	17
10	54	17	58	17	59	17
11*	55	17	60	17	60	17
12	58	17	63	17	65	17
13	54	17	58	17	58	17
14	59	17	65	17	67	17
15	58	17	62	17	64	17
16	58	17	64	17	65	17
17	50	17	53	17	52	17
18	58	17	62	17	64	17
19	49	17	52	17	52	17
20	57	17	61	17	63	17
21	59	17	65	17	65	17
22	56	17	58	17	60	17
23	51	17	53	17	54	17
24	52	17	56	17	57	17
25	53	17	53	17	54	17
26	55	17	58	17	60	17
27	50	17	52	17	53	17
28	47	17	49	17	50	17
29	50	17	52	17	53	17
30	64	17	70	17	72	17
31	62	17	68	17	69	17
32	51	17	55	17	55	17
33	61	17	66	17	69	17
34	52	17	52	17	53	17
35	63	17	69	17	71	17

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
36	53	17	54	17	56	17
37	51	17	53	17	53	17
38	54	17	56	17	58	17
39	56	17	58	17	61	17
40	56	17	59	17	62	17
41	47	17	49	17	50	17
42	58	17	61	17	66	17
43	54	17	55	17	58	17
44	55	17	56	17	59	17
45	47	17	49	17	51	17
46	53	17	54	17	57	17
47	54	17	56	17	59	17
48	56	17	59	17	63	17
49	53	17	54	17	58	17
50	51	17	51	17	54	17
51	54	17	56	17	58	17
52	48	17	49	17	52	17
53	50	17	51	17	54	17
54	47	17	49	17	50	17
55	54	17	55	17	60	17
56	50	17	51	17	54	17
57	49	17	51	17	54	17
58	54	17	56	17	61	17
59	49	17	51	17	54	17
60	49	17	51	17	54	17
61	47	17	48	17	48	17
62	49	17	51	17	54	17
63	50	17	52	17	56	17
64	49	17	52	17	55	17
65	50	17	53	17	56	17
66	49	17	51	17	54	17
67	45	17	46	17	49	17
68	49	17	52	17	55	17
69	49	17	51	17	54	17
70	45	17	47	17	49	17
71	49	17	51	17	54	17
72	48	17	52	17	54	17
73	48	17	51	17	54	17
74	47	17	48	17	49	17
75	49	17	52	17	55	17
76	48	17	50	17	51	17
77	57	17	63	18	64	18
78	63	17	74	18	78	19
79*	57	17	63	18	63	18
80	46	17	48	17	51	17
81	56	17	62	17	64	17

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
82	48	17	50	17	51	17
83*	57	17	62	18	62	18
84	47	17	48	17	51	17
86	50	17	54	17	56	17
87	54	17	60	17	66	17
89	47	17	49	17	52	17
90	59	18	61	18	60	18
91*	59	18	61	18	61	18
92*	47	17	49	17	53	17
93	60	18	61	18	64	18
94*	60	18	60	18	62	18
95	52	17	59	17	62	17
96*	61	18	60	18	64	18
97	56	17	64	17	70	17
98	55	17	63	17	70	17
99*	63	18	59	18	64	18
100	57	17	63	17	69	17
101	58	17	67	17	70	17
102	64	18	58	18	64	18
103*	51	17	52	17	56	17
104	59	17	70	17	80	17
105	63	18	56	18	62	17
106	63	17	76	17	87	17
107	60	17	67	17	88	17
108	62	17	71	17	105	18
109*	84	20	79	19	61	18
110	61	17	69	17	104	17
111	48	17	51	17	50	17
112	62	17	89	17	129	18
113*	48	17	54	17	54	17
114	55	17	54	17	55	17
115*	51	17	57	17	68	17
116	52	17	54	17	63	17
117	49	17	52	17	51	17
118	49	17	53	17	51	17
118	49	17	53	17	51	17
119	50	17	55	17	62	17
120	48	17	49	17	49	17
121	48	17	50	17	52	17
122	48	17	49	17	50	17
123	48	17	49	17	53	17
124	48	17	49	17	51	17
125	57	18	54	18	54	18
126	64	18	55	18	56	18
127	57	17	56	17	59	17
128	61	18	55	18	58	18

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
129	58	18	53	17	54	17
130	55	17	51	17	53	17
131	61	18	60	18	63	18
133	52	17	51	17	55	17
134	55	17	51	17	53	17
135	82	18	74	18	71	18
136	80	18	72	18	71	18
137	54	17	51	17	53	17
138	69	18	68	18	70	18
139	54	17	53	17	54	17
140	75	18	69	18	71	18
141	50	17	51	17	54	17
142	53	17	50	17	53	17
143	53	17	50	17	54	17
144	62	18	60	18	59	18
145*	59	17	60	17	59	17
146	63	18	60	18	59	18
147	55	17	55	17	55	17
148	61	18	59	17	58	17
149	57	17	57	17	57	17
150	63	18	62	17	60	17
151*	64	18	63	18	62	18
152	52	17	53	17	55	17
153	58	17	57	17	56	17
154*	59	17	59	17	57	17
155	52	17	51	17	52	17
156	53	17	52	17	52	17
157	52	17	51	17	51	17
158	49	17	53	17	52	17
160	48	17	51	17	48	17
161	48	17	50	17	48	17
162	48	17	50	17	48	17
163	48	17	50	17	48	17
165	50	17	53	17	62	17
167	49	17	49	17	54	17
168	48	17	50	17	54	17
169	51	17	50	17	54	17
170	50	17	50	17	54	17
172	52	17	50	17	54	17
173	52	17	50	17	54	17
174	50	17	50	17	54	17
175	50	17	50	17	54	17
176	49	17	50	17	54	17
177	50	17	50	17	53	17
178	49	17	50	17	52	17
179	50	17	49	17	50	17

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
180	52	17	56	17	57	17
181	53	17	56	17	57	17
182	53	17	56	17	57	17
183	51	17	54	17	55	17
184	50	17	52	17	51	17
185	50	17	53	17	52	17
186	51	17	55	17	53	17
187	52	17	55	17	54	17
188	54	17	55	17	54	17
189*	58	17	59	17	57	17
190	63	18	61	17	59	17
191	52	17	56	17	56	17
192	55	17	59	17	58	17
193	46	17	47	17	48	17
194*	47	17	48	17	48	17
195*	46	17	48	17	48	17
196*	46	17	47	17	47	17
197	45	17	46	17	46	17
198*	45	17	46	17	46	17
199	44	17	45	17	45	17
200	44	17	45	17	45	17
201	44	17	45	17	46	17
202	44	17	45	17	46	17
203	45	17	46	17	46	17
204	45	17	46	17	47	17
205	45	17	46	17	47	17
206	45	17	46	17	47	17
207	45	17	47	17	47	17
208	46	17	48	17	48	17
209*	57	17	57	17	55	17
210	50	17	52	17	56	17
211	49	17	52	17	55	17
215	64	17	70	17	72	17
217	57	17	62	17	64	17
218	52	17	56	17	57	17
219	51	17	54	17	55	17
220	53	17	57	17	59	17
221	51	17	54	17	56	17
222	51	17	54	17	56	17
223	52	17	55	17	57	17
224	51	17	55	17	56	17
225	53	17	56	17	58	17
226	52	17	55	17	56	17
227	53	17	55	17	57	17
228	52	17	54	17	55	17
229	53	17	56	17	57	17

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
230	51	17	53	17	54	17
231	52	17	53	17	54	17
234	47	17	48	17	49	17
235	47	17	47	17	47	17
236	48	17	49	17	49	17
237	47	17	47	17	47	17
238	47	17	47	17	48	17
243	46	17	49	17	52	17
244	50	17	49	17	50	17
245	50	17	49	17	48	17
246	50	17	49	17	49	17
247	50	17	49	17	50	17
248	49	17	50	17	53	17
249	49	17	50	17	53	17
250	49	17	49	17	50	17
251	48	17	49	17	49	17
252	49	17	50	17	50	17
253	53	17	56	17	57	17
254	47	17	48	17	48	17
255	57	17	63	17	63	17
256	48	17	50	17	48	17
257	50	17	49	17	49	17
258	48	17	50	17	48	17
259	49	17	51	17	54	17
260	48	17	50	17	48	17
261	48	17	50	17	48	17
262	64	18	55	18	57	18
263	53	17	57	17	56	17
264	65	18	57	18	64	18
265	49	17	53	17	50	17
266	54	17	58	17	59	17
267	51	17	54	17	55	17
268	49	17	52	17	53	17
269*	67	17	75	17	76	17
270*	56	17	62	17	62	17
271*	53	17	64	17	63	17
903	46	17	49	17	52	17
904	45	17	46	17	47	17
905	44	17	45	17	45	17
909	46	17	48	17	50	17
911	44	17	45	17	45	17
915	64	18	60	18	60	18
917	45	17	48	17	50	17
918	46	17	49	17	51	17
919	47	17	49	17	52	17
920	49	17	51	17	54	17

Assessment location ID	Year 3		Year 9		Year 14	
	1-hour average	Annual average	1-hour average	Annual average	1-hour average	Annual average
	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)	Criterion 246 (µg/m³)	Criterion 62 (µg/m³)
921	47	17	49	17	50	17
922	46	17	47	17	48	17
923	46	17	47	17	48	17
926	47	17	48	17	49	17
927a	45	17	47	17	48	17
927b	45	17	47	17	49	17
927c	45	17	48	17	49	17
927d	46	17	47	17	48	17
927e	46	17	48	17	48	17
927f	46	17	48	17	49	17
927g	44	17	45	17	46	17
927h	45	17	46	17	47	17
927i	45	17	46	17	47	17
927j	45	17	46	17	48	17
928	45	17	47	17	49	17
929	45	17	47	17	50	17
932	54	17	53	17	52	17
936	45	17	47	17	49	17
937a	58	17	56	17	56	17
937b	58	17	55	17	56	17
937c	57	17	53	17	53	17
937d	52	17	52	17	52	17
937e	52	17	52	17	52	17
941*	64	18	57	18	64	18

*Other mine owned property

10.4 Results

10.4.1 Analysis of NO_2 modelling

The modelling predictions in **Table 10-2** indicate that in Year 3, 9 and 14 all assessment locations are predicted to experience maximum 1-hour average and annual average NO_2 concentrations below the relevant criterion of 246µg/m³ and 63µg/m³, respectively.

10.4.2 Other diesel powered plant impacts

The ambient air quality goals for CO are set at higher concentration levels than the NO_2 goals. Based on the NO_2 monitoring data which are low compared to the goals, and consideration of the typical mix of ambient pollutant levels and associated emissions of CO, the indication is that predictions of CO would be well below the air quality goals and do not require further consideration.

11 ASSESSMENT OF BLAST FUME EMISSIONS

11.1 Preamble

Air quality impacts of blast operations at Warkworth Mine are managed under MTW's Blast Management Plan (BMP) MTW-10-ENVMP-SITE-060. The purpose of the BMP is to ensure that blasting operations comply with all relevant requirements particularly noise, overpressure, vibration, blast fume and dust effects.

The BMP applies a blasting permissions flowchart to guide operators on the suitability of various factors including the current weather conditions for blasting. The BMP takes into consideration meteorological factors such as wind speed and direction which can affect the scale of potential blast impacts at assessment locations.

A predictive blast system is also used, to schedule blast events to the least-risk time of the day where feasible. This approach minimises the risk of any off-site impact occurring, and is based on hourly forecast weather conditions that may affect the dispersion of blast emissions.

11.2 Approach to assessment

11.2.1 Emission estimation

Blast fume emissions (NO_2) were estimated on the basis of emission levels presented in a CSIRO study of Hunter Valley blasts (**Attala et al., 2008**). Blast fume emissions can vary greatly depending on a number of factors but largely depend on the tendency of a particular blast to generate NO_2 emissions. The assessment is based on the measured level of emissions presented in the CSIRO study.

11.2.2 Dispersion modelling

Dispersion modelling of the potential blast fume emissions was conducted for each indicative mine plan year. The model setup was generally in accordance with the setup discussed in **Section 6**. Blast emission sources were modelled in the centre of the active pit location during each year. It is noted that the source location would vary; however, for the purposes of this assessment it is considered that the centre of the pit would provide a suitable indication of the potential impacts.

The model was set up to generate a blast during each hour of the day when blasting is permitted, and considering weather conditions and the existing blast permissions. In other words the model was programmed to halt a blast based on the weather condition if that is what the blasting permissions would require.

As a comparison, modelling of blasts during each hour of the day without consideration of the blasting permissions was also conducted to determine the suitability of these permissions.

11.3 Modelling predictions

Figure H-1 to **Figure H-27** in **Appendix H** present isopleth diagrams of the predicted modelling results for the assessed maximum 1-hour average NO_2 concentrations during each potential blast hour of each year. It should be noted that the isopleth diagrams show the maximum hourly extent of all potential blasts in all daytime hours in a full year per the blast permissions, and do not represent a single blast event.

The isopleth diagrams indicate that based on the potential blast hours in each day, blasts occurring at 4:00pm and 5:00pm have the potential to result in adverse blast fume impacts. This indicates that the meteorological conditions during these periods may at times be unfavourable for blasting and the most case should be taken if conducting blasting at these times.

The decision to blast under such conditions is based on skilled and experienced operator judgement of the actual prevailing weather conditions, forecast weather conditions and the expected nature of potential plume travel towards the nearest assessment locations. It is not reasonably possible to incorporate the human decision making element of the blast permissions into a computer model, thus it is considered likely that the potential late evening impacts that are predicted in the modelling would not arise in practice, due to the benefit of the actual human intervention that occurs.

An examination of the blast impact isopleth diagrams shown in **Figure H-1** to **Figure H-27** in **Appendix H** was conducted to analyse any potential issues of compliance with the NO_2 criterion of 246µg/m^3, 1-hour average. The red isopleths show the impact that could hypothetically occur if blasting occurred without any regard to the blast permissions (on every hour of the day) and the light blue isopleths show the potential impact if the blast permissions that apply are adhered to.

The results indicate that whilst the blast permissions take into account the location of the blast in reference to the surrounding assessment locations, the prevailing meteorological conditions in which blasts are not permitted occur infrequently and the modelling results show little difference.

11.4 Conclusions

Overall, it is noticeable that during the middle daytime hours no impacts due to blasting fume emissions are predicted to occur. During these times, the blast permissions have a relatively small effect in mitigating impacts (largely as there would not be any appreciable impact to mitigate).

However, in the early evening, when there is potential for impacts to arise off-site, the results show that application of the blasting permissions would avert such potential impacts for most assessment locations.

As the proposal is moving west, the potential for blast fume impacts to the west increases. This means that potential impacts at assessment locations to the west will need to be managed more stringently in later years of mining.

It is noted that in this regard MTW have implemented a predictive management system to aid with management of blasting operations. Such a system uses actual conditions for each blast to predict the potential impact which may occur. The prediction is made on the basis of forecast weather data, allowing operators to schedule a blast to the time of least impact over the course of the upcoming day. In effect the system updates the blasting permissions for each individual blast on the basis of predicted impact. The system thus deals with the spatially and time varying weather and terrain influences and is generally more reliable than relying on a fixed set of wind speed and wind direction restrictions.

Overall, it is anticipated that with due care, potential blast impacts would be averted.

12 PARTICULATE MATTER HEALTH EFFECTS

12.1 Introduction

The following section is a summarised excerpt of private correspondence from Environmental Risk Sciences Pty Ltd to Todoroski Air Sciences.

Detailed reviews of the available studies that relate to health effects associated with exposure to particulates are available from various sources (**NEPC 2010, USEPA 2009**, **Anderson et al. 2004, WHO 2003, OEHHA 2002**). Particulate matter is comprised of a diverse range of substances, with varying morphological, chemical, physical and thermodynamic properties, across a large size range. Particulates can be derived from natural sources such as crustal dust, pollen, sea salts and moulds, and anthropogenic (human) activities including combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The most significant contributors to secondary particulates include nitrogen oxides, ammonia, sulfur oxides, and certain organic gases (emitted from vehicles, combustion, agriculture, industry and biogenic sources).

Particulate matter comprises particles which can remain suspended in the air for extended periods, and is typically classified by particle size.

12.2 Particulate size

The size of particulates is important as it determines how far from an emission source the particulates may be present in air (with larger particulates settling out first and smaller particles remaining airborne for greater distances) but also the potential for adverse effects to occur as a result of exposure.

The common measures of particulate matter that are considered in the assessment of air quality and health risks are previously outlined in **Section 3.1** with more detail in regard to health as follows:

- TSP refers to all particulate with an equivalent aerodynamic particle size below approximately 50µm diameter. Larger particles (termed "inspirable", comprise particles around 10µm and larger) that may cause nuisance and would deposit out of the air (measured as deposited dust) closer to the source. Such particles, if inhaled are mostly trapped in the upper respiratory system[2] and do not reach the lungs. Finer particles (smaller than 10µm, termed "respirable") tend to be of more concern as these particles can penetrate into the lungs. As only a fraction of TSP material is harmful to human health, it is a measure of nuisance impact, not health impact.

- PM_{10}, particulate matter below 10µm in diameter, $PM_{2.5}$, particulate matter below 2.5µm in diameter and PM_1, particulate matter below 1µm in diameter. These particles are small and have the potential to penetrate beyond the nose and upper respiratory system, with the smaller particles able to penetrate into the lower respiratory tract[3] and lungs which may result in adverse health effects (**OEHHA, 2002**).

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[2] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.

[3] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

Monitoring for PM_{10} is the most commonly applied metric in local and regional air quality monitoring program. Smaller particulates such as $PM_{2.5}$ and PM_1 are generally of most significance with respect to evaluating health effects as a higher proportion of these particles penetrate into the lungs; however, monitoring for such particulate matter is technically challenging and thus is not widely established. Thus PM_{10} monitoring serves as a defacto method of measuring $PM_{2.5}$ (**WHO, 2005**).

Apart from small aerodynamic diameter factors such as the hygroscopicity, electrostatic charge, and characteristics of the human respiratory system including airway structure and geometry, as well as depth, rate and mode of breathing (eg nasal vs. oral/nasal) affect the extent of particulate penetration and deposition into the lung.

A significant amount of research has been conducted on the health effects of particulates with causal effects relationships identified for exposure to $PM_{2.5}$. A more limited body of evidence suggests an association between exposure to larger particles, PM_{10} and adverse effects (**USEPA, 2009 and WHO, 2003**).

12.3 Particulates composition

Evaluation of size alone in regard to particle health impacts is difficult as particle size may not be independent of chemical composition. Certain particulate size fractions tend to contain certain chemical components, such as crustal materials in the coarse particle fraction (PM_{10} or larger) or metals in fine particulates ($<PM_{2.5}$). In addition, different sources of particulates may emit other pollutants in addition to particulate matter. For example, combustion sources, the dominant particulate source in urban areas, emit predominantly fine particulates as well as gaseous pollutants such as ozone, nitrogen dioxide, carbon monoxide and sulfur dioxide, all of which have independent health effects.

There is strong evidence (**WHO, 2003**) to conclude that fine particles (<2.5µm, $PM_{2.5}$) are more hazardous than coarse particles, primarily on the basis of studies conducted in urban air environments where there is a higher proportion of fine particulates present from fuel combustion sources, rather than from crustal origins. Studies indicate that particles generated from fossil fuel combustion may be a significant contributor to adverse health outcomes. Amongst the characteristics found to be contributing to these outcomes are high organic carbon content, metal content, presence of Poly-cyclic Aromatic Hydrocarbons (PAHs), other organic components, endotoxin and both small (<2.5µm) and extremely small size (<100nm) particulate (**USEPA 2009, WHO 2006a**, **WHO 2003**).

This does not mean that the coarse fraction of PM_{10} is not harmful, however, it appears to be a less critical source (**WHO, 2003 and USEPA, 2009**).

The observed health effects are derived from studies conducted in urban areas, whereas the actual health impacts from particulate matter in a specific location would be affected by the specific characteristics of the mix of particulate matter at the location.

Reviews of the currently available information have not been able to identify any single physical or chemical property of particles that is responsible for the array of adverse health outcomes reported in epidemiological studies (**USEPA, 2009 and WHO, 2003**). Hence, WHO (**WHO, 2006b**) and NEPC (**NEPC, 2010**) concluded that the evidence at present cannot support an indicator for a standard that is more specific than size fraction alone.

As a consequence, the potential for adverse health effects is assumed to apply equally for all sources and composition of particulates at this time.

12.4 Health effects

Adverse health effects associated with exposure to particulate matter have been primarily derived from population-based epidemiological studies. It is difficult to obtain reliable measures of $PM_{2.5}$, hence much of data considered in the studies is based on ambient PM_{10} data measured in urban areas.

Short term exposure (days to weeks) and long term exposure (years) to PM_{10} has been linked to adverse health effects.

Mortality effects relate to the increase in the number of deaths due to existing (underlying) respiratory or cardiovascular diseases that have been associated with exposure to PM_{10} or $PM_{2.5}$ in population-based epidemiological studies.

Morbidity effects relate to a wide range of health indicators used to define illness or the severity of illness associated with exposure to PM_{10} or $PM_{2.5}$, primarily related to the respiratory and cardiovascular system (**USEPA, 2009 and Morawska et al., 2004**) and include:

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days);
- Changes in cardiovascular risk factors such as blood pressure;
- Changes in lung function and increased respiratory symptoms (including asthma);
- Changes to lung tissues and structure; and
- Altered respiratory defence mechanisms.

These effects are commonly used as measures of population exposure to particulate matter in community epidemiological studies. While there is general agreement on the mortality effects associated with exposure to particulate matter, it is noted that there is less agreement on the wide range of morbidity indicators.

12.5 Summary of health effects

The following table presents a summary of the adverse effects associated with exposure to particulate matter in generally large cities and the susceptible populations identified (relevant to the health endpoint).

Table 12-1: Summary of potential adverse health effects from exposure to particulate matter in cities

Health-effect	Susceptible group	Comments
Short term		
Mortality	Elderly, infants, persons with chronic cardiopulmonary disease, influenza or asthma	Causal relationship has been identified for exposure to PM_{10} and $PM_{2.5}$.
Hospitalisation rates (respiratory and cardiovascular effects)	Elderly, infants, persons with chronic cardiopulmonary disease, pneumonia, influenza or asthma	Reflects substantive health impacts in terms of illness, discomfort, treatment costs, work or school time lost.
Increased respiratory symptoms	Most consistently observed in people with asthma, and children	For most, effects are transient with minimal overall health consequences. May result in some short term absence from work or school due to illness.
Decreased lung function	Observed in both children and adults	For most, effects seem to be small and transient.
Long term		
Increased mortality rates, reduced survival times, chronic cardiopulmonary disease, reduced lung function, lung cancer	Observed in population-wide epidemiological studies, including adults, children and infants. All chronically exposed are potentially affected	Long-term repeated exposure appears to increase the risk of cardiopulmonary disease and mortality. May also result in lower lung function.

12.6 Considerations relevant to mining

Table 12-1 relates to studies of human exposure to particulate matter in generally large cities, where a larger portion of the particulates are in the fine fraction that would penetrate into the lung, and also where a greater portion of the particulate matter is from combustion sources, and thus carries with it other individually toxic substances that are damaging to human health.

It is important to understand that the majority of particulate emissions from mining are dust which originates from the soil. Due to the extreme forces required at the micro level to break down a particle of dust into smaller particles in the fine fraction, mining techniques used at coal mines generally cannot breakdown rock, coal or soil material into these very fine fractions. As a result emissions from mines are predominantly in the coarse size fraction which would not penetrate as deeply into the lung, or carry additional toxic combustion substances. On average it has been measured that approximately 5 per cent of the total dust (TSP) from mining is in the $PM_{2.5}$ size fraction, and approximately 12 per cent of PM_{10} from mining is in the $PM_{2.5}$ fraction (**SPCC, 1986**).

In contrast, in the urban areas in which the majority of the health studies have been conducted, approximately 50 per cent of the PM_{10} is comprised of particles in the $PM_{2.5}$ size range, and most of these are from combustion.

It needs to be understood that rural populations are simply too small for conclusive epidemiological studies to be conducted in those areas, and insufficient alternative data is available for rural areas to identify specific issues that health experts can agree on. Therefore, as a matter of precaution, the findings for urban areas (as shown in **Table 12-1**) are extrapolated to cover rural areas in order to have a basis for managing exposure to particulate matter for rural populations.

This is not to say that particulate emissions from mining are harmless. Mining emissions include a component of particles in the PM_{10} and $PM_{2.5}$ range and this would include fine combustion particles from diesel equipment.

In the context of health impacts in rural areas, it needs to be noted that in many rural areas domestic wood smoke is a key issue of health impact. Wood smoke warrants close attention in any evaluation of health impact as it can be a significant, highly localised source of toxic pollution in the winter period for rural communities and individuals.

The recent studies by CSIRO (**CSIRO, 2013**) into the composition of particulate matter in the Hunter Valley found that a key source of fine particulate is wood smoke. As has occurred in many rural towns, NSW EPA has launched an initiative to target particulates in the Hunter Valley (**NSW EPA, 2013**), and a key action relates to management of wood smoke in the urban areas.

In this regard it is also important to interpret emission inventory data, such as NPI data and data from NSW EPA's air emissions inventory for the Greater Metropolitan Region (GMR) in NSW in the correct context. For example, if one compares mine dust emissions with those from wood heaters based on only the inventory data, one would see that the two produce roughly the same amount of $PM_{2.5}$ emissions. However, it would be wrong to conclude that mines and wood heaters have similar health impacts on the residential population. Unlike coal mines, wood heaters are located inside living rooms and their chimneys are closer to residents than coal mines, which means the air that the population breathes will be affected by wood heater emissions to a much greater degree.

It also needs to be noted that health should be considered in terms of risk of adverse impacts to individuals residing in a specific location, but also in regard to the impacts on the whole community. In the Hunter Valley, the community includes mine workers, and to maintain overall population health it is reasonable to also minimise mine staff exposure to pollutants that may be harmful, or to situations that may be dangerous.

13 GREENHOUSE GAS ASSESSMENT

13.1 Introduction

Dynamic interactions between the atmosphere and surface of the earth create the unique climate that enables life on earth. Solar radiation from the sun provides the heat energy necessary for this interaction to take place, with the atmosphere acting to regulate the complex equilibrium. A large part of this regulation occurs from the "greenhouse effect" with the absorption and reflection of the solar radiation dependent on the composition of specific greenhouse gases in the atmosphere.

Over the last century, the composition and concentration of greenhouse gases in the atmosphere has increased due to increased anthropogenic activity. Climatic observations indicate that the average pattern of global weather is changing as a result. The measured increase in global average surface temperatures indicate an unfavourable and unknown outcome if the rate of release of greenhouse gas emissions remain at the current rate.

This assessment aims to estimate the predicted emissions of greenhouse gases (GHG) to the atmosphere due to the proposal and to provide a comparison of the direct emissions from the proposal at the state and national level.

13.2 Greenhouse gas inventory

The National Greenhouse Accounts (NGA) Factors document published by the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICSRTE) defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions generated are from "direct" or "indirect" sources.

Scope 1 emissions encompass the direct sources from the proposal defined as:

"*...from sources within the boundary of an organisation as a result of that organisation's activities*" (**DIICSRTE, 2013a**).

Scope 2 and 3 emissions occur due to the indirect sources from the proposal as:

"*...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation*" (**DIICSRTE, 2013a**).

For the purpose of this assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total GHG emissions generated from the proposal.

Scope 3 emissions can often result in a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the proposal. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the proposal. The primary contribution of the Scope 3 emissions from the proposal occurs from the transportation of the product coal and from the end use of the product coal.

Scope 3 emissions also have the potential to arise from a greater number of sources associated with the operation of the proposal. As these are often difficult to quantify due to the diversity of sources and relatively minor individual contributions, they have not been considered in this assessment.

13.2.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the proposal are the on-site combustion of diesel fuel, petrol fuel, petroleum based greases and oils, explosives, emissions of methane from the exposed coal seams, gaseous fuels and on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, petrol, petroleum based greases and oils, electricity for use on-site, the transport of product to its final destination and the final use of the product.

Estimated quantities of materials that have the potential to emit GHG emissions associated with Scope 1 and 2 emissions for the proposal have been summarised in **Table 13-1** below. These estimates are based on a conservative upper limit of the assumed maximum production throughout the life of the proposal. The assessment provides a reasonable worst case approximation of the potential GHG emissions for the purpose of this assessment.

Table 13-1: Summary of quantities of materials estimated for the proposal

Period	ROM coal (tonnes)	Diesel (kL)	Petrol (kL)	Grease/oils/lubes (kL)	Electricity (kWh)	Explosives (t)	LPG (kL)	Acetylene (m^3)
Annual	18,000,000	116,729	125	864	179,697	67,645	0.19	1,279
Total	378,000,000	2,451,315	2,627	18,136	3,773,636	1,420,536	4	26,851

Scope 3 emissions for the transport and final use of the coal may have the potential to vary in the future depending on the market situation at the time. These assumptions include emission factors for the transport modes of rail and shipping and the associated average weighted distance travelled for the export coal.

13.2.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the proposal, emission factors obtained from the NGA Factors (**DIICSRTE, 2013a**) and other sources as required and are summarised in **Table 13-2**.

Table 13-2: Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope	Source
		CO_2	CH_4	N_2O			
Diesel	38.6	69.2	0.2	0.5	kg CO_2-e/GJ	1	Table 4 (**DIICSRTE, 2013a**)
		5.3				3	Table 40 **DIICSRTE, 2013a**)
Petrol	34.2	66.7	0.6	2.3	kg CO_2-e/GJ	1	Table 4 (**DIICSRTE, 2013a**)
		5.3				3	Table 40 (**DIICSRTE, 2013a**)
Grease/oils/lubes	38.8	27.9			kg CO_2-e/GJ	1	Table 3 (**DIICSRTE, 2013a**)
		5.3				3	Table 40 (**DIICSRTE, 2013a**)
Electricity		0.87			kg CO_2-e/kWh	2	Table 5 (**DIICSRTE, 2013a**)

Type	Energy content factor	Emission factor			Units	Scope	Source
		CO_2	CH_4	N_2O			
		0.19				3	Table 41 (**DIICSRTE, 2013a**)
Explosives[(1)]		0.18			t CO2-e/tonne	1	Table 4 (**DCC, 2008**)
LPG	25.7	1.547			kg CO_2-e/GJ	1	Proponent
Acetylene	0.0393	0.002			t CO_2-e/m^3	1	Proponent
Fugitive emissions		0.045			kg CO_2-e/t ROM	1	Table 7 (**DIICSRTE, 2013a**)
Rail		16.66			t CO_2-e/Mt-km	3	Proponent
Ship – Handy		5.422			t CO_2-e/Mt-km	3	Proponent
Ship – Panamax		3.459			t CO_2-e/Mt-km	3	Proponent
Ship – Bulk Carrier		2.090			t CO_2-e/Mt-km	3	Proponent
Thermal coal[(2)]	29	88.2	0.03	0.2	kg CO_2-e/GJ	3	Table 1 (**DIICSRTE, 2013a**)

(1)Assumes all explosives considered as Heavy ANFO

(2)Assumes type of coal is anthracite

Product coal is transported to the Port of Newcastle by rail and then transferred to coal loaders before being shipped to its final destination. The approximate rail distance is taken to be 166km (return distance). The approximate shipping distance of 13,000km (return distance) is based predominately on destinations in the Asian market.

The emissions generated from the end use of coal produced by the proposal have assumed that 5 per cent of the product coal is consumed at the Redbank power station and the remaining quantity is assumed to be used in power generation and steel manufacturing. As it is difficult to estimate emissions from power stations in other countries, this assessment has assumed the emissions generated would be equivalent to those generated from a power station in NSW. For the product coal used in steel manufacture we have taken a mass balance approach and assumed that all the carbon used will be converted to CO_2, where in reality some of the carbon would be captured in the steel. This approach is very conservative; however, in the absence of specific data, it has been adopted for this assessment.

13.3 Summary of greenhouse gas emissions

Table 13-3 summarises the estimated annual CO_2-e emissions due to the operation of the proposal.

Table 13-3: Summary of CO_2-e emissions for the proposal (t CO_2-e)

		Annual	Total
Fugitive emissions	Scope 1	553,687	11,627,437
Diesel	Scope 1	314,952	6,613,990
	Scope 3	23,880	501,490
Petrol	Scope 1	298	6,252
	Scope 3	23	476
Grease/oil/lubes	Scope 1	935	19,633
	Scope 3	178	3,730
Electricity	Scope 2	156,336	3,283,063
	Scope 3	34,142	716,991
Explosives	Scope 1	12,176	255,696
LPG	Scope 1	7.7	160.7
Acetylene	Scope 1	0.1	2.1
Transport via rail	Scope 3	33,104	695,179
Transport via ship	Scope 3	446,919	9,385,292
Final use of product – power supply	Scope 3	16,963,969	356,243,350

		Annual	Total
Final use of product – steel	Scope 3	21,945,000	460,845,000

13.4 Contribution of greenhouse gas emissions

Table 13-4 summarises the emissions associated with the proposal based on Scopes 1, 2 and 3.

Table 13-4: Summary of CO2-e emissions per scope (t CO_2-e)

Period	Scope 1	Scope 2	Scope 3
Annual	882,056	156,336	39,447,215
Total	**18,523,171**	**3,283,063**	**828,391,507**

The estimated annual greenhouse emissions for Australia for the period October 2012 to September 2013 was 567.5 Mt CO_2-e (**DoE, 2014**). In comparison, the conservative estimated annual average greenhouse emission over the 21-year life of the proposal is 1.038Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the proposal in comparison to the Australian greenhouse emissions for the period October 2012 to September 2013 is conservatively estimated to be approximately 0.18 per cent.

At a state level, the estimated greenhouse emissions for NSW in the 2010-11 period was 159 Mt CO_2-e (**DIICSRTE, 2013b**). The annual contribution of greenhouse emissions from the proposal in comparison to the NSW greenhouse emissions for the 2010-11 period is conservatively estimated to be approximately 0.65 per cent.

The estimated greenhouse gas emissions generated in all three scopes are based on approximated quantities of materials and where applicable generic emission factors. Therefore the estimated emissions for the proposal are considered conservative.

13.5 Greenhouse gas management

The proposal will continue to utilise various mitigation measures to minimise the overall generation of greenhouse gas emissions. The proposal's climate change programme has objectives in four key areas delivered through ongoing integration into existing business processes:

- Supporting research and promotion of technologies that reduce carbon dioxide emission from the use of coal;
- The improved use of energy at operations, projects and supply chain;
- Designing future projects with energy efficiency and climate change risks considered; and
- Raising awareness amongst stakeholders that climate change is an issues that requires us all to change how we currently operate.

Research programme funding is provided for the COAL21 Fund, the Australian Coal Association Research Programme (ACARP) and the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) to support and develop the research of low emissions coal technologies.

The bulk consumption of diesel is monitored and reported monthly with the on-site fuel management system monitoring the quantity of fuel dispensed from tanks and service trucks through metering. Vehicles and plant equipment are fitted with identification tags to assist in tracking diesel consumption; the regular maintenance of diesel equipment ensures operational efficiency.

The total site electricity consumption is monitored and reported monthly with significant infrastructure and equipment such as the CPPs, draglines and electric rope shovels fitted with various meters to monitor electricity consumption.

MTW have developed and implemented energy efficiency performance metrics for fuel and electricity consumption which are tracked monthly against internal targets.

Waste is managed across the site in accordance with an appropriate waste management procedure. Waste management contributes to energy efficiency through measures such as planning when purchasing items to avoid or minimise waste with preference is given to products that are recyclable and reusable over ones that are not; consideration of minimum of packaging or packaging which is reusable or recyclable; and segregating waste to facilitate maximum reuse or recycling.

14 CONCLUSION

The study has identifies the potential air quality impacts that may arise from the proposal. The assessment utilises air dispersion modelling and focuses on potential dust impacts from the proposal in isolation (incrementally) and cumulatively with other nearby mines and background levels of dust. The assessment also investigates the potential air quality impacts associated with diesel fuel combustion, blast fume emissions and calculates potential greenhouse gas emissions.

The dispersion modelling predictions show that 27 assessment locations may experience levels above the relevant criterion for certain dust metrics due to the proposal.

Of these 27 potentially affected assessment locations, 24 are mine owned properties. The other three are identified as assessment locations 77, 102 and 264. Location 102 is the Warkworth community hall, and the remaining two assessment locations are privately owned residences in Warkworth. All three of these properties would lie within the area encompassed by the acquisition zone of the neighbouring mines, but it should be noted that assessment location 264 is newly identified and does not appear in the explicit list of affected properties. In any case, all three of these potentially affected, non-mine owned properties would be afforded acquisition rights should the proposal proceed.

The assessment of cumulative 24-hour average PM_{10} concentrations found that impacts may potentially occur near the Warkworth, Knodlers Lane and MTIE monitoring locations. Of these locations, the potential risk of cumulative impacts is greatest near the Warkworth monitor as would be expected given the prevailing wind conditions in the area are likely to transport material from the operation towards this location as it progresses in a westerly direction.

An indicative cumulative 24-hour average $PM_{2.5}$ assessment reveals that no assessment location (predicted to comply with the criteria for other pollutants) would experience $PM_{2.5}$ level above the NEPM advisory reporting standards.

The assessment of diesel emissions show that in the assessed years, all assessment locations are predicted to experience NO_2 concentrations below the relevant criterion.

The investigation into potential blast impacts found that the area of potential risk would shift towards the west over time with the progression of the proposal. With the current blast management practices, it is anticipated that any potential blast impacts can be adverted.

The greenhouse gas assessment conservatively estimated the annual Scope 1 and Scope 2 emission generated from the proposal is 1.038Mt CO_2-e. Relative to the annual greenhouse gas emissions from Australian and NSW is estimated the proposal would contribute to be approximately 0.18 per cent and 0.65 per cent respectively.

15 REFERENCES

AECOM (2013)

"Preliminary Environmental Assessment Rix's Creek Continuation of Mining Project", Prepared by AECOM Australia Pty Ltd for Rix's Creek Pty Ltd, November 2013

Anderson, C. H., Atkinson, R. W., Peacock, J. L., Marston, L. and Konstantinou, K. (2004)

"Meta-analysis of time-series studies and panel studies of Particulate Matter (PM) and Ozone (O3), Report of a WHO task group", World Health Organisation, 2004.

Attalla M. I., Day S. J., Lange T., Lilley W. and Morgan S. (2008)

"NOx emissions from blasting operations in open-cut coal mining", Atmospheric Environment, Vol 42

Bureau of Meteorology (2014)

Climate statistics for Australian locations, Bureau of Meteorology website. http://www.bom.gov.au/climate/averages

Coal & Allied (2012)

"Coal Mine Particulate Matter Control Best Practice Management Determination Mount Thorley Warkworth", Coal & Allied, July 2012

CSIRO (2013)

"Upper Hunter Valley Particle Characterization Study – Final Report", prepared for the NSW Office of Environment and Heritage and NSW Department of Health by CSIRO Marine & Atmospheric Research, 17 September 2013

DCC (2008)

"National Greenhouse Account (NGA) Factors" January 2008. Published by the Department of Climate Change.

Dieselnet (2012)

Emission Standards - United States, Nonroad Diesel Engines, Dieselnet website. http://www.dieselnet.com/standards/us/nonroad.php#tier3

DIICSRTE (2013a)

"Australian National Greenhouse Accounts – National Greenhouse Accounts Factors", July 2013. Department of Industry, Innovation, Climate Change, Science Research and Tertiary Education.

DIICSRTE (2013b)

"Australian National Greenhouse Accounts – State and Territory Greenhouse Gas Inventories", 2013. Department of Industry, Innovation, Climate Change, Science Research and Tertiary Education.

DoE (2014)

"Australian National Greenhouse Accounts – Quarterly Update of Australia's National Greenhouse Gas Inventory, September Quarter 2013", 2014. Department of the Environment.

Gregory P. H. (1973)

"The microbiology of the atmosphere", Halstead Press, New York.

Holmes Air Sciences (1994)

“Air Quality Assessment: Proposed Rix’s Creek Open Cut Mine, Near Singleton, NSW”, Prepared by Holmes Air Sciences for Rix’s Creek Pty Ltd, November 1994

Holmes Air Sciences (2003)

“Air Quality Assessment: Wambo Development Project”, Prepared by Holmes Air Sciences for Wambo Coal Pty Ltd, April 2003

Holmes Air Sciences (2008)

“Air Quality Assessment: Hunter Valley Operations South Coal Project”, Prepared for ERM Australia by Holmes Air Sciences, January 2008

Janssen, L. H. J. M., van Wakeren, J. H. A., van Duuren, H. and Elshout, A. J. (1988)

"A Classification of NO oxidation rates in power plant plumes based on atmospheric conditions". Atmospheric Environment, Volume 22, Number 1, 43-53.

Katestone Environmental Pty Ltd (2010)

"NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", Katestone Environmental Pty Ltd prepared for DECCW, 2010.

Morawska, L., Moore, M. R. and Ristovski, Z. D. (2004)

"Health Impacts of Ultrafine Particles, Desktop Literature Review and Analysis", Australian Government, Department of the Environment and Heritag, 2004.

NEPC (1988)

"Ambient Air - National Environmental Protection Measure for Ambient Air Quality", National Environment Protection Council, Canberra.

NEPC (2003)

"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as PM2.5", May 2003.

NEPC (2010)

"Review of the National Environment Protection (Ambient Air Quality) Measure, Discussion Paper, Air Quality Standards", National Environmental Protection Council, 2010.

NPI (2012)

"Emission Estimation Technique Manual for Mining Version 3.1", National Pollutant Inventory, January 2012. ISBN 0 642 54700 9

NSW DEC (2005)

“Approved Methods for the Modelling and Assessment of Air Pollutants in NSW”, August 2005.

NSW EPA (2013)
"Upper Hunter Air Particles Action Plan", (NSW) Environment Protection Authority, April 2013

OEHHA (2002)
"Staff Report: Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates", Office of Environmental Health Hazard Assessment, 2002.

Pacific Environment Limited (2013)
"Bulga Optimisation Project Revised Project – Air Impact Assessment". Appendix 3 of Response to Submissions and Revised and Amended Project Application Bulga Optimisation Project. Prepared by Pacific Environment Limited, August 2013

Pfender W., Graw R., Bradley W., Carney M. And Maxwell L. (2006)
"Use of a complex air pollution model to estimate dispersal and deposition of grass stem rust urendiniospores at landscape scale", Agriculture and Forest Meteorology, Vol 139.

Pleim J., Venkatram A. and Yamartino R. J. (1984)
"ADOM/TADAP model development program, Vol 4, The Dry Deposition Model", Ministry of the Environment, Rexdale, Ontario, Canada.

SEPP (2001)
"State Environment Protection Policy (Air Quality Management)", Victoria Government Gazette S 24021 December 2001

Simpson, R., Williams, G., Petroeschevsky, A., Best, T., Morgan, G., Denison, L., Hinwood, A. and Neville, G. (2005a)
"The short-term effects of air pollution on hospital admissions in four Australian cities", Australian and New Zealand Journal of Public Health, 29(3), 213-21, 2005.

Simpson, R., Williams, G., Petroeschevsky, A., Best, T., Morgan, G., Denison, L., Hinwood, A., Neville, G. and Neller, A. (2005b)
"The short-term effects of air pollution on daily mortality in four Australian cities", Australian and New Zealand Journal of Public Health, 29(3), 205-12, 2005.

Slinn S. A. and Slinn W. G. N. (1980)
"Predictions for particle deposition on natural waters", Atmospheric Environment, Vol 14.

SPCC (1983)
"Air Pollution from Coal Mining and Related Developments", State Pollution Control Commission.

SPCC (1986)
"Particle size distributions in dust from open cut mines in the Hunter Valley", Report Number 10636-002-71. Prepared for the State Pollution Control Commission of NSW by Dames & Moore, 41 McLaren Street, North Sydney, NSW, 2060.

Todoroski Air Sciences (2014)

"Air Quality and Greenhouse Gas Assessment Mount Thorley 2014 Project", Todoroski Air Sciences, 2014.

TRC (2011)

"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

US EPA (1985 and updates)

"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

US EPA (2009)

"Integrated Science Assessment for Particulate Matter", United States Environmental Protection Agency, 2009.

US EPA (2011)

"Health Effects of Pollution", United States Environmental Protection Agency website http://www.epa.gov/region07/air/quality/health.htm, 2011

WHO (2003)

"Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide", Report on a WHO Working Group, World Health Organisation, 2003.

WHO (2005)

"Air Quality Guidelines Global Update", World Health Organisation, 2005

WHO (2006a)

"Health risks or particulate matter from long-range transboundary air pollution", World Health Organisation Regional Office for Europe, 2006.

WHO (2006b)

"WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global Update, Summary of risk assessment, World Health Organisation, 2006.

Appendix A

Assessment locations

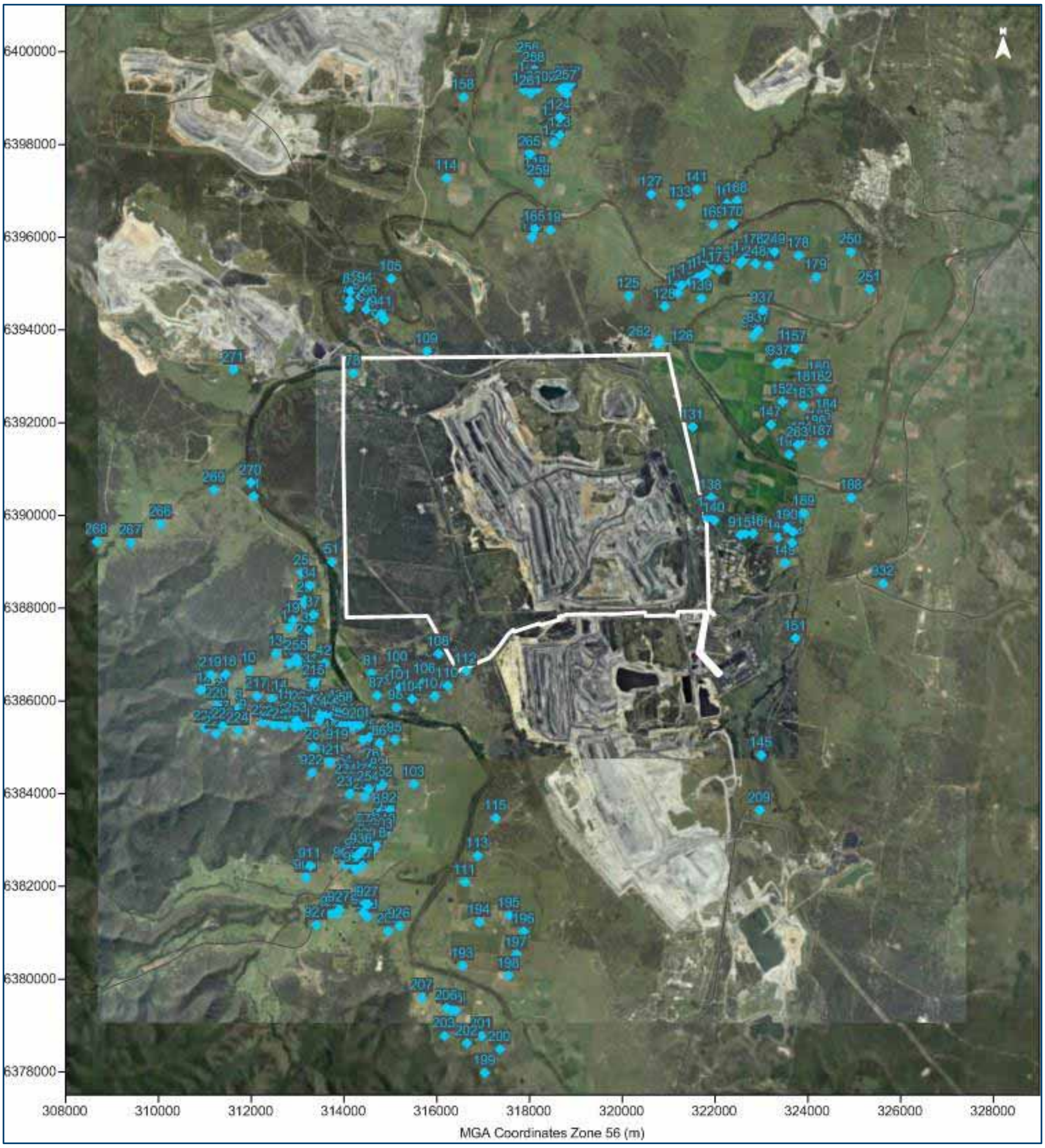

Figure A-1: Location of assessment locations assessed in this study

Table A-1: List of assessment locations assessed in this study

ID	X	Y	NAME
1	310903	6386238	JUDITH LESLIE
2	311055	6386261	SHAYNE AARON CURRIE
3	311295	6386059	PAUL TEMPLE VINES JESSOP
4	311336	6385751	GRAEME O'BRIEN & SUSANN FLORENCE O'BRIEN
5	311384	6386200	TREVOR HALTON MCTAGGART
6	311422	6386223	DOUGLAS KEITH PARTRIDGE
7	311470	6385618	DARRAL KEITH MARGERY & ANNETTE GAYE MARGERY
8	311735	6385855	LAURENCE FLETCHER & MARGARET ANN FLETCHER
9	311832	6385649	DONALD BRUCE ROSER
10	311950	6386665	PAKA INVESTMENTS PTY LIMITED
11**	312058	6390414	WAMBO MINING CORPORATION
12	312442	6386044	RONALD ALEXANDER CORINO
13	312532	6387028	ILARIO FRANCISCO CIRCOSTA & MARIA ANGELA CIRCOSTA
14	312632	6386066	KARIN MARGARET HUNT
15	312729	6385875	WILLIAM LINDSAY GORDON SLANEY
16	312822	6386804	LEONA ANN WILLIAMS
17	312814	6387573	GEORGE DAVID LIANOS
18	312935	6385847	BARRY JOHN ANDERSON & MELISSA GAI ANDERSON
19	312900	6387741	DENIS CYRIL MAIZEY
20	313041	6385812	GREGORY WILLIAM BANKS & MARION ELIZABETH BANKS
21	312998	6386821	GREGORY WILLIAM BANKS
22	313169	6385713	ELIZABETH MACKENZIE
23	313193	6385453	PETER JASON KOLATCHEW & HEIDI KOLATCHEW
24	313145	6387267	RONALD GARRY BAILEY
25	313091	6388764	WARKWORTH MINING LIMITED
26	313266	6385706	BARBARA GAE HARRISON & TREVOR ERIC HARRISON
27	313151	6388111	WARKWORTH MINING LIMITED
28	313335	6385003	HUBERT GEORGE UPWARD
29	313160	6388183	ILARIO FRANCISCO CIRCOSTA
30	313270	6386465	DAMIEN MICHAEL HANSON
31	313281	6386646	GREGORY MALCOLM CABAN
32	313252	6387528	PAUL MARK DUNN
33	313338	6386039	IAN NORRIS BARTHOLOMEW
34	313265	6388491	ALLAN CLYDE LEPISTO
35	313406	6386485	LAWRENCE MALCOLM CABAN
36	313473	6385589	RAYMOND CARL POWELL & CHRISTINE THERESE SHANNON
37	313345	6387861	GREGORY PAUL CROWE
38	313489	6385650	CHRISTOPHER LEONARD PRICE & LESLEY PRICE
39	313511	6385747	FERDINANDO FAMELI & JOELLE FAMELI
40	313595	6385794	MARGARET PLAYER & JOHN MACLACHLAN PLAYER
41	313690	6384726	HUBERT GEORGE UPWARD
42	313580	6386816	MARK ANTHONY LANCASTER
43	313658	6385668	DAVID JOHN BENSON
44	313658	6385708	BARRY FOGWELL
45	313725	6385198	ADAM CHARLES CAMERON
46	313798	6385640	DAVID JAMES GOLDSTEIN & VANESSA AMY GOLDSTEIN
47	313793	6385729	PHILIP ADAMTHWAITE
48	313823	6385853	BRETT JAMES GALLAGHER
49	313872	6385678	DEON PIERRE JANSE VAN RENSBURG
50	313898	6385517	SCOTT JAMES PRINGLE & LEANNE PRINGLE

ID	X	Y	NAME
51	313744	6389001	WARKWORTH MINING LIMITED
52	313956	6385265	STEWART JAMES MITCHELL & MARIE CLARE MITCHELL
53	313965	6385488	ROBERT MCLAUGHLIN
54	314037	6384456	CHRISTOPHER STANLEY NEVILLE & ELIZABETH ANN NEVILLE
55	313981	6385757	ROBERT JOHN EVANS
56	314005	6385480	LEONARD WALTER MCLACHLAN
57	314055	6385470	PAUL WILLIAM HARRIS
58	314046	6385804	DAVID ANDREW GREGORY
59	314088	6385479	WARKWORTH MINING LIMITED
60	314128	6385459	DAVID SAUNDERS
61	314231	6384325	DARRELL STANLEY KAIZER
62	314225	6385443	PATRICK JOHN MAGIN
63	314229	6385540	PETER JAMES COOKE
64	314242	6385504	DUSKO DRAGICEVIC
65	314239	6385584	GORDON KEITH GRAINGER
66	314258	6385447	MICHAEL VIVIAN BENDALL
67	314434	6383176	MICHAEL SHANE DAWSON & SUZANA DAWSON
68	314306	6385515	WARKWORTH MINING LIMITED
69	314329	6385371	WARKWORTH MINING LIMITED
70	314462	6383042	PETER FRANCIS RITCHIE AND FIONA JENNIFER RITCHIE
71	314354	6385377	ROBERT IAN HEDLEY
72	314392	6385359	FRANCIS HENRY TURNBULL
73	314407	6385160	PHILLIP JOSEPH REID
74	314514	6384263	RONALD GUY GODYN & ANNE-MARIE GODYN
75	314546	6385220	LINDSAY ROBERT SMITH
76	314618	6384591	THE STATE OF NEW SOUTH WALES
77	314103	6394482	WILLIAM JOSEPH KELLY
78	314203	6393069	WARKWORTH MINING LIMITED
79**	314121	6394634	WAMBO MINING CORPORATION LIMITED
80	314769	6383296	DIMITRIOUS VIKAS & JOY MARY VIKAS
81	314590	6386597	JOHN CHARLES MULALLY & PETER EDWIN MCMAUGH & GARRETT JOHN BURKE
82	314734	6384379	DONALD JAMES WALTERS
83**	314144	6394841	XSTRATA COAL PTY LIMITED
84	314796	6383618	MARY VERONICA THOMPSON
86	314767	6385091	THE STATE OF NEW SOUTH WALES
87	314711	6386122	MILLER POHANG COAL COMPANY PTY LTD
89	314951	6383454	BRYAN DUDLEY MEDHURST
90	314344	6394886	COAL & ALLIED OPERATIONS PTY LIMITED
91**	314359	6394718	WAMBO COAL PTY LTD
92**	314985	6383647	SAXONVALE COAL PTY LIMITED
93	314481	6394444	COAL & ALLIED OPERATIONS PTY LIMITED
94**	314463	6394855	WAMBO COAL PTY LTD
95	315097	6385163	MILLER POHANG COAL COMPANY
96**	314571	6394587	WAMBO MINING CORPORATION PTY LIMITED
97	315058	6386183	WARKWORTH MINING LIMITED
98	315125	6385857	MILLER POHANG COAL COMPANY
99**	314699	6394352	WAMBO COAL PTY LTD
100	315144	6386684	MILLER POHANG COAL COMPANY PTY LTD
101	315208	6386297	MILLER POHANG COAL COMPANY
102	314800	6394348	BRIAN EDWARD KENNEDY & JOHN GRIFFITHS

ID	X	Y	NAME
103**	315505	6384205	SAXONVALE COAL PTY. LIMITED
104	315463	6386048	MILLER POHANG COAL COMPANY
105	315017	6395104	COAL & ALLIED OPERATIONS PTY LIMITED
106	315742	6386435	MILLER POHANG COAL COMPANY
107	315949	6386105	MILLER POHANG COAL COMPANY PTY LIMITED
108	316037	6387020	MILLER POHANG COAL COMPANY PTY LIMITED
109**	315789	6393545	XSTRATA COAL (NSW) PTY LIMITED
110	316226	6386333	MILLER POHANG COAL COMPANY PTY LIMITED
111	316609	6382098	WALLACE RUSSELL
112	316629	6386649	MILLER POHANG COAL COMPANY PTY LIMITED
113**	316882	6382664	SAXONVALE COAL PTY LIMITED
114	316208	6397277	COAL & ALLIED OPERATIONS PTY LIMITED
115**	317271	6383479	SAXONVALE COAL PTY. LIMITED
116	318052	6396001	COAL & ALLIED OPERATIONS PTY LIMITED
117	317982	6397794	PHILLIP & COLLEEN ALGIE
118	318128	6397356	ROBERT ALGIE
118	318128	6397356	ROBERT ALGIE
119	318452	6396156	COAL & ALLIED OPERATIONS PTY LIMITED
120	318504	6398457	R & J WENHAM
121	318530	6398039	JULIE & GREGORY ERNST
122	318608	6398554	STEPHEN EDWARDS
123	318658	6398205	N & G NELSON
124	318655	6398582	STEPHEN EDWARDS
125	320142	6394738	COAL & ALLIED OPERATIONS PTY LIMITED
126	320764	6393699	PETER GLEN STUART
127	320624	6396932	NOEL & ELAINE RILEY
128	320916	6394511	PETER & DAPHNE WELSH
129	321192	6394796	COAL & ALLIED OPERATIONS PTY LIMITED
130	321271	6394970	FRANK & JOANNE VENTRA
131	321519	6391910	WARKWORTH MINING LIMITED
133	321261	6396710	COAL & ALLIED OPERATIONS PTY LIMITED
134	321472	6395034	LUCIANO CHARLES GATT
135	321816	6389971	WARKWORTH MINING LIMITED
136	321862	6390017	WARKWORTH MINING LIMITED
137	321617	6395135	COAL & ALLIED OPERATIONS PTY LIMITED
138	321914	6390390	WARKWORTH MINING LIMITED
139	321707	6394686	KEVIN DENNIS
140	321981	6389895	WARKWORTH MINING LIMITED
141	321604	6397030	WARREN AND LESLEY BARRY
142	321715	6395167	COAL & ALLIED OPERATIONS PTY LIMITED
143	321817	6395230	COAL & ALLIED OPERATIONS PTY LIMITED
144	322654	6389614	CAROL ANNE DYSON
145**	322998	6384833	SAXONVALE COAL PTY. LIMITED
146	322820	6389611	PAUL HENRY RUSSELL
147	323200	6391960	WARKWORTH MINING LIMITED
148	323360	6389527	DOROTHY CLARE RUSSELL
149	323510	6388982	IAN BULMER HEDLEY
150	323560	6389775	KEITH DAVID ISAAC AND SHARON ANN ISAAC
151**	323731	6387355	BULGA COAL MANAGEMENT PTY LIMITED
152	323454	6392457	GRAHAM EDWIN BERRY

ID	X	Y	NAME
153	323662	6389415	THOMAS WILLIAM KERMODE & KATHLEEN MAY KERMODE
154**	323680	6389650	BULGA COAL MANAGEMENT PTY LIMITED
155	323565	6393343	KEITH GEORGE BERRY
156	323610	6393617	ROBERT O'HARA
157	323739	6393594	ROBERT O'HARA
158	316576	6399021	COAL & ALLIED OPERATIONS PTY LIMITED
160	317883	6399178	ELIZABETH BOWMAN
161	318010	6399448	WYOMING HOLSTEINS PTY LTD
162	318011	6399407	WYOMING HOLSTEINS PTY LTD
163	318114	6399572	WYOMING HOLSTEINS PTY LTD
165	318110	6396180	COAL & ALLIED
167	322254	6396725	NATHAN JAMES LAING
168	322468	6396793	STUART FRANCIS NICHOL WRIGHT AND PAMELA LYNN WRIGHT
169	321959	6396271	HAROLD DOUGLAS HOBDEN
170	322379	6396285	JOHN MARCHEFF
172	321925	6395400	JOHN STUART GOUGH AND LYNETTE JEAN GOUGH
173	322099	6395301	JOHN STUART GOUGH AND LYNETTE JEAN GOUGH
174	322545	6395438	COLIN RAYMOND NEAL AND MARGARET ANNE NEAL
175	322633	6395534	BRADLEY JOHN HALTER
176	322830	6395688	MICHAEL RAYMOND MAPP AND SHIRLEY MAREE MAPP
177	323156	6395384	DELANEY
178	323801	6395607	CRAIG IAN FLISSINGER AND CATHERINE ANNE FLISSINGER
179	324177	6395141	TICKALARA PTY. LIMITED
180	324246	6392934	MOORE
181	323983	6392725	DAVID CHARLES VASSALLO AND SHEREE ANN VASSALLO
182	324296	6392725	ROBERT FRANCIS HOLSTEIN AND ANDREA TERRY HOLSTEIN
183	323903	6392368	HALL
184	324407	6392127	CAMPBELL STUART BALL AND GAIL AGNES BALL
185	324272	6391894	LEONARD DALE FRANKS
186	324164	6391772	LEONARD DALE FRANKS
187	324308	6391565	HEUSTON PTY LTD
188	324940	6390387	WALDOCK
189**	323916	6390047	BULGA COAL MANAGEMENT PTY LIMITED
190	323552	6389746	KEITH DAVID ISAAC AND SHARON ANN ISAAC
191	323873	6391630	ROBERT JOHN VIDLER AND CORAL MAY VIDLER
192	323595	6391320	O'HARA R & J
193	316558	6380293	ROBERT KENNEDY
194**	316918	6381236	SAXONVALE COAL PTY LIMITED
195**	317561	6381382	SAXONVALE COAL PTY LIMITED
196**	317877	6381030	SAXONVALE COAL PTY LIMITED
197	317716	6380532	ROBERT KENNEDY
198**	317549	6380075	SAXONVALE COAL PTY LIMITED
199	317036	6377983	ADRIAN GARTON
200	317360	6378494	KARREN ANNE MCCRAW
201	316963	6378778	RICHARD JAMES OWENS
202	316649	6378621	RICHARD JAMES OWENS
203	316167	6378781	GRAPEMEN HOLDINGS PTY LIMITED
204	316407	6379326	ESSLEMONT FAMILY HOLDINGS PTY LIMITED
205	316333	6379327	VICTORIA ANN FOSTER
206	316214	6379385	THEO POULOS

ID	X	Y	NAME
207	315682	6379608	JOHN STEPHEN TULLOCH
208	314955	6381041	CYBELE GENEVIEVE ORTON
209**	322962	6383649	SAXONVALE COAL PTY LIMITED
210	314178	6385559	MERIA VIOLET FORD
211	314331	6385481	MIKE DEAN SILK
215	313354	6386390	
217	312125	6386110	
218	311450	6386578	
219	311134	6386568	
220	311258	6385905	
221	311001	6385414	
222	311233	6385294	
223	311393	6385458	
224	311716	6385367	
225	312256	6385540	
226	312474	6385495	
227	312569	6385509	
228	312698	6385457	
229	312866	6385557	
230	312952	6385439	
231	313060	6385467	
234	314048	6384261	
235	314181	6384088	
236	314679	6384143	
237	314116	6383992	
238	314448	6383932	
243	314883	6383176	
244	318808	6399092	
245	318679	6399194	
246	318795	6399314	
247	318879	6399292	
248	322876	6395431	
249	323284	6395685	
250	324927	6395679	
251	325339	6394874	
252	314827	6384207	
253	312973	6385584	
254	314529	6384103	
255	312973	6386930	ILARIO FRANCISCO CIRCOSTA & MARIA ANGELA CIRCOSTA
256	317979	6399821	BRUCE ERIC MOXEY
257	318793	6399221	ROBERT JOHN ALGIE
258	318104	6399611	WYOMING HOLSTEINS PTY LTD
259	318211	6397178	ROBERT JOHN ALGIE
260	318180	6399198	WYOMING HOLSTEINS PTY LTD
261	318030	6399106	WYOMING HOLSTEINS PTY LTD
262	320794	6393794	PETER GLEN STUART
263	323786	6391522	JOHN KLASEN
264	314870	6394227	GEORGE ROBERT MILLER
265	318014	6397793	PHILLIP JOHN ALGIE
266	310048	6389815	RONALD WAYNE FENWICK

ID	X	Y	NAME
267	309407	6389413	KENNETH MAX BROSI & CORAL MAUDE BROSI
268	308672	6389436	KENNETH MAX BROSI
269**	311206	6390559	WAMBO MINING CORPORATION PTY LIMITED
270**	311995	6390710	WAMBO MINING CORPORATION PTY LIMITED
271**	311622	6393146	WAMBO MINING CORPORATION PTY LIMITED
903	314821	6383080	ADAM JOHN BAKER
904	314024	6382465	ALLAN MARK BRASINGTON, JUDITH ANNE BRASINGTON
905	313176	6382198	CAMERON MICHAEL TURNER, MELISSA JAYNE HARRIS
909	314611	6382770	EMANUEL VICTOR VASSALLO
911	313271	6382442	GARY DALE HARRIS
915	322542	6389581	JASON CYRIL RUMBEL, REBECCA RUTH RUMBEL
917	314549	6382967	JOHN ROBERT LAMB
918	314686	6382893	JOSEPH VASSALLO, DORIS VASSALLO
919	313866	6385003	KENNETH NEIL CAMERON
920	314208	6385455	LINDSAY GORDON HARRIS, JILLIAN MAY FERGUSON
921	313692	6384676	MELANIE CABAN, KEIRAN LIONEL CABAN
922	313313	6384456	MELANIE EVELYN UPWARD
923	314505	6381343	MICHELLE MARIA BRENNAN
926	315197	6381155	PAUL WILLIAM MACKAY, SUZANNE ELIZABETH MACKAY
927a	314213	6382445	PHILLIP JOHN GUNTER, LEONA MARY GUNTER
927b	314251	6382364	
927c	314400	6382451	
927d	314414	6381446	
927e	314462	6381631	
927f	314521	6381618	
927g	313398	6381173	
927h	313742	6381405	
927i	313851	6381411	
927j	313902	6381509	
928	314270	6382655	SARAH ELIZABETH PURSER, STIRLING OWEN KEAYES
929	314462	6382864	SIMON JAMES BEAVIS
932	325626	6388538	STEPHEN DENNIS TIPPING
936	314376	6382753	THOMAS CHARLES JACKSON, SUSAN GAI JACKSON
937a	322832	6393883	TREVOR KEITH BERRY, GRAHAM EDWIN BERRY
937b	322935	6394004	
937c	323028	6394431	
937d	323333	6393272	
937e	323391	6393295	
941**	314808	6394346	XSTRATA COAL PTY LIMITED

**Other mine owned property

Appendix B

Monitoring Data

Table B-1: TEOM Monitoring data

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
1/01/2012	ND	ND	20	21	16	15	1/01/2013	22	21	26	19	25	28
2/01/2012	ND	ND	18	27	21	18	2/01/2013	19	34	31	34	ND	22
3/01/2012	ND	12	17	21	20	20	3/01/2013	30	32	39	53	33	37
4/01/2012	ND	14	17	19	22	14	4/01/2013	ND	17	21	ND	ND	20
5/01/2012	26	22	36	38	25	21	5/01/2013	21	15	18	21	26	21
6/01/2012	33	ND	ND	39	ND	ND	6/01/2013	ND	16	21	15	ND	29
7/01/2012	18	11	16	16	13	15	7/01/2013	18	13	16	21	28	21
8/01/2012	19	13	19	22	20	15	8/01/2013	14	10	11	13	ND	14
9/01/2012	34	ND	30	26	31	24	9/01/2013	ND	32	42	35	ND	40
10/01/2012	18	ND	17	22	16	ND	10/01/2013	41	42	52	49	ND	39
11/01/2012	15	ND	20	25	13	ND	11/01/2013	33	23	27	32	40	33
12/01/2012	19	ND	42	45	23	ND	12/01/2013	ND	29	36	30	34	33
13/01/2012	17	ND	26	32	18	ND	13/01/2013	ND	36	6	43	ND	ND
14/01/2012	23	ND	29	28	22	18	14/01/2013	30	15	30	30	35	ND
15/01/2012	18	ND	24	31	19	20	15/01/2013	9	6	10	5	10	ND
16/01/2012	15	ND	13	22	13	12	16/01/2013	18	12	14	18	22	12
17/01/2012	15	7	11	32	15	14	17/01/2013	27	24	31	33	32	29
18/01/2012	19	11	17	26	20	17	18/01/2013	ND	38	ND	ND	ND	31
19/01/2012	14	8	13	18	13	15	19/01/2013	ND	46	54	ND	41	39
20/01/2012	15	ND	16	ND	13	15	20/01/2013	27	26	31	25	26	34
21/01/2012	27	ND	23	43	20	20	21/01/2013	10	12	13	18	13	12
22/01/2012	15	14	24	23	13	17	22/01/2013	20	13	15	19	23	22
23/01/2012	12	ND	15	18	11	19	23/01/2013	16	16	2	30	17	ND
24/01/2012	17	ND	ND	12	16	14	24/01/2013	13	16	18	14	15	ND
25/01/2012	14	ND	ND	1	11	14	25/01/2013	17	15	18	16	20	19
26/01/2012	9	ND	ND	12	9	13	26/01/2013	13	7	8	6	14	13
27/01/2012	10	ND	ND	10	10	12	27/01/2013	16	10	11	12	ND	15
28/01/2012	15	ND	ND	15	16	15	28/01/2013	7	7	9	7	10	11
29/01/2012	11	ND	ND	6	11	12	29/01/2013	4	4	4	1	6	7
30/01/2012	14	ND	ND	10	14	12	30/01/2013	6	6	7	10	8	10
31/01/2012	17	ND	ND	17	15	16	31/01/2013	18	17	10	ND	21	22
1/02/2012	ND	ND	13	11	13	13	1/02/2013	ND	18	23	6	ND	24
2/02/2012	5	4	7	8	6	7	2/02/2013	12	17	18	19	ND	19
3/02/2012	4	4	5	2	5	5	3/02/2013	4	7	7	3	6	6
4/02/2012	7	ND	9	5	8	8	4/02/2013	9	12	15	17	10	11
5/02/2012	9	ND	15	15	11	14	5/02/2013	13	17	16	17	14	17
6/02/2012	17	ND	18	15	17	17	6/02/2013	13	13	15	16	ND	15
7/02/2012	18	ND	26	ND	17	22	7/02/2013	13	10	12	12	ND	14
8/02/2012	8	ND	15	18	17	12	8/02/2013	13	12	15	18	16	19
9/02/2012	17	ND	19	21	ND	17	9/02/2013	21	20	25	23	27	26
10/02/2012	13	ND	18	17	13	16	10/02/2013	41	22	29	21	ND	30
11/02/2012	12	ND	17	18	14	ND	11/02/2013	ND	21	25	23	ND	24
12/02/2012	9	ND	15	16	10	12	12/02/2013	7	11	13	20	10	10
13/02/2012	14	ND	11	15	16	11	13/02/2013	6	10	11	8	9	13
14/02/2012	13	ND	18	13	14	13	14/02/2013	8	8	9	8	12	15
15/02/2012	10	ND	12	8	12	13	15/02/2013	11	11	13	14	12	13
16/02/2012	9	ND	11	11	10	12	16/02/2013	8	8	8	12	11	20
17/02/2012	13	ND	6	13	14	14	17/02/2013	8	7	10	11	9	12
18/02/2012	18	ND	18	22	17	18	18/02/2013	10	9	10	10	12	14
19/02/2012	18	ND	28	22	22	24	19/02/2013	9	12	13	21	12	15
20/02/2012	22	ND	24	21	20	17	20/02/2013	12	12	12	14	ND	18
21/02/2012	13	ND	13	14	14	14	21/02/2013	ND	12	15	16	14	21
22/02/2012	8	ND	9	12	8	9	22/02/2013	11	12	13	13	14	18

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
23/02/2012	13	ND	19	15	ND	17	23/02/2013	13	14	15	14	16	21
24/02/2012	17	ND	12	ND	17	13	24/02/2013	5	7	8	7	9	10
25/02/2012	13	ND	12	15	15	17	25/02/2013	12	9	10	ND	18	15
26/02/2012	15	ND	11	9	13	14	26/02/2013	14	10	12	ND	16	18
27/02/2012	11	ND	13	15	11	14	27/02/2013	17	12	14	13	20	20
28/02/2012	14	ND	17	18	ND	14	28/02/2013	15	12	14	7	17	19
29/02/2012	16	ND	24	ND	17	19	1/03/2013	ND	ND	15	13	12	16
1/03/2012	13	ND	28	21	15	19	2/03/2013	ND	3	4	ND	4	4
2/03/2012	15	ND	22	21	16	19	3/03/2013	ND	4	6	ND	6	6
3/03/2012	3	ND	4	5	5	7	4/03/2013	ND	10	13	10	15	16
4/03/2012	10	ND	10	7	13	10	5/03/2013	14	12	15	15	20	21
5/03/2012	16	ND	ND	18	15	15	6/03/2013	14	ND	13	11	17	16
6/03/2012	8	ND	12	14	11	11	7/03/2013	11	9	12	12	14	18
7/03/2012	11	ND	18	20	16	17	8/03/2013	15	10	ND	18	14	12
8/03/2012	10	ND	13	15	10	10	9/03/2013	12	10	ND	14	13	15
9/03/2012	3	ND	8	17	6	6	10/03/2013	10	10	10	14	12	14
10/03/2012	9	13	15	21	11	14	11/03/2013	13	11	12	24	14	15
11/03/2012	10	14	19	19	13	17	12/03/2013	13	12	13	14	14	16
12/03/2012	23	17	22	22	21	18	13/03/2013	12	11	13	15	15	17
13/03/2012	14	17	15	21	16	16	14/03/2013	14	12	16	19	19	15
14/03/2012	12	11	ND	17	14	ND	15/03/2013	20	19	22	34	22	25
15/03/2012	11	15	13	24	14	17	16/03/2013	16	18	19	ND	15	16
16/03/2012	ND	13	20	21	16	17	17/03/2013	19	19	24	24	21	21
17/03/2012	16	12	15	ND	ND	13	18/03/2013	17	21	24	28	15	17
18/03/2012	8	12	14	12	9	11	19/03/2013	13	16	20	27	16	17
19/03/2012	11	13	15	12	14	14	20/03/2013	10	14	18	21	13	14
20/03/2012	ND	9	10	11	10	12	21/03/2013	9	9	10	24	13	13
21/03/2012	8	11	14	20	13	15	22/03/2013	14	18	24	21	15	20
22/03/2012	8	10	12	16	12	14	23/03/2013	21	40	39	46	25	27
23/03/2012	8	15	17	16	7	17	24/03/2013	13	17	15	14	15	12
24/03/2012	17	27	26	30	20	21	25/03/2013	9	26	24	ND	12	16
25/03/2012	10	18	20	21	14	16	26/03/2013	21	35	39	50	24	ND
26/03/2012	9	15	16	21	13	17	27/03/2013	ND	30	38	35	ND	30
27/03/2012	12	12	14	13	15	16	28/03/2013	ND	ND	21	ND	20	21
28/03/2012	11	13	14	17	16	16	29/03/2013	19	38	28	30	22	20
29/03/2012	9	10	11	11	12	15	30/03/2013	10	10	14	16	12	14
30/03/2012	11	16	20	17	11	16	31/03/2013	12	15	17	24	14	16
31/03/2012	10	21	21	21	12	16	1/04/2013	10	21	23	32	9	15
1/04/2012	10	ND	14	19	14	15	2/04/2013	10	15	17	25	9	14
1/04/2012	13	22	22	32	16	17	3/04/2013	9	15	16	16	10	15
2/04/2012	12	14	16	23	13	14	4/04/2013	8	17	19	19	8	13
3/04/2012	ND	20	21	32	15	17	5/04/2013	6	11	13	10	7	10
4/04/2012	ND	20	20	25	23	24	6/04/2013	9	8	11	13	9	12
5/04/2012	12	12	12	34	18	18	7/04/2013	6	10	12	20	6	10
6/04/2012	13	11	11	16	13	15	7/04/2013	8	10	12	22	10	11
7/04/2012	26	28	30	33	27	24	8/04/2013	9	10	11	17	12	12
8/04/2012	24	27	31	29	26	27	9/04/2013	6	12	12	22	8	14
9/04/2012	10	16	17	20	11	13	10/04/2013	5	7	5	12	8	10
10/04/2012	9	16	21	21	10	12	11/04/2013	9	10	11	21	10	15
11/04/2012	8	16	15	23	9	10	12/04/2013	10	12	13	25	10	15
12/04/2012	ND	9	12	15	9	11	13/04/2013	14	20	20	22	12	21
13/04/2012	12	13	12	21	14	13	14/04/2013	10	17	19	27	13	20
14/04/2012	10	15	19	18	12	13	15/04/2013	16	27	35	42	19	25
15/04/2012	17	22	26	27	17	21	16/04/2013	6	12	14	15	9	13

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
16/04/2012	12	14	17	19	13	24	17/04/2013	6	14	16	15	9	ND
17/04/2012	8	16	16	21	10	9	18/04/2013	ND	14	16	ND	11	12
18/04/2012	6	6	7	8	6	11	19/04/2013	7	15	19	23	7	12
19/04/2012	ND	6	6	13	9	ND	20/04/2013	4	16	19	5	6	7
20/04/2012	7	ND	16	19	11	14	21/04/2013	4	10	12	10	7	11
21/04/2012	9	13	19	23	13	20	22/04/2013	8	19	25	32	9	17
22/04/2012	13	20	23	28	16	20	23/04/2013	17	16	22	31	9	12
23/04/2012	10	18	23	23	14	15	24/04/2013	13	ND	10	29	ND	13
24/04/2012	6	14	17	22	8	14	25/04/2013	17	25	28	42	16	20
25/04/2012	7	13	14	20	11	9	26/04/2013	10	26	31	43	12	18
26/04/2012	12	17	21	ND	13	16	27/04/2013	19	30	36	38	20	24
27/04/2012	16	17	20	22	18	15	28/04/2013	38	34	36	51	32	28
28/04/2012	16	21	24	27	19	16	29/04/2013	79	38	47	67	72	51
29/04/2012	10	18	20	26	13	17	30/04/2013	25	24	28	32	28	30
30/04/2012	14	17	9	24	17	16	1/05/2013	21	28	32	37	26	26
1/05/2012	15	15	17	26	14	15	2/05/2013	ND	ND	19	25	14	18
2/05/2012	13	15	18	21	14	16	3/05/2013	14	20	23	29	13	17
3/05/2012	9	10	15	10	10	12	4/05/2013	20	22	34	33	24	25
4/05/2012	ND	15	14	18	13	14	5/05/2013	19	34	34	35	23	24
5/05/2012	8	13	14	29	6	11	6/05/2013	ND	14	17	25	11	16
6/05/2012	10	20	18	25	ND	11	7/05/2013	11	ND	ND	27	15	22
7/05/2012	10	20	8	35	11	14	8/05/2013	ND	15	10	21	ND	15
8/05/2012	10	19	24	32	11	11	9/05/2013	26	18	18	30	19	23
9/05/2012	12	22	30	ND	12	15	10/05/2013	38	25	25	42	40	35
10/05/2012	12	ND	29	47	ND	16	11/05/2013	25	29	31	46	29	35
11/05/2012	15	31	31	46	17	19	12/05/2013	23	13	13	23	14	12
12/05/2012	12	28	28	55	12	17	13/05/2013	ND	ND	32	48	19	23
13/05/2012	10	25	34	47	13	18	14/05/2013	5	10	12	16	8	8
14/05/2012	8	16	24	35	9	12	15/05/2013	6	16	21	22	10	10
15/05/2012	ND	21	30	34	ND	13	16/05/2013	10	17	23	36	14	12
16/05/2012	14	24	28	38	17	18	17/05/2013	6	10	16	28	10	12
17/05/2012	16	17	22	30	14	16	18/05/2013	6	16	19	23	9	10
18/05/2012	13	22	24	33	13	19	19/05/2013	7	12	13	26	10	9
19/05/2012	15	25	29	43	17	16	20/05/2013	13	21	32	29	16	13
20/05/2012	14	28	32	35	15	16	21/05/2013	12	27	29	36	14	18
21/05/2012	14	18	ND	31	16	16	22/05/2013	ND	32	39	41	14	20
22/05/2012	12	27	29	39	18	17	23/05/2013	3	6	7	13	5	5
23/05/2012	15	27	35	47	15	15	24/05/2013	6	8	11	ND	9	8
24/05/2012	14	29	38	54	19	20	25/05/2013	3	8	9	10	5	7
25/05/2012	7	10	11	14	8	10	26/05/2013	6	9	11	25	8	10
26/05/2012	9	13	15	13	12	10	27/05/2013	11	18	23	34	14	16
27/05/2012	7	13	14	27	6	7	28/05/2013	6	10	11	14	7	13
28/05/2012	12	24	26	ND	12	16	29/05/2013	9	13	14	27	11	12
29/05/2012	7	ND	14	12	ND	10	30/05/2013	10	ND	19	ND	11	16
30/05/2012	8	11	12	13	8	12	31/05/2013	9	15	16	17	10	13
31/05/2012	9	13	14	14	11	16	1/06/2013	10	18	21	19	ND	13
1/06/2012	7	7	9	19	8	12	2/06/2013	3	5	7	7	2	6
2/06/2012	6	7	8	11	6	11	3/06/2013	5	8	12	24	3	9
3/06/2012	4	5	5	6	4	5	4/06/2013	8	12	18	31	3	11
4/06/2012	4	6	5	3	5	5	5/06/2013	9	12	14	26	10	11
5/06/2012	6	8	8	10	8	7	6/06/2013	11	18	27	41	12	14
6/06/2012	9	8	10	9	10	9	7/06/2013	6	15	20	22	12	11
7/06/2012	6	7	9	18	ND	8	8/06/2013	9	11	13	27	10	15
8/06/2012	6	9	10	11	8	10	9/06/2013	10	11	11	21	11	13

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
9/06/2012	9	10	10	15	10	10	10/06/2013	7	9	11	18	10	13
10/06/2012	9	14	15	22	10	12	11/06/2013	4	6	7	24	6	7
11/06/2012	5	7	9	5	5	7	12/06/2013	8	9	10	21	9	10
12/06/2012	7	8	9	11	7	7	13/06/2013	3	6	7	10	6	6
13/06/2012	ND	9	9	10	ND	8	14/06/2013	3	6	7	10	6	5
14/06/2012	12	10	10	19	16	ND	15/06/2013	4	7	9	14	7	6
15/06/2012	8	15	19	16	11	13	16/06/2013	5	10	10	13	8	6
16/06/2012	8	13	14	24	9	10	17/06/2013	6	12	11	20	10	8
17/06/2012	6	8	9	8	8	6	18/06/2013	5	9	11	24	7	8
18/06/2012	7	14	13	ND	8	8	19/06/2013	6	13	ND	19	7	9
19/06/2012	5	9	13	ND	6	8	20/06/2013	6	13	ND	21	8	11
20/06/2012	6	13	17	10	8	10	21/06/2013	7	18	20	35	12	14
21/06/2012	8	17	ND	19	11	10	22/06/2013	7	10	14	17	9	10
22/06/2012	10	14	19	16	15	10	23/06/2013	5	10	13	16	5	7
23/06/2012	6	9	11	9	6	6	24/06/2013	2	12	11	18	5	6
24/06/2012	8	10	16	11	9	9	25/06/2013	4	6	ND	26	8	9
25/06/2012	10	10	20	22	11	9	26/06/2013	11	13	17	18	12	13
26/06/2012	6	17	21	18	7	12	27/06/2013	8	10	13	6	7	8
27/06/2012	8	8	10	10	8	9	28/06/2013	4	7	8	12	6	ND
28/06/2012	ND	10	9	17	6	9	29/06/2013	4	ND	7	6	5	ND
29/06/2012	12	14	20	19	15	ND	30/06/2013	8	10	11	7	4	ND
30/06/2012	6	11	10	14	7	8	1/07/2013	2	13	11	20	5	ND
1/07/2012	8	17	20	29	10	9	2/07/2013	4	9	10	21	9	ND
2/07/2012	5	12	11	20	8	6	3/07/2013	5	8	9	15	8	6
3/07/2012	7	9	14	16	9	8	4/07/2013	9	14	16	ND	11	11
4/07/2012	9	17	23	21	9	10	5/07/2013	6	14	14	20	10	10
5/07/2012	7	16	23	24	8	11	6/07/2013	6	14	16	20	13	9
6/07/2012	6	9	12	11	7	7	7/07/2013	6	12	16	22	9	10
7/07/2012	6	15	19	10	8	13	8/07/2013	8	15	17	26	12	12
8/07/2012	13	16	20	26	16	12	9/07/2013	10	19	24	24	11	15
9/07/2012	12	10	12	20	14	12	10/07/2013	5	13	16	17	ND	11
10/07/2012	7	12	15	36	7	13	11/07/2013	7	13	16	21	10	14
11/07/2012	5	6	7	12	6	8	12/07/2013	7	13	17	23	9	11
12/07/2012	8	12	15	31	8	12	13/07/2013	16	10	13	18	13	18
13/07/2012	4	9	9	11	7	7	14/07/2013	14	12	14	24	15	15
14/07/2012	4	6	6	9	7	6	15/07/2013	11	19	22	ND	14	15
15/07/2012	6	7	7	8	10	5	16/07/2013	5	ND	16	23	8	12
16/07/2012	8	11	15	11	11	9	17/07/2013	7	11	14	4	9	ND
17/07/2012	6	13	16	29	5	10	18/07/2013	7	11	14	24	9	ND
18/07/2012	ND	14	18	22	7	11	19/07/2013	7	12	15	19	10	12
19/07/2012	ND	12	17	25	8	11	20/07/2013	2	9	9	23	6	11
20/07/2012	7	18	21	26	10	11	21/07/2013	4	12	11	27	8	8
21/07/2012	8	16	28	25	11	13	22/07/2013	5	14	15	35	8	9
22/07/2012	7	13	19	17	9	10	23/07/2013	5	10	12	12	7	10
23/07/2012	6	9	13	10	8	10	24/07/2013	9	14	22	30	9	11
24/07/2012	4	8	9	13	6	5	25/07/2013	16	19	23	35	19	17
25/07/2012	6	10	16	18	8	2	26/07/2013	10	18	25	36	14	16
26/07/2012	ND	19	26	27	12	7	27/07/2013	15	17	26	33	16	16
27/07/2012	5	12	14	25	7	9	28/07/2013	15	13	18	32	18	16
28/07/2012	5	10	12	18	9	6	29/07/2013	11	16	21	33	15	19
29/07/2012	10	12	18	17	12	8	30/07/2013	ND	18	26	39	14	15
30/07/2012	5	6	15	36	6	11	31/07/2013	ND	12	14	17	10	11
31/07/2012	7	8	30	ND	10	14	1/08/2013	ND	11	12	21	8	10
1/08/2012	6	15	17	15	12	9	2/08/2013	2	16	28	28	ND	13

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
2/08/2012	6	10	14	18	8	8	3/08/2013	4	13	15	26	11	12
3/08/2012	8	16	23	36	11	12	4/08/2013	4	13	16	26	12	10
4/08/2012	8	18	23	31	11	13	5/08/2013	7	22	29	34	17	19
5/08/2012	13	22	32	37	15	13	6/08/2013	7	29	34	32	14	18
6/08/2012	12	18	25	ND	24	16	7/08/2013	5	22	30	41	16	17
7/08/2012	11	17	28	28	12	13	8/08/2013	ND	5	6	10	5	6
8/08/2012	12	23	34	33	15	11	9/08/2013	3	10	ND	21	8	10
9/08/2012	10	19	30	37	16	13	10/08/2013	6	18	21	20	13	10
10/08/2012	10	14	23	44	15	12	11/08/2013	4	18	23	27	11	12
11/08/2012	7	12	20	33	12	11	12/08/2013	7	23	31	ND	11	15
12/08/2012	10	15	24	18	17	12	13/08/2013	ND	23	22	27	11	13
13/08/2012	13	17	24	28	27	20	14/08/2013	6	34	35	37	11	ND
14/08/2012	14	22	32	36	26	16	15/08/2013	5	16	22	34	8	11
15/08/2012	15	30	41	48	26	15	16/08/2013	ND	ND	36	ND	18	18
16/08/2012	15	20	31	57	21	15	17/08/2013	21	39	47	55	27	27
17/08/2012	33	33	50	68	35	32	18/08/2013	6	20	23	39	12	12
18/08/2012	12	17	30	34	27	14	19/08/2013	7	41	36	61	14	16
19/08/2012	9	11	15	24	20	8	20/08/2013	2	10	16	47	7	11
20/08/2012	16	19	29	37	23	18	21/08/2013	4	18	19	29	15	10
21/08/2012	14	23	30	23	22	15	22/08/2013	3	26	19	29	12	10
22/08/2012	17	28	41	59	28	24	23/08/2013	7	29	24	32	15	11
23/08/2012	17	20	30	38	26	22	24/08/2013	10	12	17	27	15	12
24/08/2012	6	9	9	19	36	8	25/08/2013	7	23	21	30	11	13
25/08/2012	8	14	18	24	25	12	26/08/2013	12	22	29	41	17	15
26/08/2012	10	12	18	23	11	8	27/08/2013	17	ND	34	44	19	21
27/08/2012	12	15	20	27	28	12	28/08/2013	19	11	28	ND	ND	20
28/08/2012	12	14	20	19	20	12	29/08/2013	35	33	37	21	ND	37
29/08/2012	20	27	34	34	29	26	30/08/2013	28	37	46	51	34	34
30/08/2012	14	25	37	65	23	19	31/08/2013	ND	25	36	69	20	23
31/08/2012	11	17	31	47	26	19	1/09/2013	21	21	29	61	25	23
1/09/2012	9	12	18	34	10	10	2/09/2013	17	18	20	15	20	20
2/09/2012	12	19	25	30	19	13	3/09/2013	10	13	15	21	15	17
3/09/2012	17	18	26	62	25	16	4/09/2013	18	14	18	24	20	18
4/09/2012	18	25	35	47	23	21	5/09/2013	17	30	ND	33	28	22
5/09/2012	28	42	ND	59	37	33	6/09/2013	22	ND	49	ND	ND	32
6/09/2012	28	39	50	53	45	38	7/09/2013	18	36	40	55	25	27
7/09/2012	18	ND	55	56	31	26	8/09/2013	24	27	37	40	28	35
8/09/2012	15	30	23	24	31	17	9/09/2013	22	29	35	38	28	31
9/09/2012	13	15	22	23	20	15	10/09/2013	ND	53	61	77	36	43
10/09/2012	16	ND	35	41	19	20	11/09/2013	4	22	29	57	16	ND
11/09/2012	25	40	41	ND	30	ND	12/09/2013	10	27	30	59	12	16
12/09/2012	25	35	19	42	28	30	13/09/2013	11	19	22	35	21	17
13/09/2012	20	ND	52	76	ND	30	14/09/2013	9	17	21	31	18	18
14/09/2012	12	12	19	25	19	15	15/09/2013	ND	11	11	25	13	17
15/09/2012	14	20	23	51	19	22	16/09/2013	9	9	12	9	ND	15
16/09/2012	17	21	23	26	17	20	17/09/2013	ND	5	6	5	ND	6
17/09/2012	ND	24	31	35	31	31	18/09/2013	ND	19	12	17	ND	8
18/09/2012	9	ND	21	21	13	16	19/09/2013	2	18	17	21	ND	15
19/09/2012	11	10	14	ND	16	11	20/09/2013	4	25	26	44	ND	17
20/09/2012	20	22	26	ND	24	20	21/09/2013	4	14	17	16	ND	13
21/09/2012	11	24	28	45	16	23	22/09/2013	8	17	19	27	ND	16
22/09/2012	15	19	26	38	17	17	23/09/2013	6	33	29	52	ND	22
23/09/2012	12	24	26	29	18	13	24/09/2013	16	47	53	94	ND	28
24/09/2012	ND	25	32	52	16	18	25/09/2013	11	24	27	54	ND	22

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
25/09/2012	ND	25	27	ND	ND	20	26/09/2013	11	54	55	102	ND	26
26/09/2012	24	16	22	ND	29	27	27/09/2013	18	22	27	37	ND	20
27/09/2012	22	29	41	34	25	27	28/09/2013	10	33	29	56	ND	21
28/09/2012	39	56	70	51	44	37	29/09/2013	14	27	35	37	ND	27
29/09/2012	14	19	28	37	14	16	30/09/2013	16	27	27	39	ND	24
30/09/2012	8	17	25	24	10	13	1/10/2013	44	51	66	103	ND	45
1/10/2012	13	16	21	31	16	17	2/10/2013	2	21	13	31	ND	10
2/10/2012	18	11	14	ND	16	ND	3/10/2013	4	20	16	32	ND	19
3/10/2012	28	ND	33	28	24	15	4/10/2013	8	20	21	25	ND	14
4/10/2012	19	43	53	63	22	25	5/10/2013	6	25	20	31	ND	11
5/10/2012	21	47	53	73	20	29	7/10/2013	9	46	41	39	ND	18
6/10/2012	41	27	33	26	41	36	8/10/2013	13	31	33	56	ND	26
8/10/2012	16	ND	21	34	ND	18	9/10/2013	12	17	20	19	ND	17
9/10/2012	18	18	22	32	20	ND	10/10/2013	10	26	28	25	ND	16
10/10/2012	17	19	21	28	18	17	11/10/2013	26	48	56	52	ND	34
11/10/2012	20	23	28	26	20	18	12/10/2013	35	38	42	52	ND	37
12/10/2012	10	ND	23	21	13	14	13/10/2013	17	31	34	36	ND	26
13/10/2012	7	12	16	20	10	7	14/10/2013	62	53	71	78	ND	57
14/10/2012	15	13	17	24	13	12	15/10/2013	4	13	14	21	ND	13
15/10/2012	11	13	17	20	12	12	16/10/2013	11	25	33	45	ND	15
16/10/2012	14	21	26	25	15	15	17/10/2013	12	ND	56	ND	ND	ND
17/10/2012	28	48	64	ND	33	27	18/10/2013	60	57	72	84	ND	49
18/10/2012	ND	44	49	ND	46	36	19/10/2013	35	31	36	40	ND	33
19/10/2012	26	19	26	31	31	ND	20/10/2013	30	27	30	35	ND	34
20/10/2012	27	33	41	38	28	31	21/10/2013	29	25	27	16	ND	29
21/10/2012	30	41	48	49	33	34	22/10/2013	ND	46	46	45	ND	38
22/10/2012	34	34	46	35	30	26	23/10/2013	ND	59	75	80	ND	58
23/10/2012	24	41	45	30	26	38	24/10/2013	42	42	43	63	ND	35
24/10/2012	16	21	23	25	18	18	25/10/2013	26	28	26	67	31	31
25/10/2012	32	29	9	41	30	26	26/10/2013	36	37	48	57	33	37
26/10/2012	26	50	56	42	27	30	27/10/2013	38	51	57	70	46	50
27/10/2012	27	49	62	72	33	38	28/10/2013	24	24	27	22	24	25
28/10/2012	22	14	20	54	22	19	29/10/2013	44	36	41	49	47	36
29/10/2012	23	18	22	24	24	26	30/10/2013	ND	43	ND	58	ND	37
30/10/2012	16	13	18	34	17	15	31/10/2013	17	13	15	15	17	14
31/10/2012	19	23	26	29	21	23	1/11/2013	16	14	15	17	20	18
1/11/2012	27	29	34	38	28	25	2/11/2013	24	16	17	16	24	22
2/11/2012	28	55	76	77	29	35	3/11/2013	ND	33	31	50	23	33
3/11/2012	23	27	31	51	29	26	4/11/2013	64	58	62	81	60	50
4/11/2012	16	13	15	18	20	19	5/11/2013	31	22	23	23	27	26
5/11/2012	23	20	27	28	ND	24	6/11/2013	22	21	19	21	21	19
6/11/2012	ND	19	25	ND	ND	ND	7/11/2013	28	20	19	29	28	19
7/11/2012	30	34	41	41	ND	40	8/11/2013	ND	35	38	38	35	38
8/11/2012	39	34	42	40	ND	35	9/11/2013	ND	62	36	80	49	ND
9/11/2012	16	18	24	11	17	16	10/11/2013	ND	44	47	47	31	30
10/11/2012	12	12	14	ND	14	14	11/11/2013	15	17	17	19	16	20
11/11/2012	13	15	17	14	20	16	12/11/2013	ND	4	5	4	4	4
12/11/2012	14	12	12	ND	17	16	13/11/2013	4	7	8	7	7	ND
13/11/2012	22	17	ND	ND	20	ND	14/11/2013	5	9	15	18	8	ND
14/11/2012	ND	31	44	33	33	29	15/11/2013	12	26	25	ND	19	16
15/11/2012	24	19	23	27	29	28	16/11/2013	ND	ND	18	ND	18	14
16/11/2012	24	21	26	1	27	28	17/11/2013	6	10	9	5	7	7
17/11/2012	17	17	21	22	20	22	18/11/2013	2	13	13	7	5	5
18/11/2012	13	11	14	10	17	15	19/11/2013	3	6	6	6	6	6

Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth	Date	Bulga	Knodlers Lane	Maison Dieu	MTIE	Wallaby Scrub Road	Warkworth
19/11/2012	17	13	14	10	20	23	20/11/2013	6	9	11	13	9	8
20/11/2012	10	20	23	21	13	16	21/11/2013	10	10	9	12	16	13
21/11/2012	15	ND	20	18	20	20	22/11/2013	12	12	12	16	16	17
22/11/2012	23	25	29	25	ND	23	23/11/2013	5	11	12	12	ND	ND
23/11/2012	27	33	31	34	32	33	24/11/2013	ND	ND	ND	ND	7	ND
24/11/2012	23	22	23	27	29	24	25/11/2013	9	11	9	16	13	ND
25/11/2012	24	ND	20	15	29	32	26/11/2013	10	20	16	17	13	ND
26/11/2012	21	27	23	33	29	ND	27/11/2013	16	21	7	18	20	13
27/11/2012	56	36	47	5	34	ND	28/11/2013	26	22	20	23	26	17
28/11/2012	18	22	24	28	ND	21	29/11/2013	ND	23	26	30	20	21
29/11/2012	12	12	13	10	15	16	30/11/2013	15	24	24	30	21	18
30/11/2012	23	16	17	14	26	24	1/12/2013	10	13	13	14	15	13
1/12/2012	ND	ND	25	25	ND	23	2/12/2013	9	10	10	12	13	12
2/12/2012	37	27	30	32	41	31	3/12/2013	9	9	9	14	15	12
3/12/2012	24	16	18	15	24	20	4/12/2013	14	10	ND	12	17	12
4/12/2012	12	10	11	11	12	15	5/12/2013	20	25	28	21	24	21
5/12/2012	9	15	21	27	9	16	6/12/2013	10	ND	13	36	13	20
6/12/2012	17	25	16	47	18	23	7/12/2013	8	11	14	13	13	9
7/12/2012	29	25	33	ND	30	29	8/12/2013	24	20	23	30	22	19
8/12/2012	25	25	26	28	29	27	9/12/2013	24	23	29	24	27	22
9/12/2012	25	32	36	28	30	29	10/12/2013	ND	ND	44	47	31	34
10/12/2012	21	24	27	25	ND	32	11/12/2013	ND	28	38	38	21	22
11/12/2012	9	14	15	21	10	ND	12/12/2013	20	27	34	35	24	23
12/12/2012	11	19	17	14	12	12	13/12/2013	23	23	26	32	29	25
13/12/2012	11	9	8	13	13	18	14/12/2013	ND	23	29	28	29	32
14/12/2012	16	12	12	21	20	16	15/12/2013	ND	19	23	32	19	22
15/12/2012	25	18	ND	22	28	27	16/12/2013	18	13	17	21	22	20
16/12/2012	28	23	ND	25	ND	26	17/12/2013	13	12	12	21	18	20
17/12/2012	19	25	ND	23	25	27	18/12/2013	ND	13	14	18	19	16
18/12/2012	ND	ND	27	25	ND	28	19/12/2013	12	15	13	30	16	ND
19/12/2012	33	25	ND	30	34	41	20/12/2013	ND	15	14	32	21	ND
20/12/2012	22	16	9	17	ND	27	21/12/2013	ND	37	36	37	32	ND
21/12/2012	26	29	40	32	32	ND	22/12/2013	ND	45	55	74	45	38
22/12/2012	28	24	28	27	33	26	23/12/2013	ND	28	36	36	30	29
23/12/2012	24	17	19	22	30	25	24/12/2013	ND	53	53	60	34	38
24/12/2012	19	15	19	30	23	22	25/12/2013	12	13	22	22	17	21
25/12/2012	ND	22	30	26	ND	20	26/12/2013	ND	13	15	12	14	14
26/12/2012	6	ND	ND	5	ND	ND	27/12/2013	ND	7	7	6	8	8
27/12/2012	14	12	14	11	15	17	28/12/2013	7	9	10	13	14	12
28/12/2012	19	16	18	28	17	17	29/12/2013	ND	13	13	14	19	17
29/12/2012	17	19	23	22	17	20	30/12/2013	ND	29	30	31	28	37
30/12/2012	27	19	23	20	17	25	31/12/2013	28	26	30	30	34	33
31/12/2012	20	14	18	18	17	20							

Table B-1: HVAS PM_{10} Monitoring data

Date	Loders Creek	MTIE	MTO	WML	Knodlers Lane	Long Point
3/01/2012	-	-	31	-	27	13
9/01/2012	-	29	-	-	16	16
12/01/2012	-	-	22	-	-	-
15/01/2012	-	31	16	-	10	4
17/01/2012	-	25	-	-	-	-
19/01/2012	-	43	-	-	-	-
21/01/2012	-	33	17	-	23	7
24/01/2012	-	12	-	-	-	-
27/01/2012	-	10	22	-	10	10
30/01/2012	-	23	-	-	-	-
2/02/2012	-	8	4	-	3	2
8/02/2012	-	19	10	-	16	-
14/02/2012	-	13	13	-	12	-
20/02/2012	-	17	11	-	18	-
26/02/2012	-	17	11	-	15	-
3/03/2012	-	10	8	-	13	-
9/03/2012	-	24	10	-	18	-
15/03/2012	-	27	22	-	18	-
21/03/2012	-	22	13	-	12	-
27/03/2012	-	16	21	-	13	-
2/04/2012	-	33	18	-	18	-
8/04/2012	-	38	32	-	34	-
14/04/2012	-	24	12	-	23	-
20/04/2012	-	21	15	-	22	-
26/04/2012	-	30	13	-	24	-
2/05/2012	-	25	13	-	20	-
8/05/2012	-	-	13	-	22	-
14/05/2012	-	-	14	-	16	-
20/05/2012	-	-	14	-	28	-
26/05/2012	-	-	7	-	12	-
1/06/2012	-	-	8	-	7	-
5/06/2012	-	12	-	-	-	-
7/06/2012	-	22	4	-	3	-
13/06/2012	-	15	2	-	2	-
14/06/2012	-	17	-	-	-	-
16/06/2012	-	22	-	-	-	-
19/06/2012	-	-	2	-	9	-
20/06/2012	-	18	-	-	-	-
25/06/2012	-	17	8	-	11	-
26/06/2012	-	11	-	-	-	-
27/06/2012	-	16	-	-	-	-
1/07/2012	-	-	7	-	17	-
4/07/2012	-	34	-	-	-	-
7/07/2012	-	19	4	-	13	-
13/07/2012	-	8	3	-	6	-
19/07/2012	-	30	5	-	13	-
25/07/2012	-	28	17	-	14	-
31/07/2012	-	47	8	-	28	-
6/08/2012	-	63	14	-	19	-
12/08/2012	-	18	9	-	21	-
18/08/2012	-	29	12	19	22	-
24/08/2012	-	22	7	6	17	-
30/08/2012	-	66	14	12	36	-
5/09/2012	-	63	51	32	59	-
11/09/2012	-	70	36	26	38	-
17/09/2012	-	44	48	17	27	-
23/09/2012	-	42	14	16	32	-

Date	Loders Creek	MTIE	MTO	WML	Knodlers Lane	Long Point
29/09/2012	-	35	11	8	17	-
5/10/2012	-	98	54	24	56	-
11/10/2012	-	19	10	11	20	-
17/10/2012	-	46	46	43	51	-
23/10/2012	-	25	26	14	28	-
29/10/2012	-	29	19	16	18	-
4/11/2012	-	35	42	10	28	-
10/11/2012	-	16	22	13	16	-
16/11/2012	-	26	17	15	19	-
22/11/2012	-	37	31	27	42	-
28/11/2012	-	10	16	15	14	-
4/12/2012	-	36	13	10	20	-
10/12/2012	-	15	7	6	20	-
16/12/2012	-	27	35	24	39	-
22/12/2012	-	22	32	21	22	-
28/12/2012	-	26	20	18	24	-
3/01/2013	-	27	33	21	22	-
9/01/2013	-	58	67	47	55	-
15/01/2013	-	15	29	15	13	-
21/01/2013	-	25	36	23	16	-
27/01/2013	-	7	10	7	7	-
2/02/2013	-	10	6	4	6	-
8/02/2013	-	26	26	22	31	-
14/02/2013	-	14	12	8	10	-
20/02/2013	-	17	12	10	12	-
26/02/2013	-	12	17	12	13	-
4/03/2013	6	-	19	15	12	-
10/03/2013	13	-	17	9	11	-
16/03/2013	25	-	22	22	28	-
22/03/2013	40	-	31	19	49	-
28/03/2013	30	-	25	20	54	-
3/04/2013	13	-	5	6	22	-
9/04/2013	9	-	6	3	13	-
15/04/2013	39	-	20	18	29	-
21/04/2013	11	-	-	5	15	-
27/04/2013	38	-	-	16	38	-
1/05/2013	-	-	16	-	-	-
2/05/2013	-	-	12	-	-	-
3/05/2013	33	-	16	12	27	-
9/05/2013	17	-	48	22	30	-
15/05/2013	19	-	10	7	22	-
21/05/2013	35	-	6	9	40	-
27/05/2013	26	-	11	9	17	-
2/06/2013	5	-	2	1	4	-
8/06/2013	15	-	6	4	9	-
14/06/2013	9	-		1	4	-
20/06/2013	16	-	4	3	12	-
26/06/2013	12	-	4	5	10	-
2/07/2013	18	-	5	6	7	-
8/07/2013	21	-	8	7	12	-
14/07/2013	18	-	11	9	11	-
20/07/2013	12	-	3	2	6	-
26/07/2013	25	-	11	9	18	-
1/08/2013	18	-	6	6	10	-
7/08/2013	21	-	6	8	25	-
13/08/2013	19	-	6	7	24	-
19/08/2013	36	-	8	10	40	-
25/08/2013	37	-	13	3	26	-

Date	Loders Creek	MTIE	MTO	WML	Knodlers Lane	Long Point
31/08/2013	74	-	19	16	31	-
6/09/2013	49	-	26	25	40	-
12/09/2013	47	-	22	8	27	-
18/09/2013	25	-	6	5	18	-
24/09/2013	73	-	19	20	47	-
30/09/2013	26	-	21	21	34	-
6/10/2013	57	-	12	14	51	-
12/10/2013	36	-	23	23	40	27
18/10/2013	32	-	37	29	-	29
21/10/2013	-	-	-	-	84	-
24/10/2013	73	-	33	36	42	37
30/10/2013	16	-	19	14	18	14
5/11/2013	23	-	25	20	31	19
11/11/2013	5	-	3	3	1	7
17/11/2013	5	-	3	5	15	8
23/11/2013	11	-	11	11	16	13
29/11/2013	27	-	20	16	28	19
5/12/2013	18	-	12	12	27	14
11/12/2013	28	-	24	22	35	28
17/12/2013	12	-	28	17	14	12
23/12/2013	51	-	39	38	72	45
29/12/2013	33	-	35	29	36	27

Table B-1: HVAS TSP Monitoring data

Date	Loders Creek	MTO	WML	Warkworth	Long Point
3/01/2012	-	132	96	65	-
9/01/2012	-	63	47	50	-
15/01/2012	-	74	40	54	-
21/01/2012	-	41	30	63	-
27/01/2012	-	77	41	48	-
2/02/2012	-	10	8	8	-
8/02/2012	-	-	31	35	-
14/02/2012	-	33	24	43	-
15/02/2012	-	40	-	-	-
20/02/2012	-	30	26	27	-
26/02/2012	-	43	35	47	-
3/03/2012	-	20	26	27	-
9/03/2012	-	28	55	50	-
15/03/2012	-	49	40	41	-
21/03/2012	-	35	34	50	-
27/03/2012	-	58	47	48	-
2/04/2012	-	60	-	37	-
4/04/2012	-	-	69	-	-
8/04/2012	-	72	29	56	-
14/04/2012	-	-	43	33	-
16/04/2012	-	17	-	-	-
20/04/2012	-	45	38	36	-
26/04/2012	-	-	55	67	-
27/04/2012	-	63	-	-	-
2/05/2012	-	40	53	50	-
8/05/2012	-	35	45	39	-
14/05/2012	-	25	28	30	-
20/05/2012	-	47	46	50	-
26/05/2012	-	31	39	31	-
1/06/2012	-	36	23	46	-
7/06/2012	-	10	12	17	-

Date	Loders Creek	MTO	WML	Warkworth	Long Point
13/06/2012	-	10	-	13	-
19/06/2012	-	15	23	17	-
21/06/2012	-	-	33	-	-
25/06/2012	-	34	39	24	-
1/07/2012	-	29	29	33	-
7/07/2012	-	19	11	51	-
13/07/2012	-	11	12	8	-
19/07/2012	-	16	17	16	-
25/07/2012	-	65	-	32	-
26/07/2012	-	-	34	-	-
31/07/2012	-	28	19	37	-
6/08/2012	-	44	51	50	-
12/08/2012	-	19	22	23	-
18/08/2012	-	52	64	60	-
24/08/2012	-	28	26	27	-
30/08/2012	-	39	34	60	-
5/09/2012	-	120	68	112	-
11/09/2012	-	103	92	103	-
17/09/2012	-	140	84	143	-
23/09/2012	-	52	55	51	-
29/09/2012	-	45	35	41	-
5/10/2012	-	151	74	83	-
11/10/2012	-	40	42	41	-
17/10/2012	-	161	160	103	-
23/10/2012	-	114	-	62	-
24/10/2012	-	-	61	-	-
29/10/2012	-	97	-	55	-
30/10/2012	-	-	105	-	-
4/11/2012	-	155	71	96	-
10/11/2012	-	106	66	49	-
16/11/2012	-	67	54	86	-
22/11/2012	-	85	54	96	-
28/11/2012	-	65	41	47	-
4/12/2012	-	56	41	52	-
10/12/2012	-	30	19	18	-
16/12/2012	-	124	83	92	-
22/12/2012	-	152	99	87	-
28/12/2012	-	55	51	76	-
3/01/2013	-	102	60	50	-
9/01/2013	-	207	119	121	-
15/01/2013	-	104	73	66	-
21/01/2013	-	138	71	77	-
27/01/2013	-	54	21	29	-
2/02/2013	-	19	12	14	-
8/02/2013	-	96	77	70	-
14/02/2013	-	69	26	39	-
20/02/2013	-	49	38	73	-
26/02/2013	-	75	-	54	-
4/03/2013	-	63	44	53	-
5/03/2013	-	-	33	-	-
10/03/2013	31	63	46	41	-
11/03/2013	18	-	-	-	-
16/03/2013	69	66	57	64	-
22/03/2013	111	99	62	87	-
28/03/2013	78	61	49	59	-
3/04/2013	31	13	12	22	-
9/04/2013	43	34	21	41	-
15/04/2013	104	56	50	77	-

Date	Loders Creek	MTO	WML	Warkworth	Long Point
21/04/2013	45	-	24	35	-
27/04/2013	107	-	54	84	-
1/05/2013	-	41	-	-	-
2/05/2013	-	31	-	-	-
3/05/2013	114	57	49	55	-
9/05/2013	50	93	50	49	-
15/05/2013	55	43	34	38	-
21/05/2013	111	23	64	78	-
27/05/2013	84	22	18	52	-
2/06/2013	24	7	9	12	-
8/06/2013	55	45	25	46	-
14/06/2013	24	10	15	8	-
20/06/2013	65	22	10	24	-
26/06/2013	41	11	22	27	-
2/07/2013	63	23	21	27	-
8/07/2013	66	35	43	35	-
14/07/2013	40	51	44	38	-
20/07/2013	33	13	9	31	-
26/07/2013	93	37	36	50	-
1/08/2013	65	26	26	31	-
7/08/2013	58	30	32	53	-
13/08/2013	52	22	21	65	-
19/08/2013	78	30	27	64	-
25/08/2013	125	60	40	61	-
31/08/2013	175	74	50	70	-
6/09/2013	114	97	101	105	-
12/09/2013	117	68	29	62	-
18/09/2013	44	31	21	27	-
24/09/2013	151	51	48	88	-
30/09/2013	106	72	44	86	-
6/10/2013	121	47	52	81	-
12/10/2013	112	76	58	93	69
18/10/2013	67	108	69	93	87
24/10/2013	150	51	50	69	93
30/10/2013	43	82	46	49	55
5/11/2013	63	88	62	65	70
11/11/2013	31	19	13	17	42
17/11/2013	20	16	11	14	23
23/11/2013	23	34	26	33	24
29/11/2013	49	-	41	40	48
2/12/2013	-	78	-	-	-
5/12/2013	49	30	25	50	45
11/12/2013	67	72	55	60	95
17/12/2013	28	99	58	51	40
23/12/2013	121	101	91	141	121
29/12/2013	68	31	63	106	55

Appendix C
Emission Calculation

Warkworth Continuation 2014 - Emission Calculation

The mining schedule and mine plan designs provided by the proponent have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions, and composition of the material being handled.

Emission factors and associated controls have been sourced from the US EPA AP42 Emission Factors (**US EPA, 1985 and Updates**), the State Pollution Control Commission document "*Air Pollution from Coal Mining and Related Developments*" (**SPCC, 1983**), the National Pollutant Inventory document "Emission Estimation Technique Manual for Mining, Version 3.1" (**NPI, 2012**) and the NSW EPA document, "*NSW Coal Mining Benchmarking Study: International Best Practise Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*", prepared by Katestone Environmental (**Katestone, 2010**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. Detailed emission inventories for each modelled year are presented in **Table C-2** to **Table C-6**.

Table C-1: Emission factor equations

Activity	Emission factor equation	Variables	Control	Source
Drilling (overburden/coal)	$EF = 0.59\ kg/hole$	-	70% - water sprays	US EPA, 1985 NPI, 2012
Blasting (overburden/coal)	$EF = 0.00022\ \times A^{1.5}\ kg/blast$	A = area to be blasted (m²)	-	US EPA, 1985
Loading / emplacing overburden	$EF = k\ \times 0.0016\ \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	-	NPI, 2012
Dragline	$EF =\ 0.0046\ \times d^{1.1}/M^{1.3}\ kg/m^3$	d = drop height (m) M = moisture content (%)	-	US EPA, 1985
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times\ k\ \times\ (s/12)^{0.7} \times\ (1.1023\ \times M/3)^{0.45}\ kg/VKT$	S = silt content (%) M = average vehicle gross mass (tonnes)	80% - watering of trafficked areas	US EPA, 1985
Dozers on overburden	$EF = 2.6\ \times \frac{s^{1.2}}{M^{1.3}}\ kg/hour$	S = silt content (%) M = moisture content (%)	-	US EPA, 1985
Dozers on coal	$EF = 35.6\ \times \frac{s^{1.2}}{M^{1.4}}\ kg/hour$	S = silt content (%) M = moisture content (%)	-	US EPA, 1985
Loading / emplacing coal	$EF = \frac{0.58}{M^{1.2}}\ kg/tonne$	M = moisture content (%)	85% - enclosed dump hopper and water sprays	US EPA, 1985
Loading product coal to stockpile	$EF = k\ \times 0.0016\ \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	25% - variable height stacker	US EPA, 1985
Wind erosion on exposed areas / stockpiles	$EF = 0.4\ kg/ha\ /hour$	-	50% - water sprays, interim rehabilitation	SPCC, 1983
Grading roads	$EF = 0.0034\ \times\ s^{2.5}\ kg/VKT$	S = speed of grader (km/hr)	-	US EPA, 1985

Table C-2: Emission inventory – Year 3

ACTIVITY	TSP emission (kg/y) - Uncontrolled	TSP emission (kg/y) - Controlled	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Warkworth																		
OB - Dozers stripping topsoil	1,674	1,674	100	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Drilling	47,975	14,392	81,313	holes/year	0.59	kg/hole											70	% Control
OB - Blasting	369,336	369,336	323	blasts/year	1143	kg/blast	30,000	Area of blast in square metres										
OB - Dragline	945,555	945,555	29,759,821	bcm/year	0.032	kg/m^3	7	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck	258,482	258,482	152,492,498	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.3 i	2	moisture content in %								
OB - Hauling to emplacement area	10,191,528	2,038,306	128,823,198	tonnes/year	0.079	kg/t	240	tonnes/load	6.5	km/return trip	2.9	kg/VKT	1.8	% silt content	275	Ave GMV (tonnes)	80	% Control
OB - Hauling to emplacement area at Mt Thorley	1,267,564	253,513	23,669,300	tonnes/year	0.054	kg/t	240	tonnes/load	4.4	km/return trip	2.9	kg/VKT	1.8	% silt content	275	Ave GMV (tonnes)	80	% Control
OB - Emplacing at area	218,361	218,361	128,823,198	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.3 i	2	moisture content in %								
OB - Dozers in pit	838,446	838,446	50,100	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab	323,134	323,134	19,309	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling	3,695	1,109	36,953	holes/year	0.10	kg/hole											70	% Control
CL - Blasting	15,821	15,821	72	blasts/year	220	kg/blast	10,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up	193,688	193,688	5,631	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CL - Loading ROM coal to haul truck	805,789	805,789	14,351,958	tonnes/year	0.056	kg/t	7	moisture content in %										
CL - Hauling ROM to hopper - Warkworth CHPP	1,398,480	279,696	10,872,890	tonnes/year	0.129	kg/t	190	tonnes/load	9.0	km/return trip	2.7	kg/VKT	1.8	% silt content	234	Ave GMV (tonnes)	80	% Control
CL - Hauling ROM to hopper - Mt Thorley CHPP	238,656	47,731	3,479,068	tonnes/year	0.069	kg/t	190	tonnes/load	4.8	km/return trip	2.7	kg/VKT	1.8	% silt content	234	Ave GMV (tonnes)	80	% Control
CHPP - Unloading ROM to hopper - Warkworth CHPP	610,457	91,569	10,872,890	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Rehandle ROM at hopper - Warkworth CHPP	122,091	18,314	2,174,578	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Dozer pushing ROM coal - Warkworth CHPP	42,997	42,997	1,250	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CHPP - Dozer pushing Product coal - Warkworth CHPP	13,593	13,593	1,250	hours/year	10.9	kg/h	5	silt content in %	11	moisture content in %								
CHPP - Loading Product coal to stockpile - Warkworth CH	1,186	890	7,611,023	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.3 i	11	moisture content in %							25	% Control
CHPP - Loading Product coal to train - Warkworth CHPP	1,186	356	7,611,023	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.3 i	11	moisture content in %							70	% Control
CHPP - Loading rejects - Warkworth CHPP	407	407	2,283,733	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.3 i	10	moisture content in %								
CHPP - Hauling rejects - Warkworth CHPP	195,824	39,165	2,283,733	tonnes/year	0.086	kg/t	190	tonnes/load	6.0	km/return trip	2.7	kg/VKT	1.8	% silt content	234	Ave GMV (tonnes)	80	% Control
CHPP - Unloading rejects - Warkworth CHPP	-	-	-	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.3 i	10	moisture content in %								
CHPP - Conveying to Redbank from Warkworth CHPP	3,490	1,047	1.0	ha	3,504	kg/ha/year											70	% Control
CHPP - Conveying to train load out from Warkworth CHPP	2,441	732	0.7	ha	3,504	kg/ha/year											70	% Control
WE - Overburden emplacement areas - Warkworth	1,674,000	837,000	477.7	ha	3,504	kg/ha/year											50	% Control
WE - Open pit - Warkworth	1,945,083	1,945,083	555.1	ha	3,504	kg/ha/year												
WE - ROM stockpiles - Warkworth	68,538	34,269	19.6	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - Warkworth	29,677	14,839	8.5	ha	3,504	kg/ha/year											50	% Control
Grading roads	110,784	110,784	180,000	km	0.62	kg/VKT	8	speed of graders in km/h										
Total TSP emissions (kg/yr)	**21,939,940**	**9,756,076**																

Table C-3: Emission inventory – Year 9

ACTIVITY	TSP emission (kg/y) - Uncontrolled	TSP emission (kg/y) - Controlled	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Warkworth																		
OB - Dozers stripping topsoil	1,674	1,674	100	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Drilling	60,330	18,099	102,254	holes/year	0.59	kg/hole											70	% Control
OB - Blasting	465,263	465,263	407	blasts/year	1143	kg/blast	30,000	Area of blast in square metres										
OB - Dragline	971,494	971,494	30,576,196	bcm/year	0.032	kg/m^3	7	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck	341,247	341,247	201,320,341	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.	2	moisture content in %								
OB - Hauling to emplacement area	13,382,991	2,676,598	152,717,507	tonnes/year	0.088	kg/t	240	tonnes/load	7.2	km/return trip	2.9	kg/VKT	1.8	% silt conter	275	Ave GMV (tonnes	80	% Control
OB - Hauling to emplacement area at Mt Thorley	2,839,453	567,891	48,602,834	tonnes/year	0.058	kg/t	240	tonnes/load	4.8	km/return trip	2.9	kg/VKT	1.8	% silt conter	275	Ave GMV (tonnes	80	% Control
OB - Emplacing at area	258,863	258,863	152,717,507	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.	2	moisture content in %								
OB - Dozers in pit	1,061,405	1,061,405	63,423	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab	313,118	313,118	18,710	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling	4,606	1,382	46,061	holes/year	0.10	kg/hole											70	% Control
CL - Blasting	19,580	19,580	89	blasts/year	220	kg/blast	10,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up	242,401	242,401	7,047	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CL - Loading ROM coal to haul truck	996,671	996,671	17,751,761	tonnes/year	0.056	kg/t	7	moisture content in %										
CL - Hauling ROM to hopper - Warkworth CHPP	1,822,284	364,457	11,591,900	tonnes/year	0.157	kg/t	190	tonnes/load	11.0	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CL - Hauling ROM to hopper - Mt Thorley CHPP	563,404	112,681	6,159,861	tonnes/year	0.091	kg/t	190	tonnes/load	6.4	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CHPP - Unloading ROM to hopper - Warkworth CHPP	650,826	97,624	11,591,900	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Rehandle ROM at hopper - Warkworth CHPP	130,165	19,525	2,318,380	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Dozer pushing ROM coal - Warkworth CHPP	42,997	42,997	1,250	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CHPP - Dozer pushing Product coal - Warkworth CHPP	13,593	13,593	1,250	hours/year	10.9	kg/h	5	silt content in %	11	moisture content in %								
CHPP - Loading Product coal to stockpile - Warkworth CH	1,265	948	8,114,330	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.	11	moisture content in %							25	% Control
CHPP - Loading Product coal to train - Warkworth CHPP	1,265	379	8,114,330	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.	11	moisture content in %							70	% Control
CHPP - Loading rejects - Warkworth CHPP	448	448	2,515,442	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.	10	moisture content in %								
CHPP - Hauling rejects - Warkworth CHPP	215,692	43,138	2,515,442	tonnes/year	0.086	kg/t	190	tonnes/load	6.0	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CHPP - Unloading rejects - Warkworth CHPP	-	-	-	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.	10	moisture content in %								
CHPP - Conveying to Redbank from Warkworth CHPP	3,490	1,047	1.0	ha	3,504	kg/ha/year											70	% Control
CHPP - Conveying to train load out from Warkworth CHPP	2,441	732	0.7	ha	3,504	kg/ha/year											70	% Control
WE - Overburden emplacement areas - Warkworth	1,821,967	910,984	520.0	ha	3,504	kg/ha/year											50	% Control
WE - Open pit - Warkworth	2,261,952	2,261,952	645.5	ha	3,504	kg/ha/year												
WE - ROM stockpiles - Warkworth	68,538	34,269	19.6	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - Warkworth	29,677	14,839	8.5	ha	3,504	kg/ha/year											50	% Control
Grading roads	110,784	110,784	180,000	km	0.62	kg/VKT	8	speed of graders in km/h										
Total TSP emissions (kg/yr)	**28,699,884**	**11,966,083**																

Table C-3: Emission inventory – Year 14

ACTIVITY	TSP emission (kg/y) - Uncontrolled	TSP emission (kg/y) - Controlled	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Warkworth																		
OB - Dozers stripping topsoil	1,673.53	1,674	100	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Drilling	56,388.66	16,917	95,574	holes/year	0.59	kg/hole											70	% Control
OB - Blasting	433,255.19	433,255	379	blasts/year	1143	kg/blast	30,000	Area of blast in square metres										
OB - Dragline	1,015,066.97	1,015,067	31,947,584	bcm/year	0.032	kg/m^3	7	drop height in m	2	moisture content in %								
OB - Loading OB to haul truck	321,755.83	321,756	189,821,298	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.3 i	2	moisture content in %								
OB - Hauling to emplacement area	20,100,000.20	4,020,000	189,821,298	tonnes/year	0.106	kg/t	240	tonnes/load	8.7	km/return trip	2.9	kg/VKT	1.8	% silt conter	275	Ave GMV (tonnes	80	% Control
OB - Hauling to emplacement area at Mt Thorley	-	-	-	tonnes/year	0.000	kg/t	240	tonnes/load	0.0	km/return trip	2.9	kg/VKT	1.8	% silt conter	275	Ave GMV (tonnes	80	% Control
OB - Emplacing at area	321,755.83	321,756	189,821,298	tonnes/year	0.00170	kg/t	1.432	average of (wind speed/2.2)^1.3 i	2	moisture content in %								
OB - Dozers in pit	1,061,405.01	1,061,405	63,423	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
OB - Dozers on dump and rehab	412,760.25	412,760	24,664	hours/year	16.7	kg/h	10	silt content in %	2	moisture content in %								
CL - Drilling	4,293.90	1,288	42,939	holes/year	0.10	kg/hole											70	% Control
CL - Blasting	18,260.00	18,260	83	blasts/year	220	kg/blast	10,000	Area of blast in square metres										
CL - Dozers ripping/pushing/clean-up	242,401.22	242,401	7,047	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CL - Loading ROM coal to haul truck	1,000,303.55	1,000,304	17,816,462	tonnes/year	0.056	kg/t	7	moisture content in %										
CL - Hauling ROM to hopper - Warkworth CHPP	1,771,553.59	354,311	10,330,097	tonnes/year	0.171	kg/t	190	tonnes/load	12.0	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CL - Hauling ROM to hopper - Mt Thorley CHPP	877,310.87	175,462	7,486,365	tonnes/year	0.117	kg/t	190	tonnes/load	8.2	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CHPP - Unloading ROM to hopper - Warkworth CHPP	579,982.30	86,997	10,330,097	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Rehandle ROM at hopper - Warkworth CHPP	115,996.46	17,399	2,066,019	tonnes/year	0.056	kg/t	7	moisture content in %									85	% Control
CHPP - Dozer pushing ROM coal - Warkworth CHPP	42,997.24	42,997	1,250	hours/year	34.4	kg/h	8	silt content in %	7	moisture content in %								
CHPP - Dozer pushing Product coal - Warkworth CHPP	13,592.94	13,593	1,250	hours/year	10.9	kg/h	5	silt content in %	11	moisture content in %								
CHPP - Loading Product coal to stockpile - Warkworth CHPP	1,126.88	845	7,231,068	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.3 i	11	moisture content in %							25	% Control
CHPP - Loading Product coal to train - Warkworth CHPP	1,126.88	338	7,231,068	tonnes/year	0.00016	kg/t	1.432	average of (wind speed/2.2)^1.3 i	11	moisture content in %							70	% Control
CHPP - Loading rejects - Warkworth CHPP	394.33	394	2,214,306	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.3 i	10	moisture content in %								
CHPP - Hauling rejects - Warkworth CHPP	196,199.54	39,240	2,214,306	tonnes/year	0.089	kg/t	190	tonnes/load	6.2	km/return trip	2.7	kg/VKT	1.8	% silt conter	234	Ave GMV (tonnes	80	% Control
CHPP - Unloading rejects - Warkworth CHPP	-	-	-	tonnes/year	0.00018	kg/t	1.432	average of (wind speed/2.2)^1.3 i	10	moisture content in %								
CHPP - Conveying to Redbank from Warkworth CHPP	3,489.98	1,047	1.0	ha	3,504	kg/ha/year											70	% Control
CHPP - Conveying to train load out from Warkworth CHPP	2,440.89	732	0.7	ha	3,504	kg/ha/year											70	% Control
WE - Overburden emplacement areas - Warkworth	1,610,322.42	805,161	459.6	ha	3,504	kg/ha/year											50	% Control
WE - Open pit - Warkworth	2,462,373.28	2,462,373	702.7	ha	3,504	kg/ha/year												
WE - ROM stockpiles - Warkworth	68,538.24	34,269	19.6	ha	3,504	kg/ha/year											50	% Control
WE - Product stockpiles - Warkworth	29,677.48	14,839	8.5	ha	3,504	kg/ha/year											50	% Control
Grading roads	110,783.83	110,784	180,000	km	0.62	kg/VKT	8	speed of graders in km/h										
Total TSP emissions (kg/yr)	**32,877,227**	**13,027,625**																

Appendix D

CALMET/CALPUFF Input Variables

Table D-1: CALMET input variables

Parameter	Value
Terrain radius of influence (TERRAD)	10km
Vertical extrapolation of surface wind observations (IEXTRP)	-4
Layer dependent weighting factor of surface vs. upper air wind observations (BIAS [NZ])	-1,-0.5,-0.25,0,0,0,0,0
Weighting parameter for Step 1 wind field vs. Observations	R1 = 2.5km, R2 = 2.5km
Maximum radius of influence for meteorological stations in Layer 1 and layers aloft	RMAX1=1.0km, RMAX2=1.0km

Table D-2: CALPUFF input variables

Parameter	Used option	Value
Aqueous phase transformation modelled?	No	0
Boundary conditions modelled?	No	0
CGRUP (Species groups)	PM2.5, PM10 and TSP	-
Chemical transformation	Not modelled	0
Dry deposition modelled?	Yes	1
Gravitational settling (plume tilt) modelled?	No	0
Horizontal size of puff (m) beyond which time-dependent dispersion equations (Heffter) are used to determine sigma-y and sigma-z	Default	550
Individual source conditions saved?	No	0
Maximum length of a slug (met. grid units)	Default	1
Maximum mixing height	Default	3000
Maximum number of sampling steps for one puff/slug during one time step	-	60
Maximum number of slugs/puffs release from one source during one time step	-	60
Maximum sigma z allowed to avoid numerical problem in calculating virtual time or distance	Default	5.00E+06
Maximum travel distance of a puff/slug during one sampling step	Default	1
Method used to compute dispersion coefficients?	Internally calculated sigma v, sigma w using micrometeorological variables	2
Method used for lagrangian timescale for Sigma-y	Draxler default 617.284	0
Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables	Standard CALPUFF subroutines	1
Minimum mixing height	Default	50
Minimum sigma y for a new puff/slug	Default	1
Minimum sigma z for a new puff/slug	Default	1
Minimum turbulence velocities sigma-v and sigma-w for each stability class over land and over water	Default	-
Near-field puffs modelled as elongated slugs?	No	0
Plume path coefficients for each stability class	Default	-
Potential temperature gradient for stable classes E, F	Default	-
Puff splitting allowed?	No	0
Range of land use categories for which urban dispersion is assumed	Default	-
Slug - to - puff transition criterion factor	Default	10
Stability class used to determine plume growth rates for puffs above the boundary layer	Default	5
Sub grid-scale complex terrain	Not Modelled	0
Switch for using Heffter equation for sigma-z	Default(Not use Heffter)	0
Terrain adjustment method	Default(Partial plume path adjustment)	3
Vegetation state in unirrigated areas	Default(Active and unstressed)	1
Vertical dispersion constant for stable conditions	Default	0.01
Vertical distribution used in the near field	Default (Gaussian)	1
Wet removal modelled?	No	0
Wind speed classes	Default	-
Wind speed profile power-law exponents for stabilities	Default	-

Appendix E

Isopleth Diagrams – Dust emissions

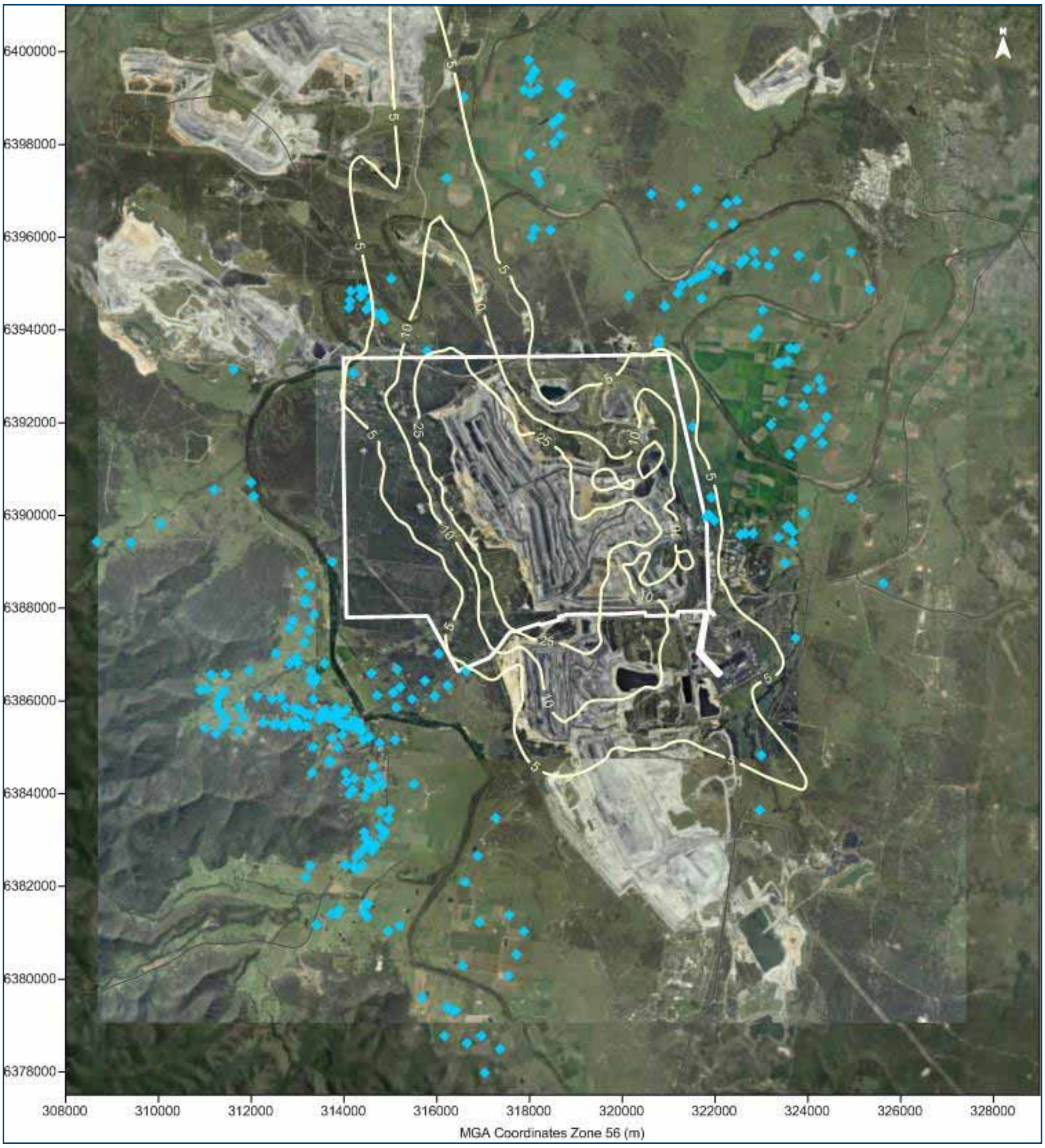

Figure E-1: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 3 (µg/m³)

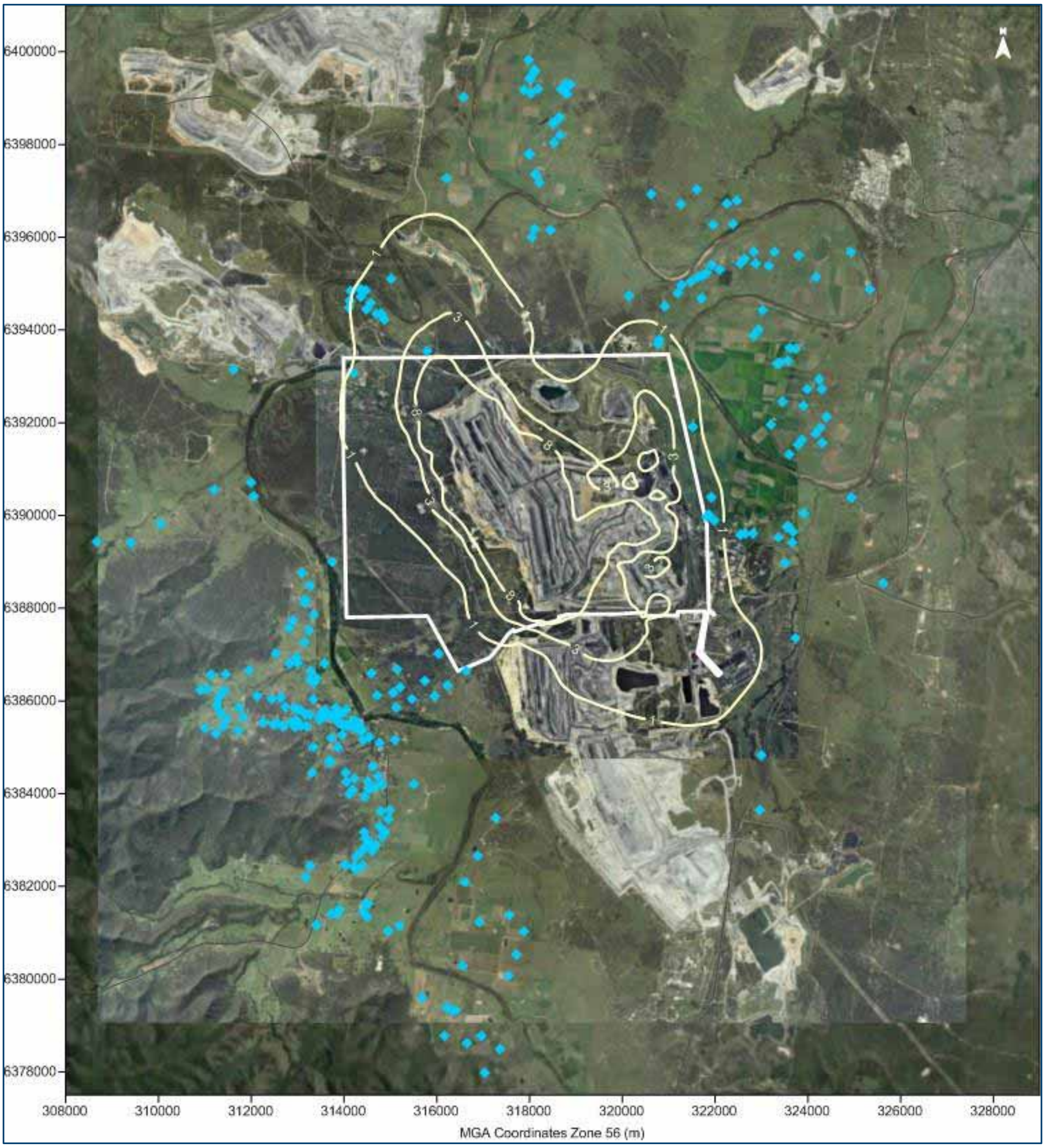

Figure E-2: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 3 (µg/m³)

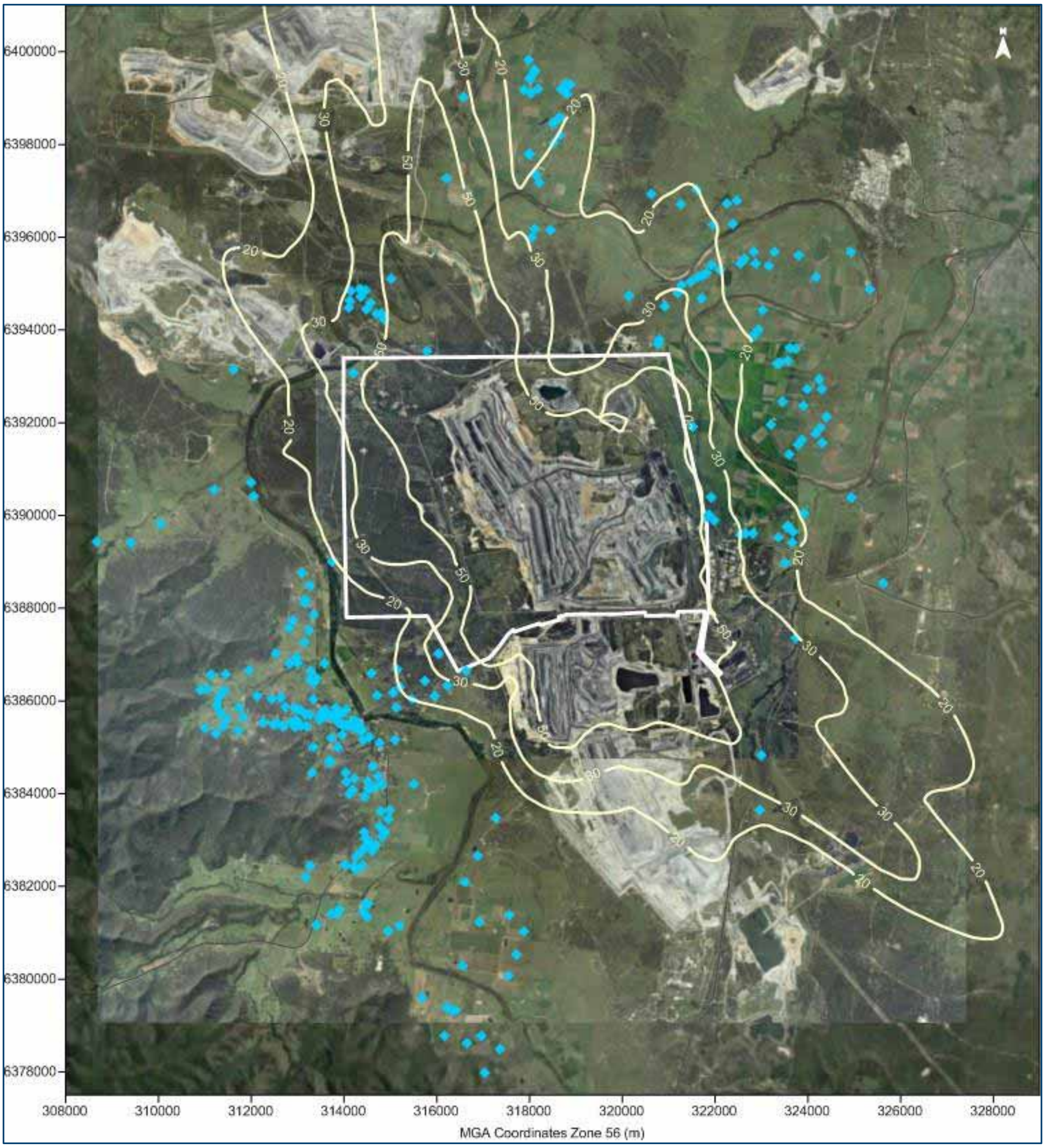

Figure E-3: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the proposal in Year 3 (µg/m³)

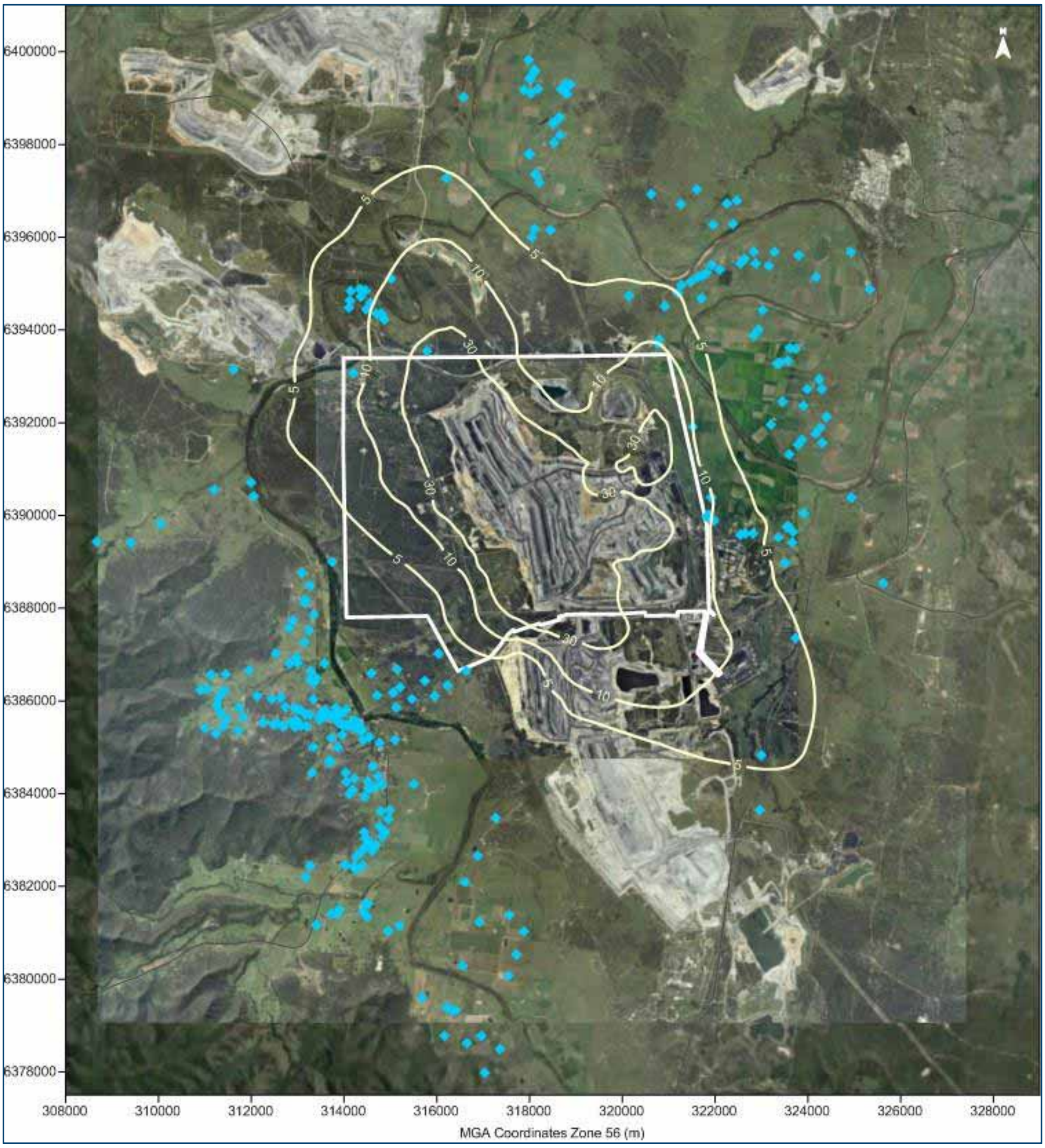

Figure E-4: Predicted annual average PM_{10} concentrations due to emissions from the proposal in Year 3 (µg/m³)

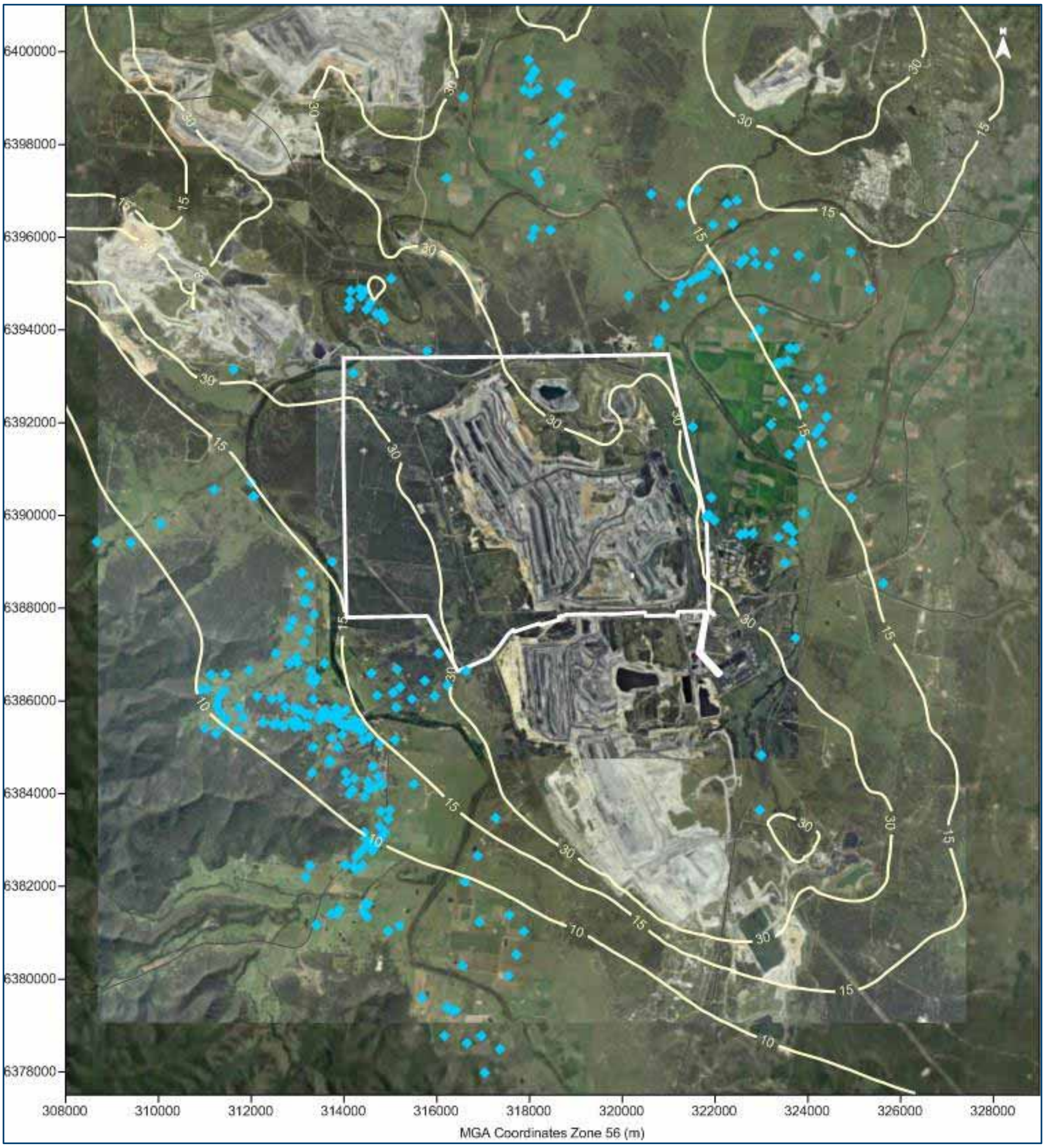

Figure E-5: Predicted annual average PM_{10} concentrations due to emissions from the proposal and other sources in Year 3 (µg/m³)

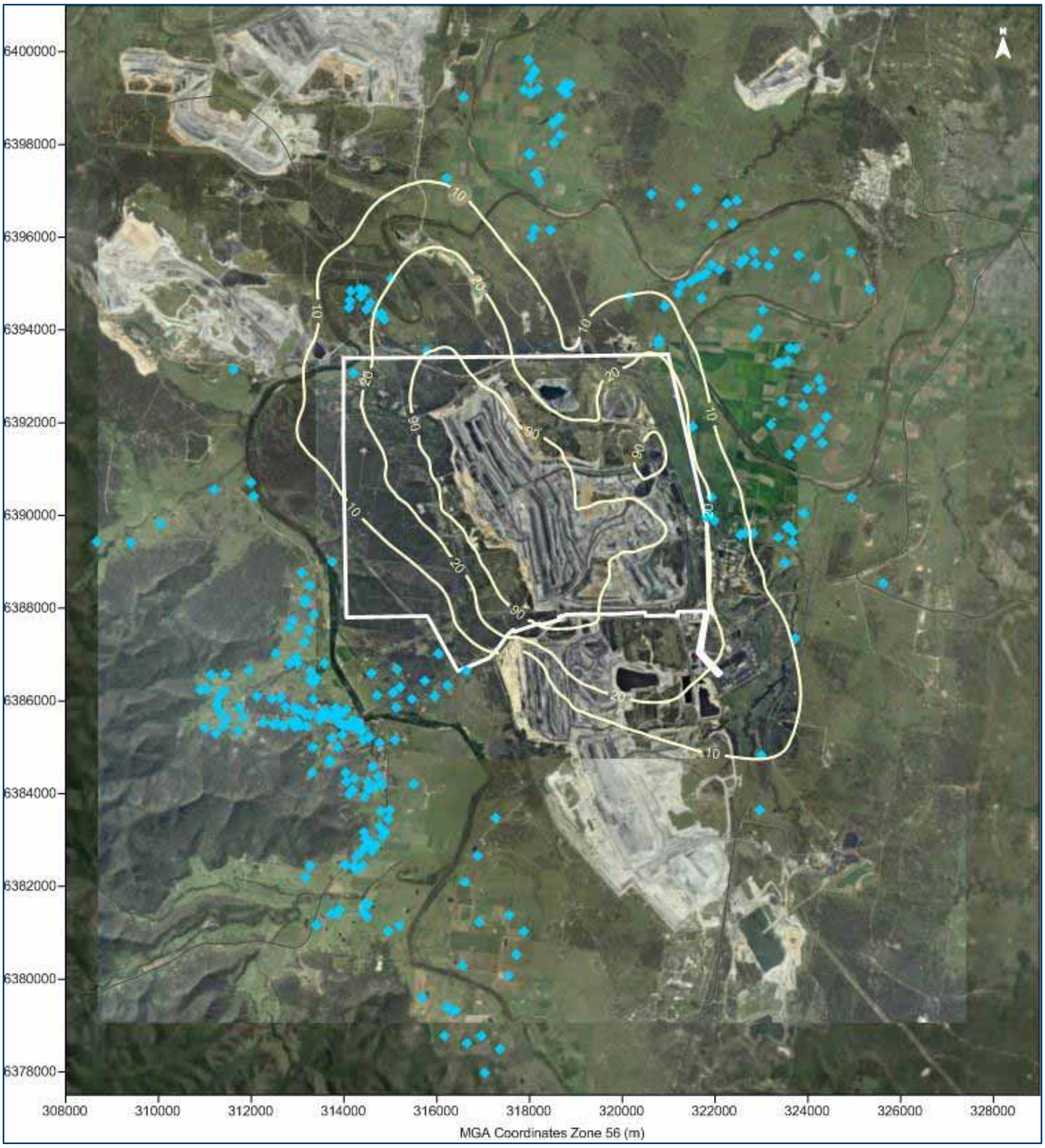

Figure E-6: Predicted annual average TSP concentrations due to emissions from the proposal in Year 3 (µg/m³)

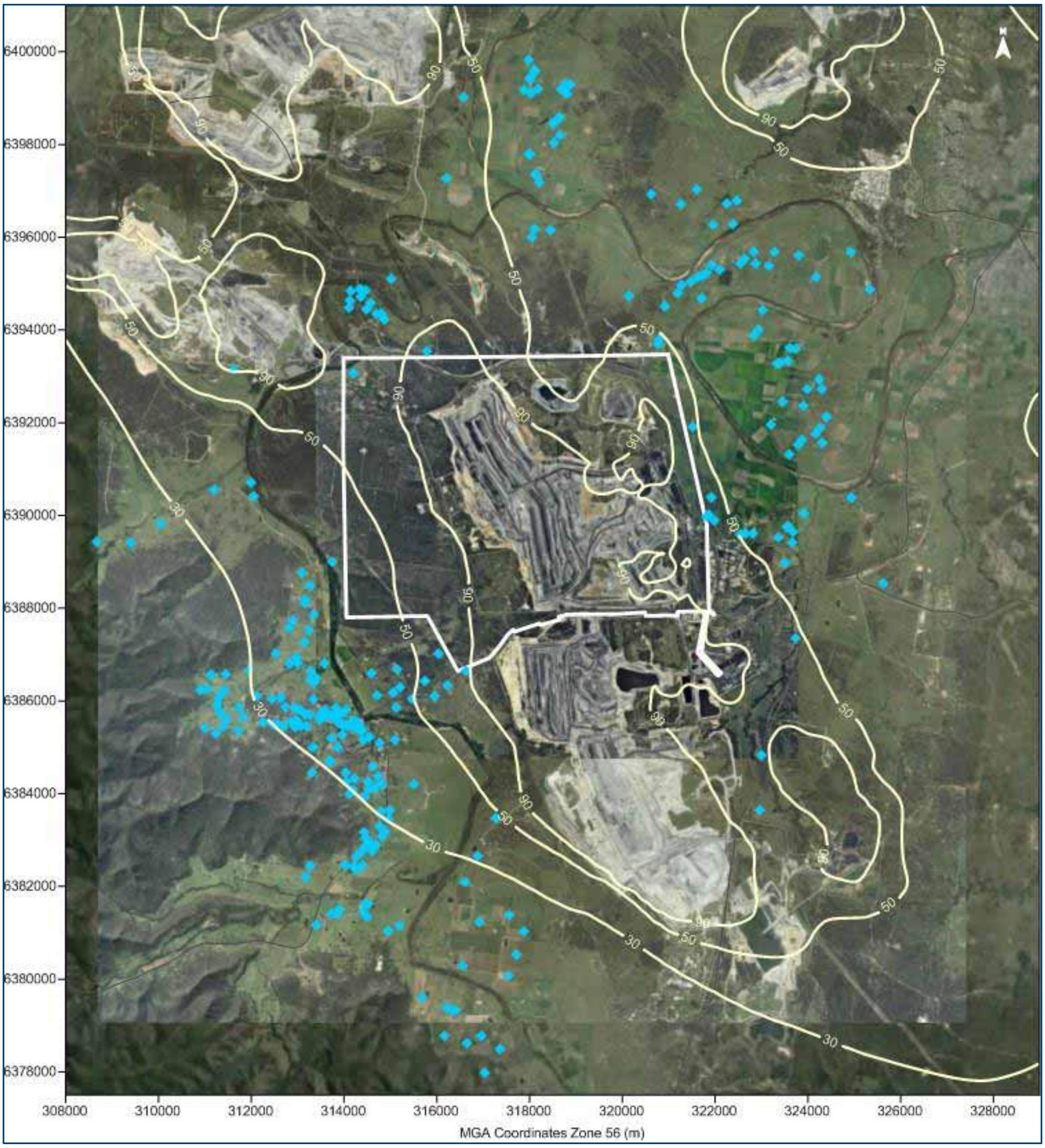

Figure E-7: Predicted annual average TSP concentrations due to emissions from the proposal and other sources in Year 3 (µg/m³)

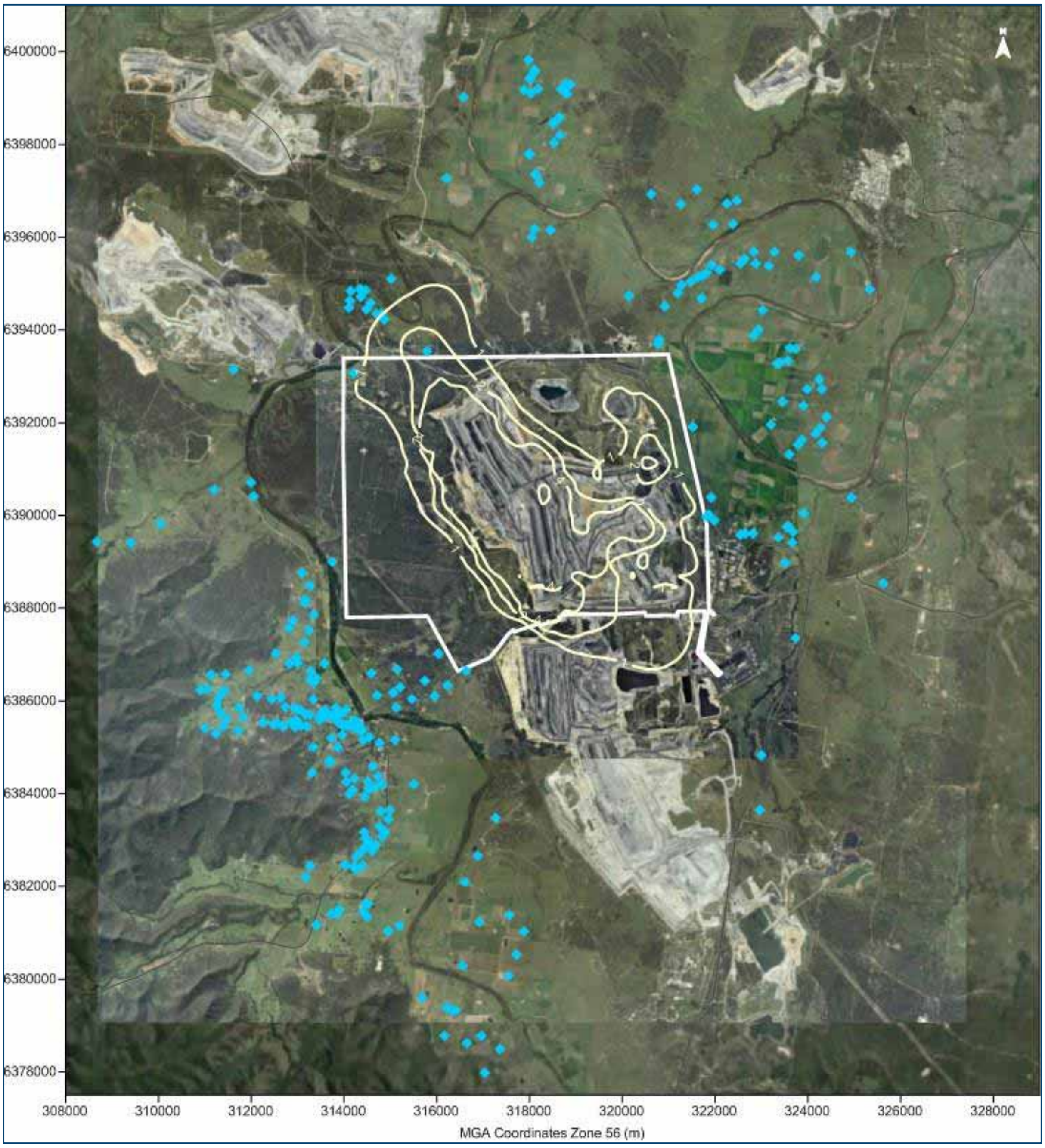

Figure E-8: Predicted annual average dust deposition levels due to emissions from the proposal in Year 3 (g/m²/month)

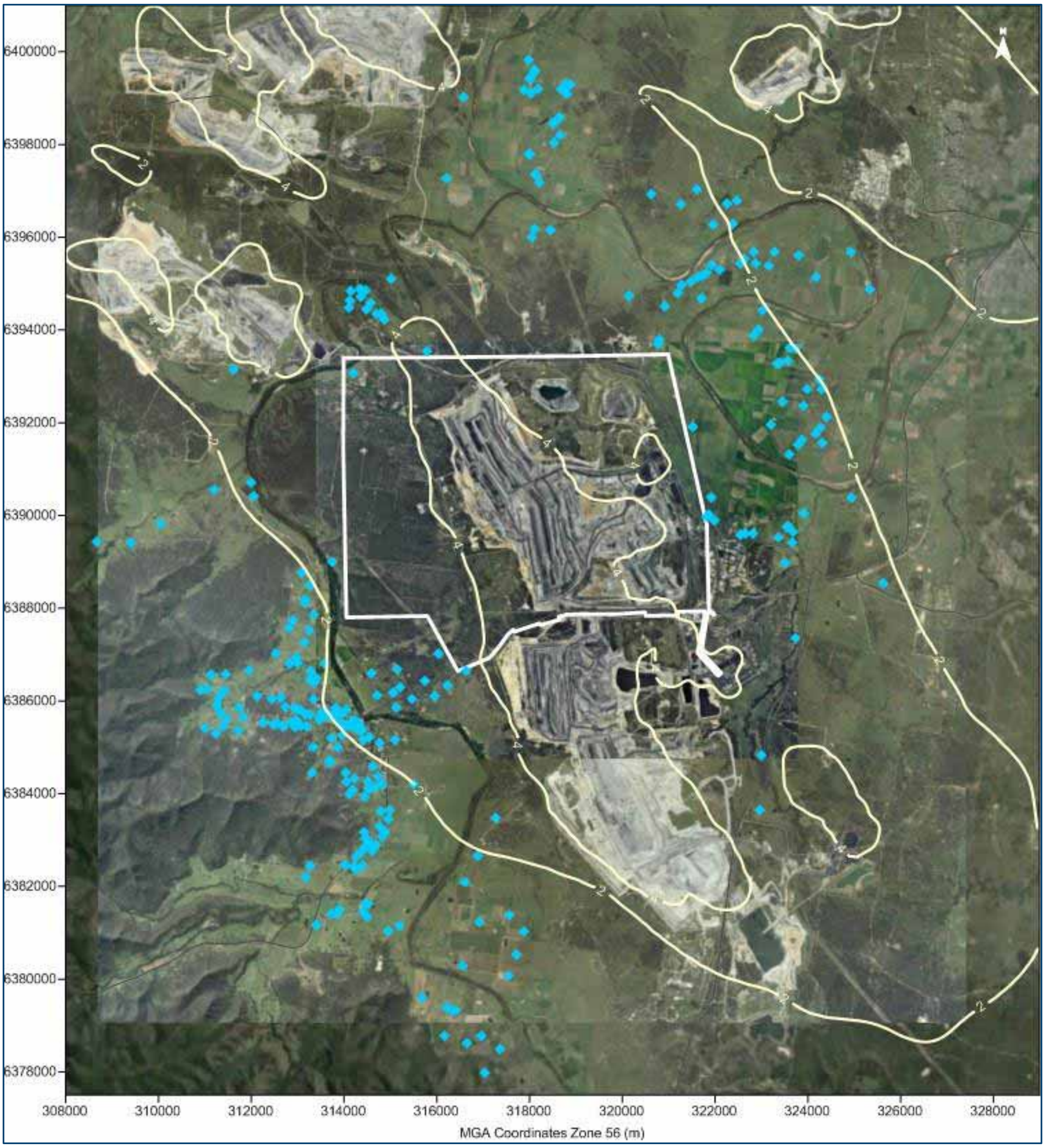

Figure E-9: Predicted annual average dust deposition levels due to emissions from the proposal and other sources in Year 3 (g/m²/month)

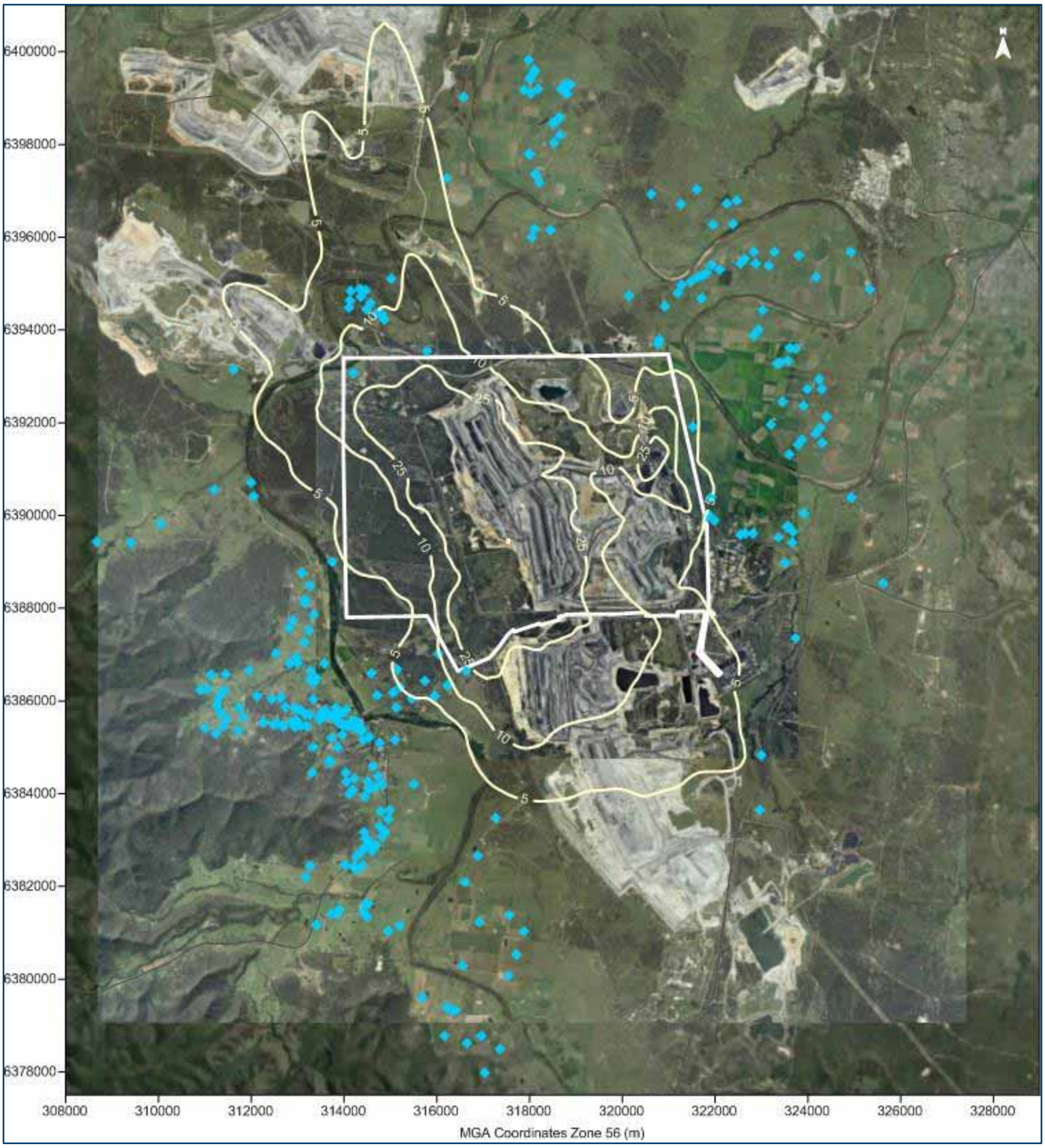

Figure E-10: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 9 (µg/m³)

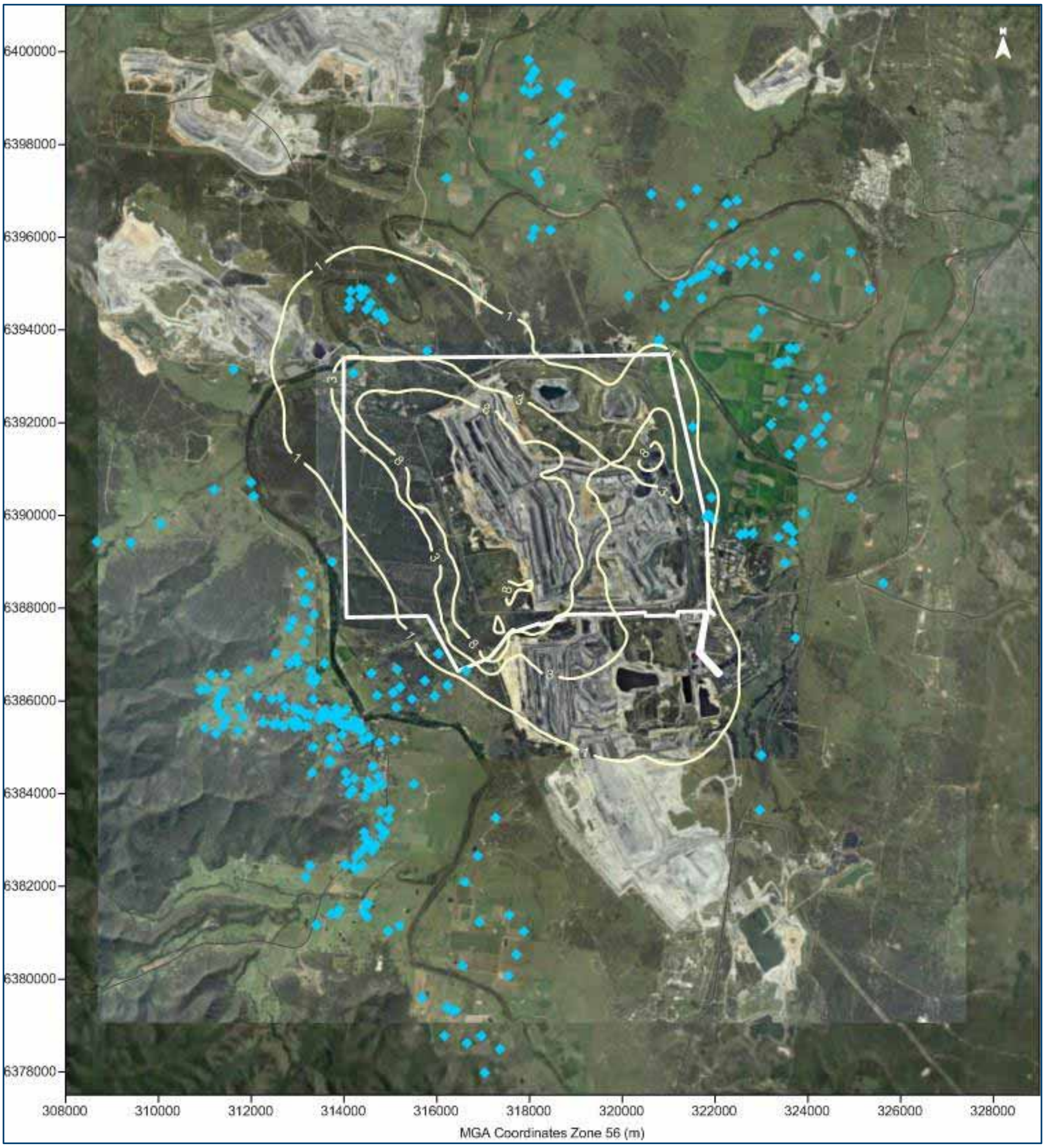

Figure E-11: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 9 (µg/m³)

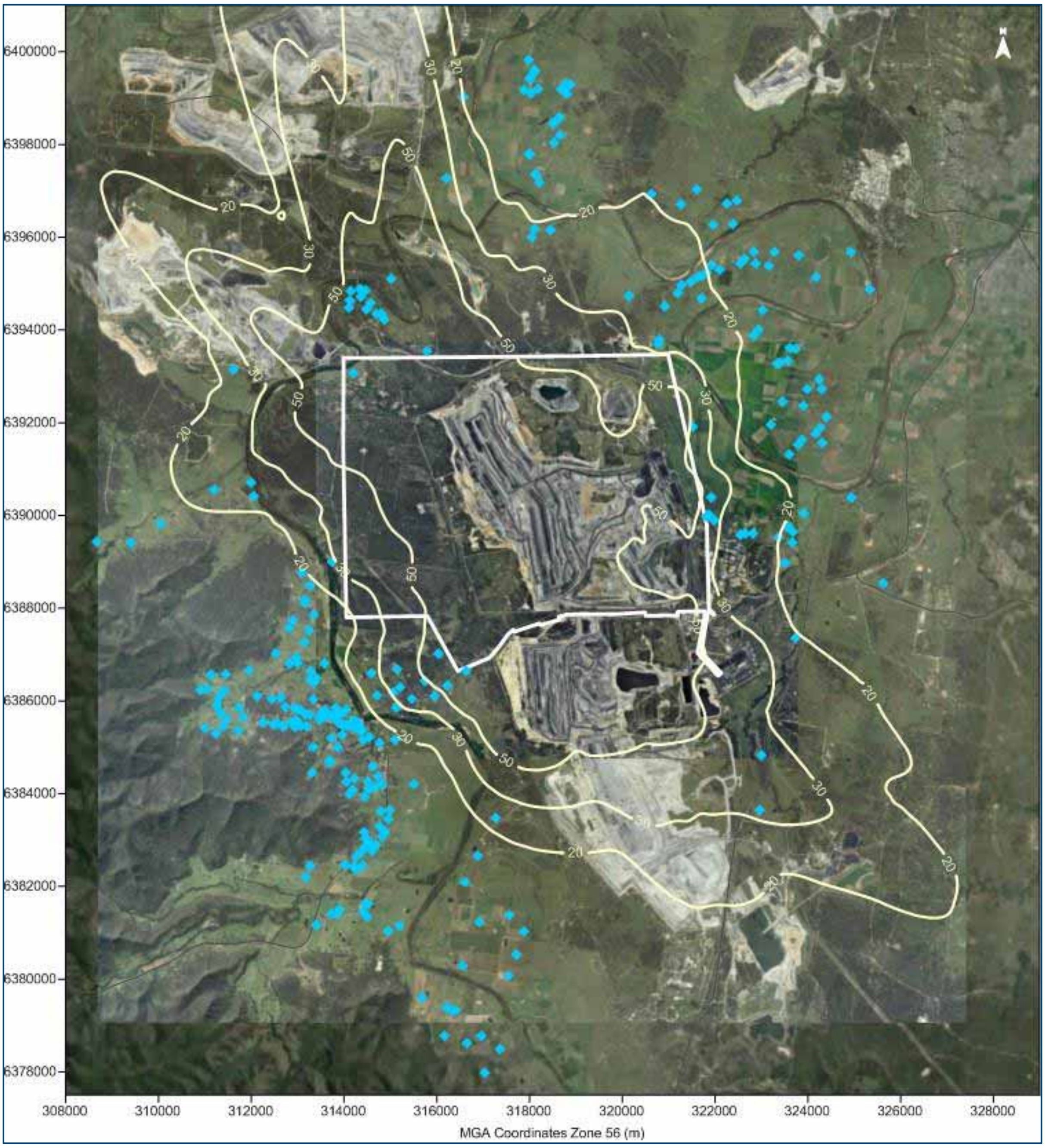

Figure E-12: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the proposal in Year 9 (µg/m³)

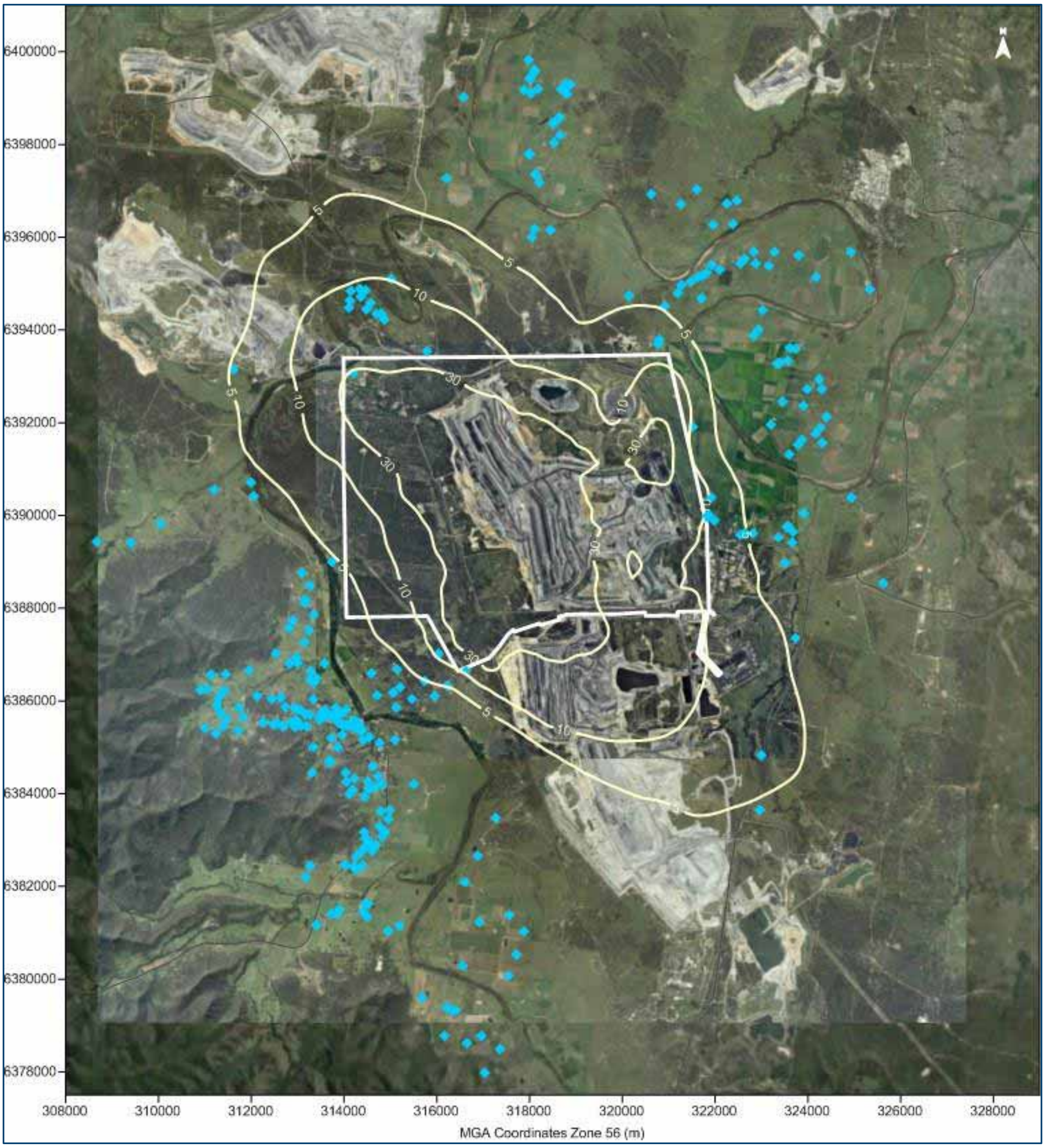

Figure E-13: Predicted annual average PM_{10} concentrations due to emissions from the proposal in Year 9 ($\mu g/m^3$)

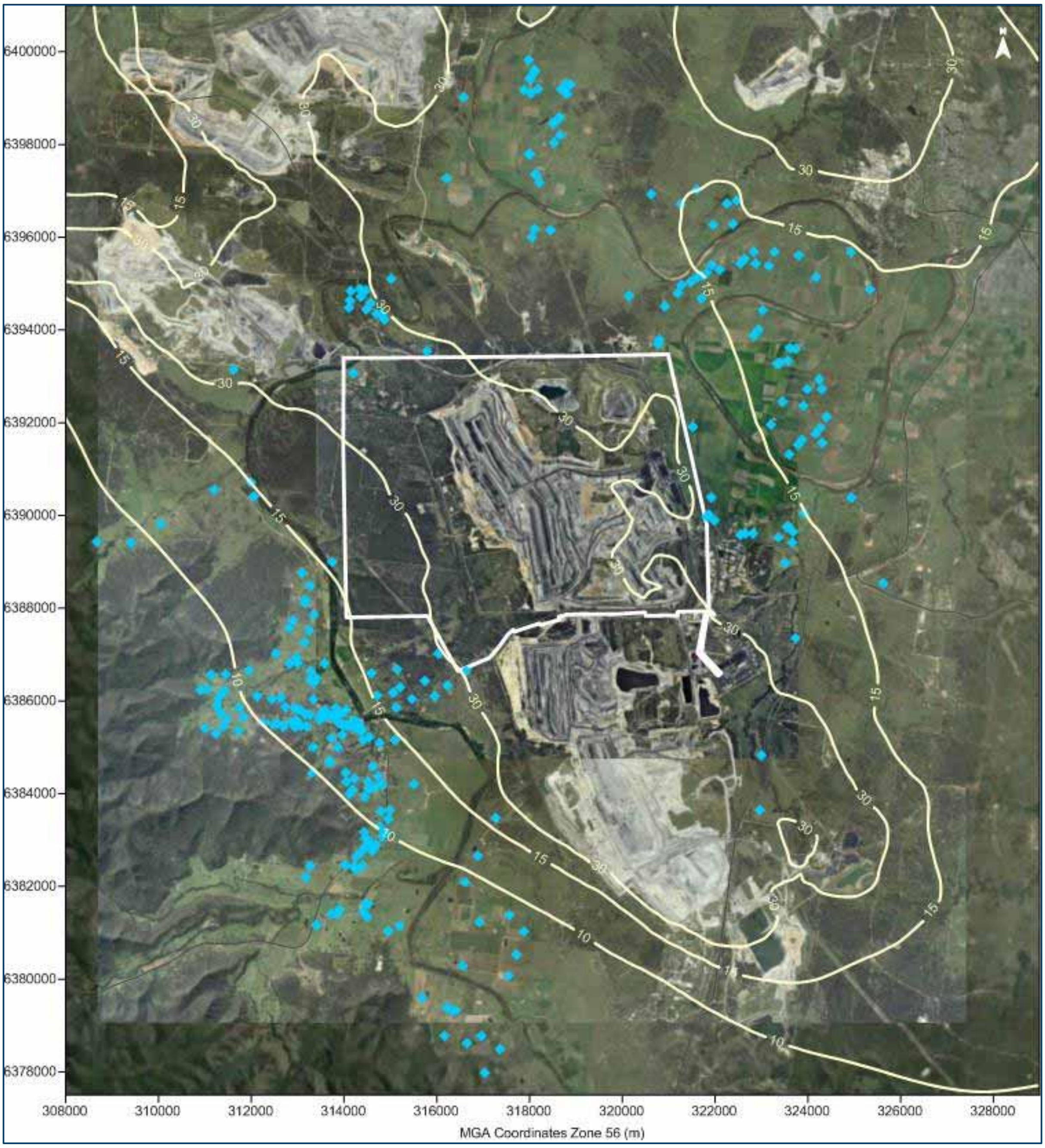

Figure E-14: Predicted annual average PM_{10} concentrations due to emissions from the proposal and other sources in Year 9 (µg/m³)

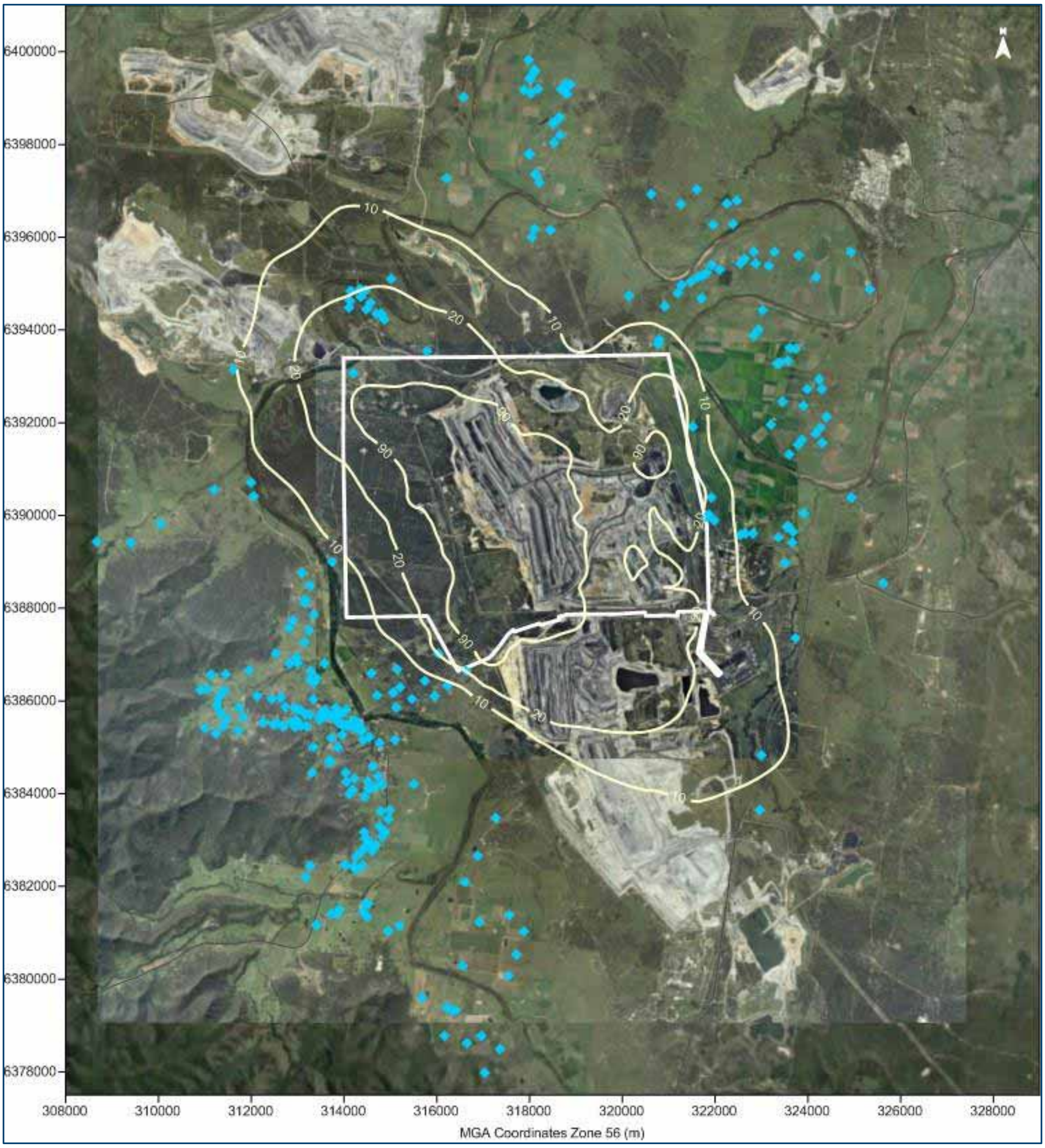

Figure E-15: Predicted annual average TSP concentrations due to emissions from the proposal in Year 9 (µg/m³)

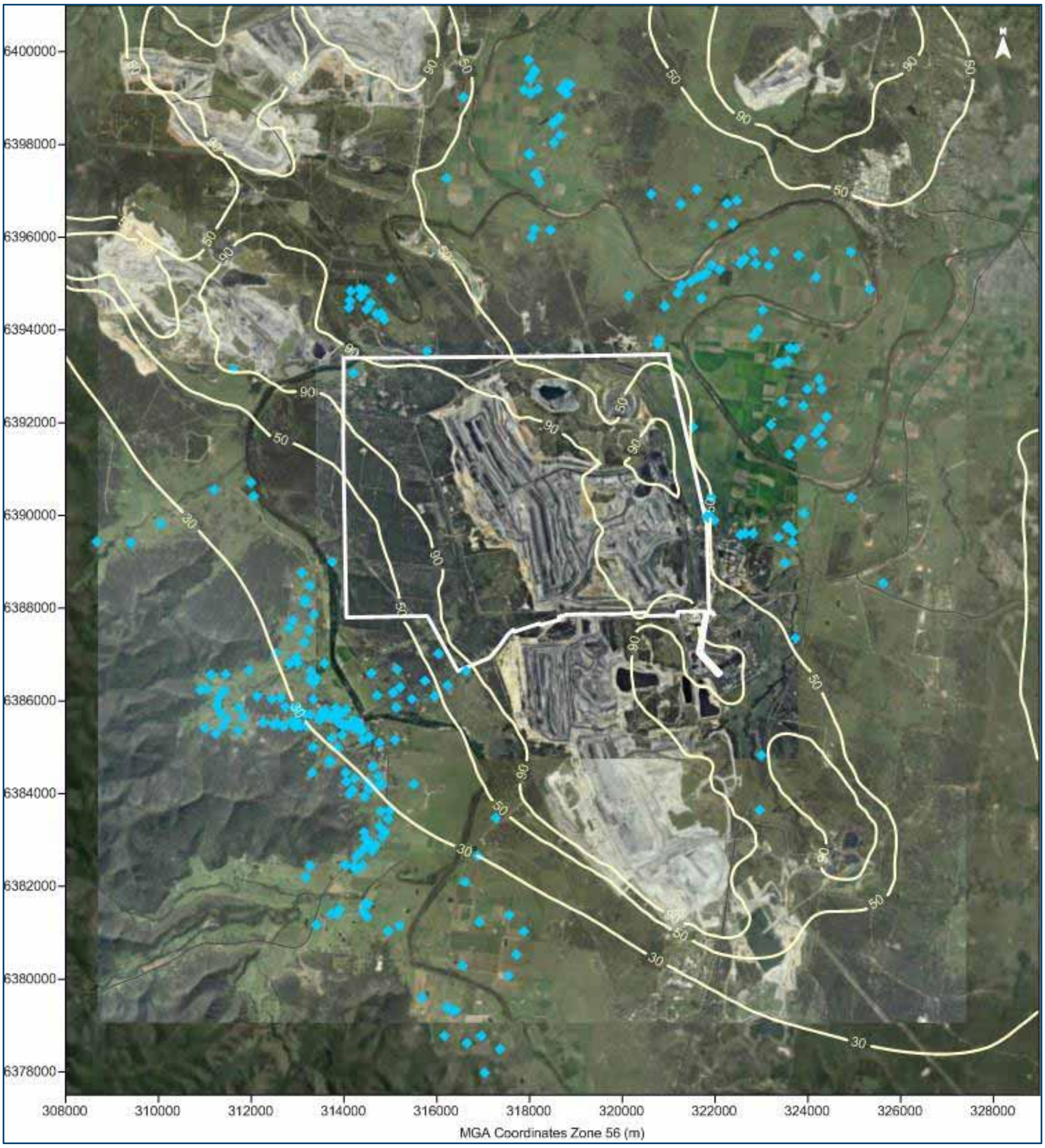

Figure E-16: Predicted annual average TSP concentrations due to emissions from the proposal and other sources in Year 9 (µg/m³)

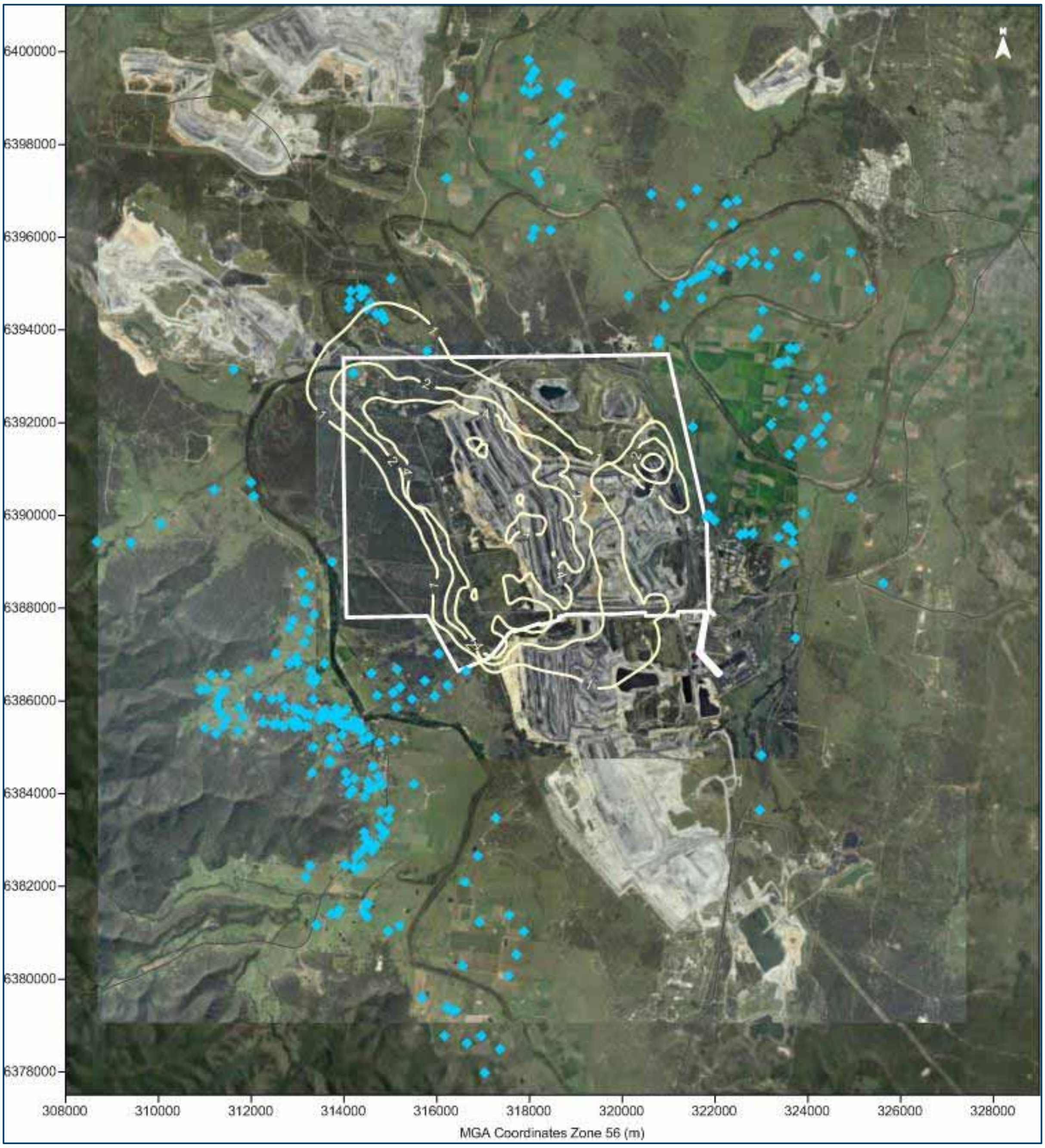

Figure E-17: Predicted annual average dust deposition levels due to emissions from the proposal in Year 9 (g/m²/month)

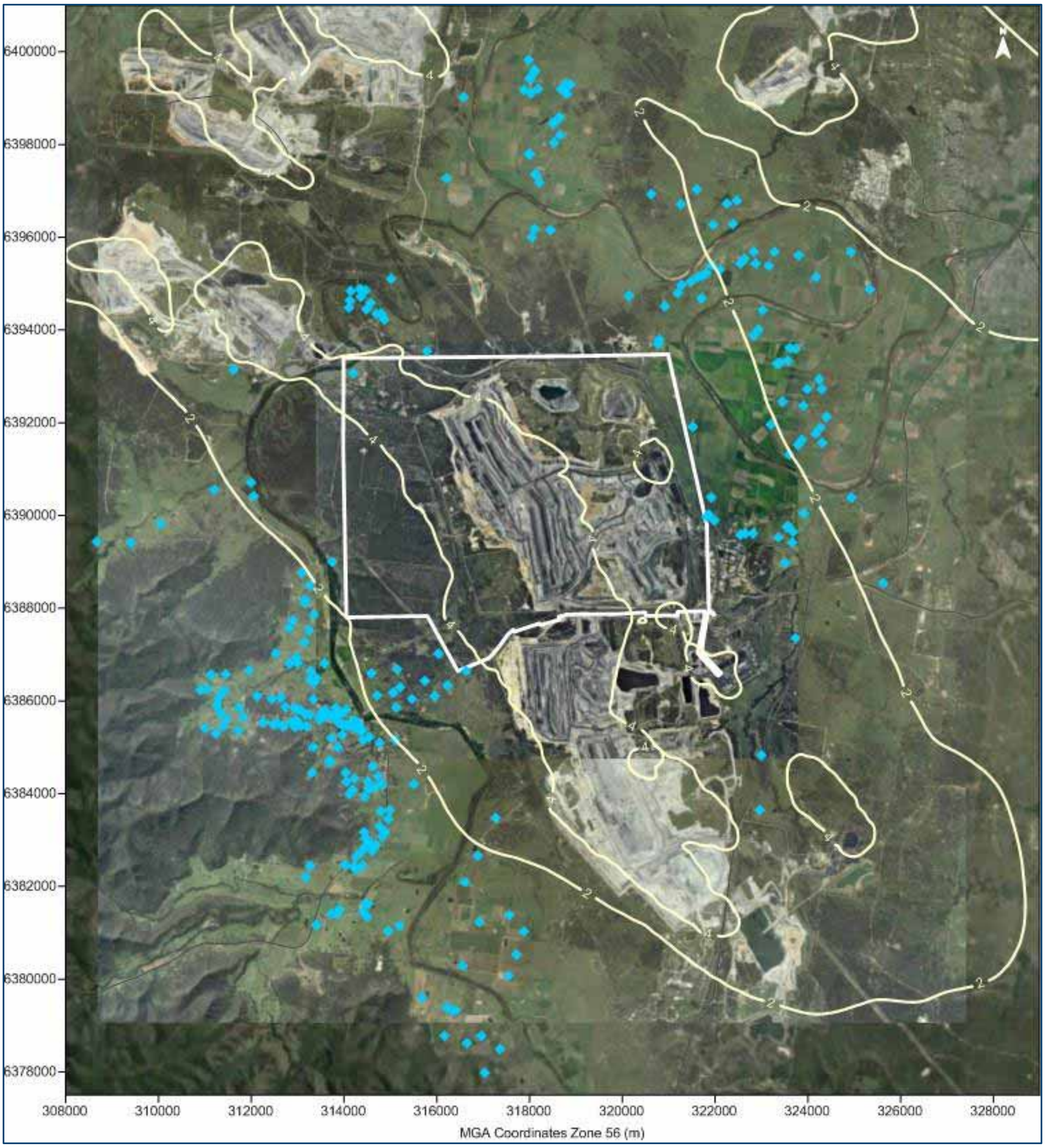

Figure E-18: Predicted annual average dust deposition levels due to emissions from the proposal and other sources in Year 9 (g/m²/month)

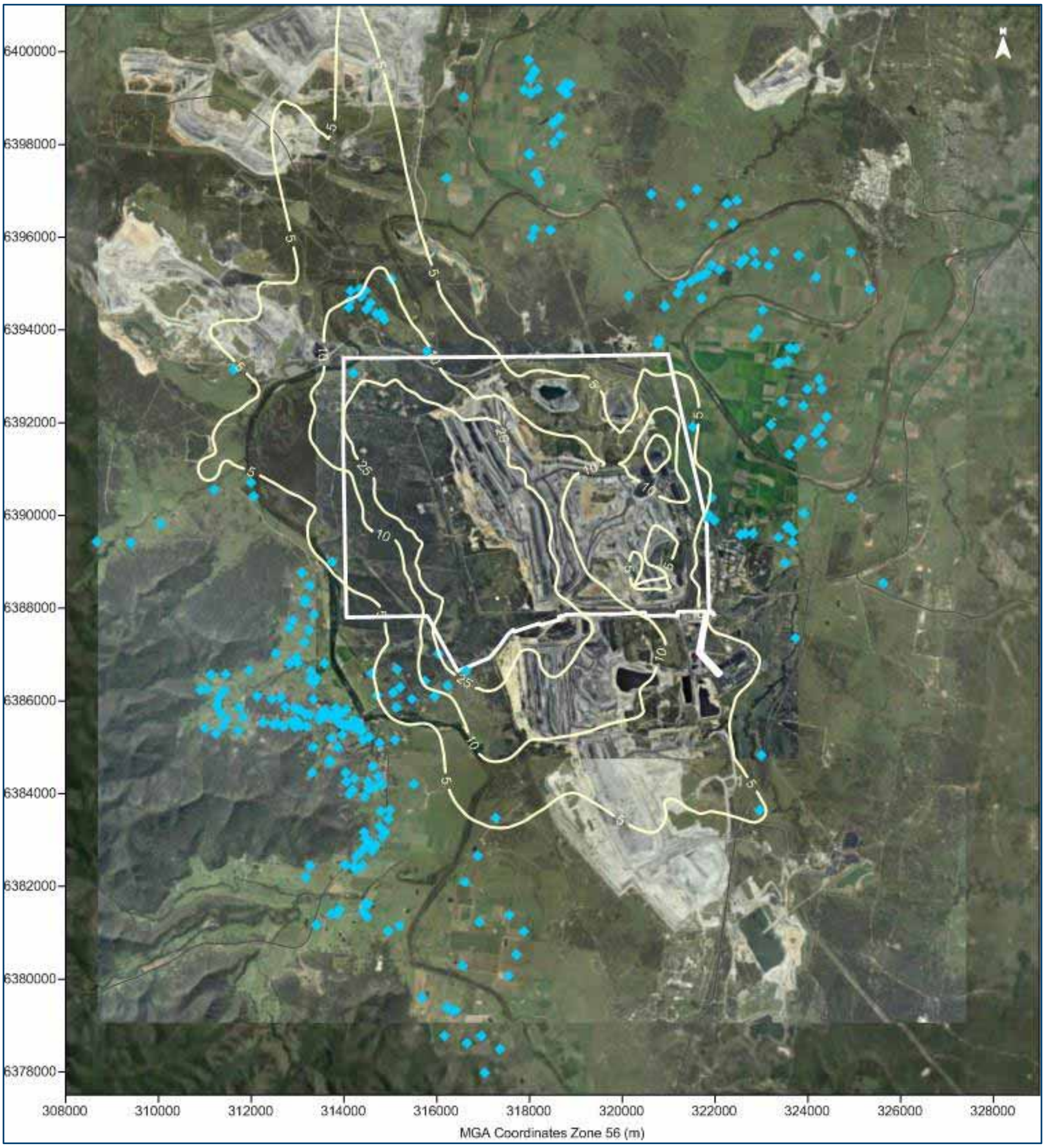

Figure E-19: Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 14 (µg/m³)

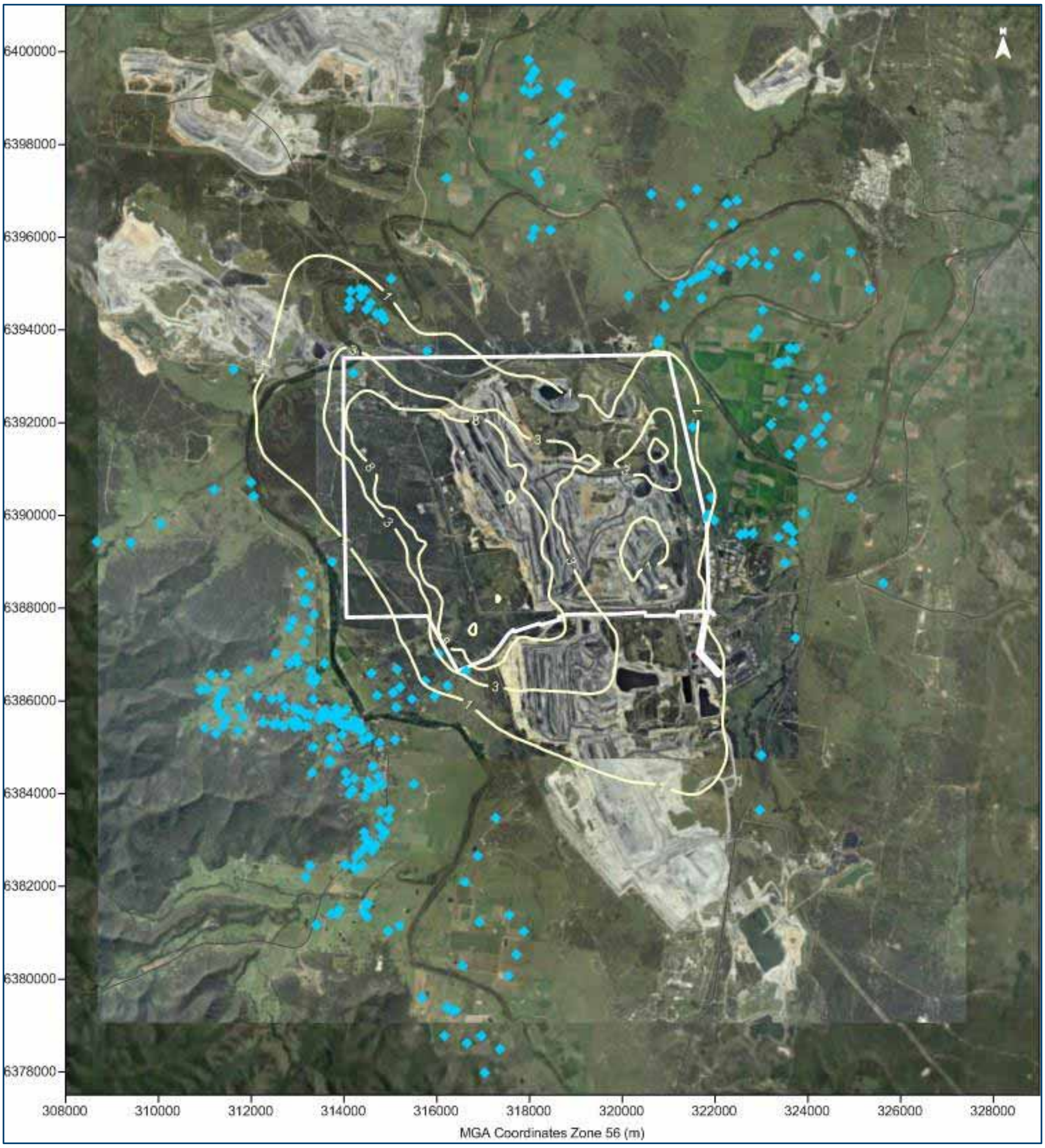

Figure E-20: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the proposal in Year 14 (µg/m³)

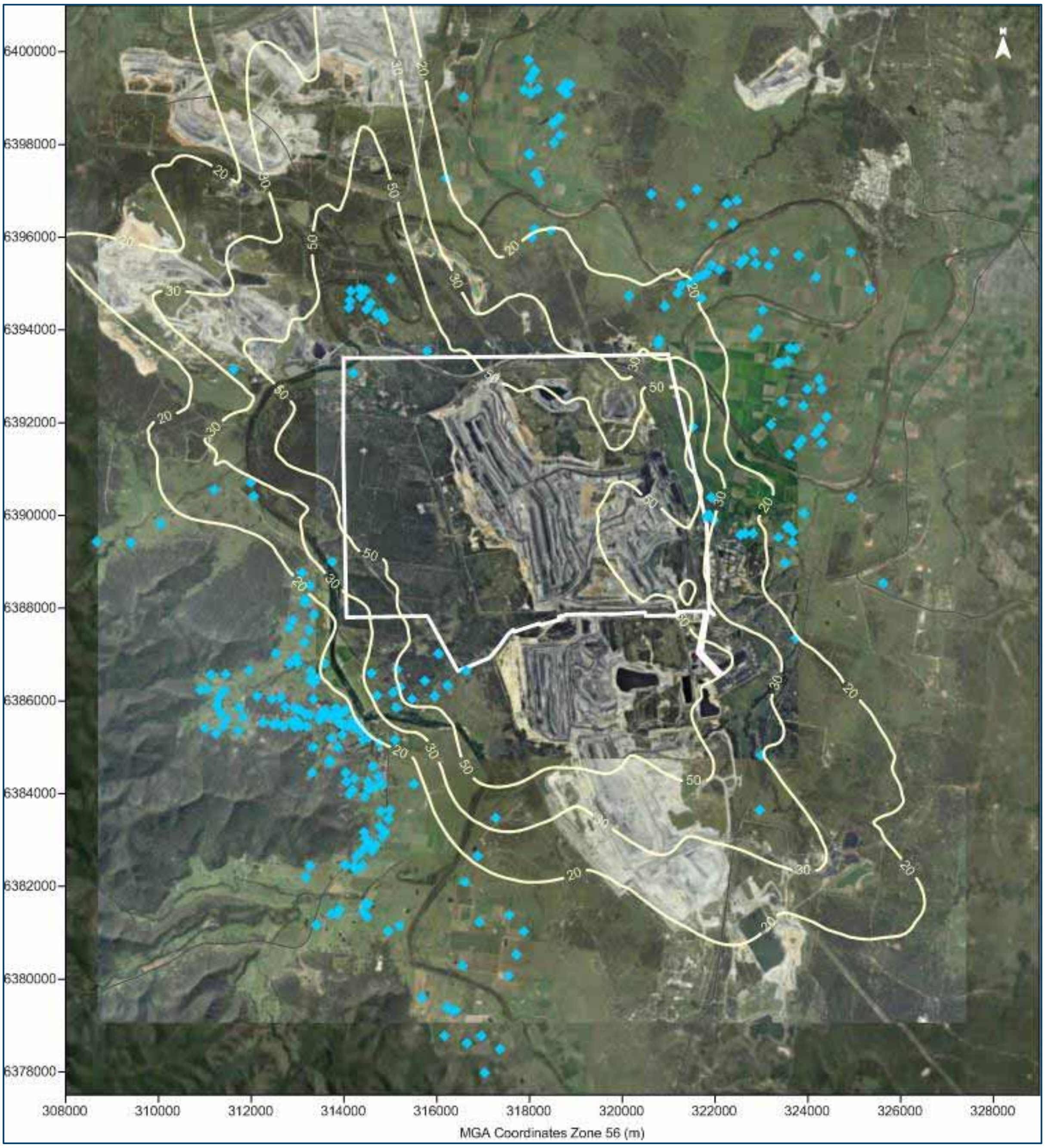

Figure E-21: Predicted maximum 24-hour average PM_{10} concentrations due to emissions from the proposal in Year 14 (µg/m³)

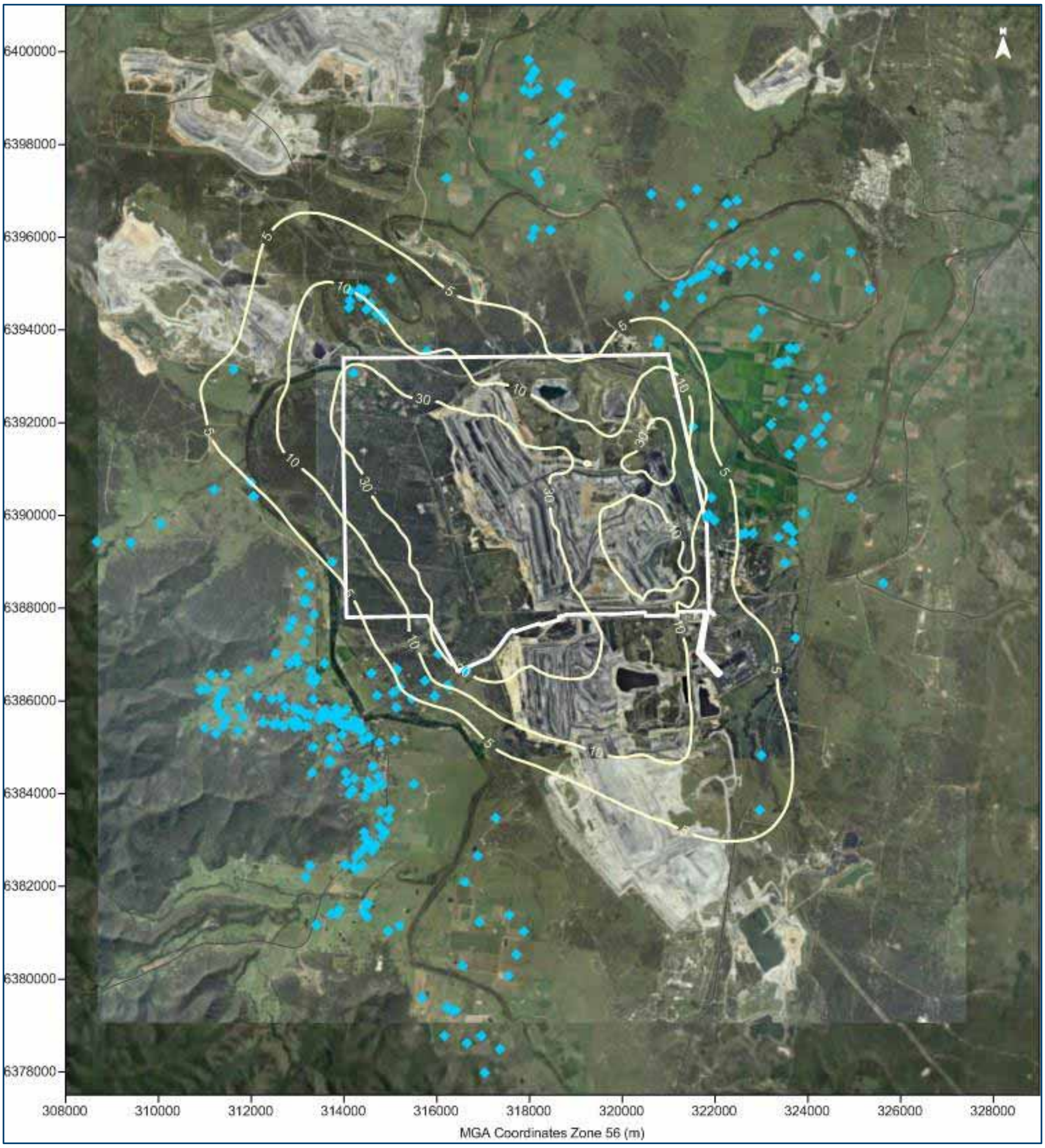

Figure E-22: Predicted annual average PM_{10} concentrations due to emissions from the proposal in Year 14 (µg/m³)

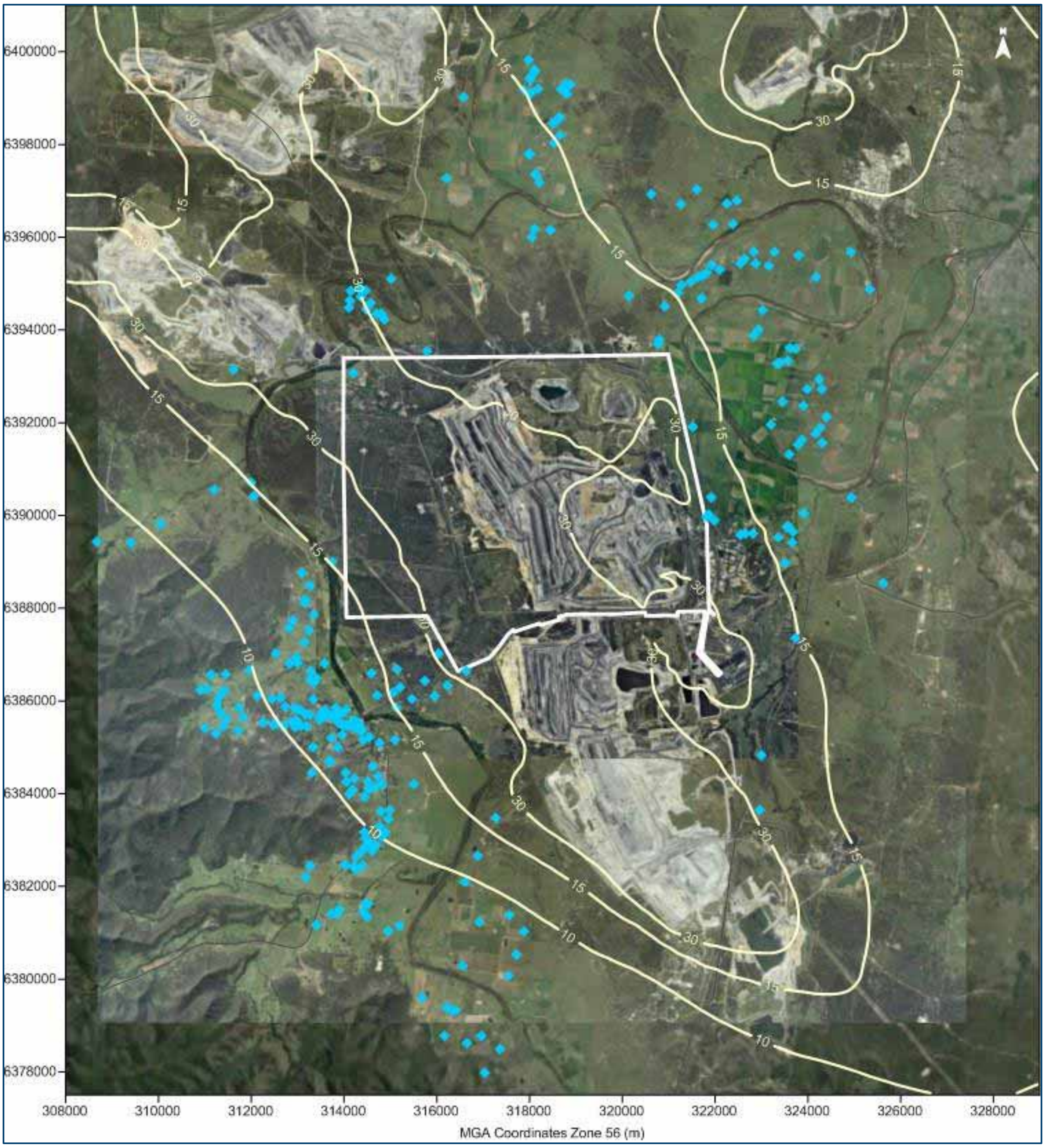

Figure E-23: Predicted annual average PM_{10} concentrations due to emissions from the proposal and other sources in Year 14 (µg/m³)

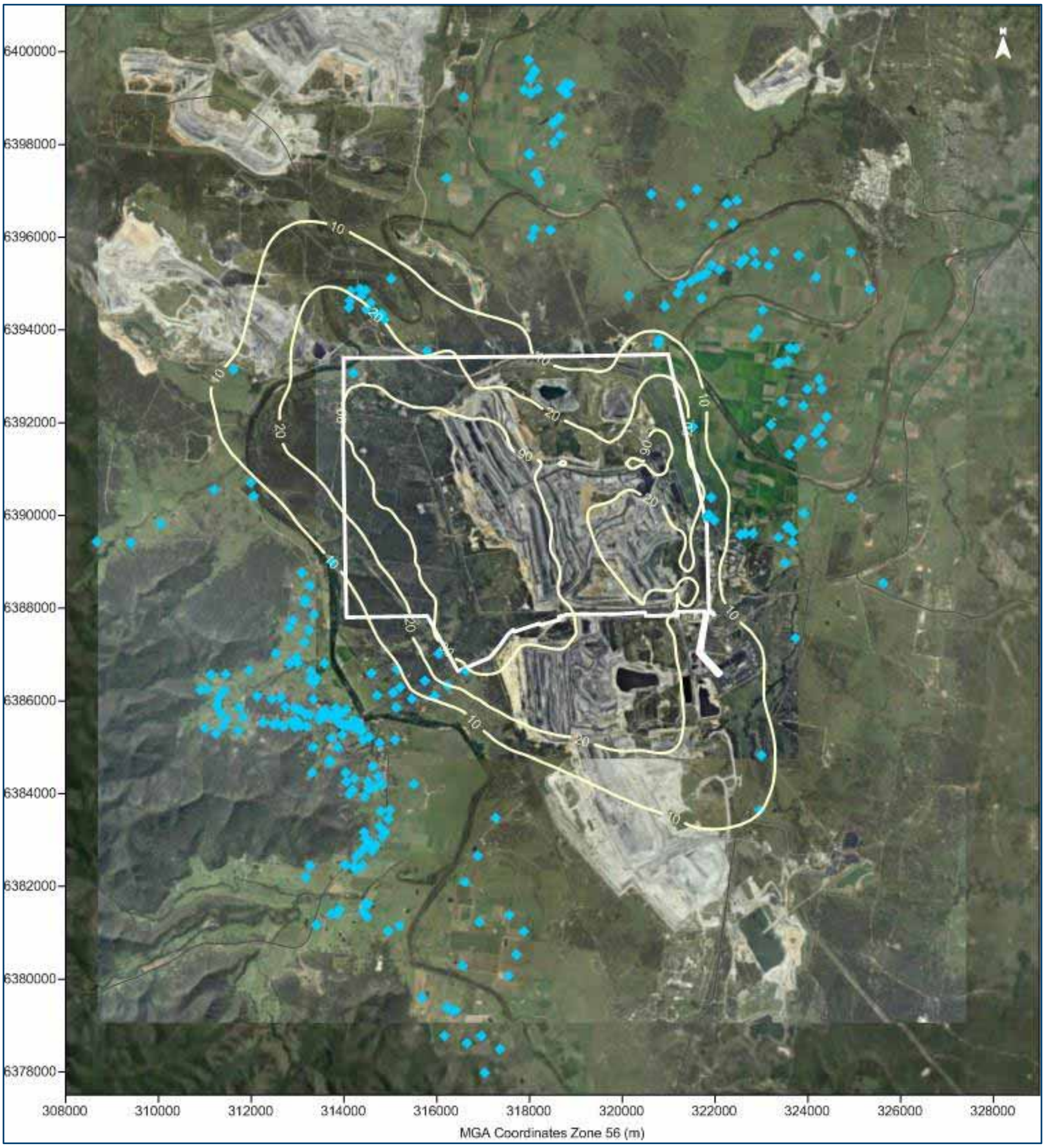

Figure E-24: Predicted annual average TSP concentrations due to emissions from the proposal in Year 14 (µg/m³)

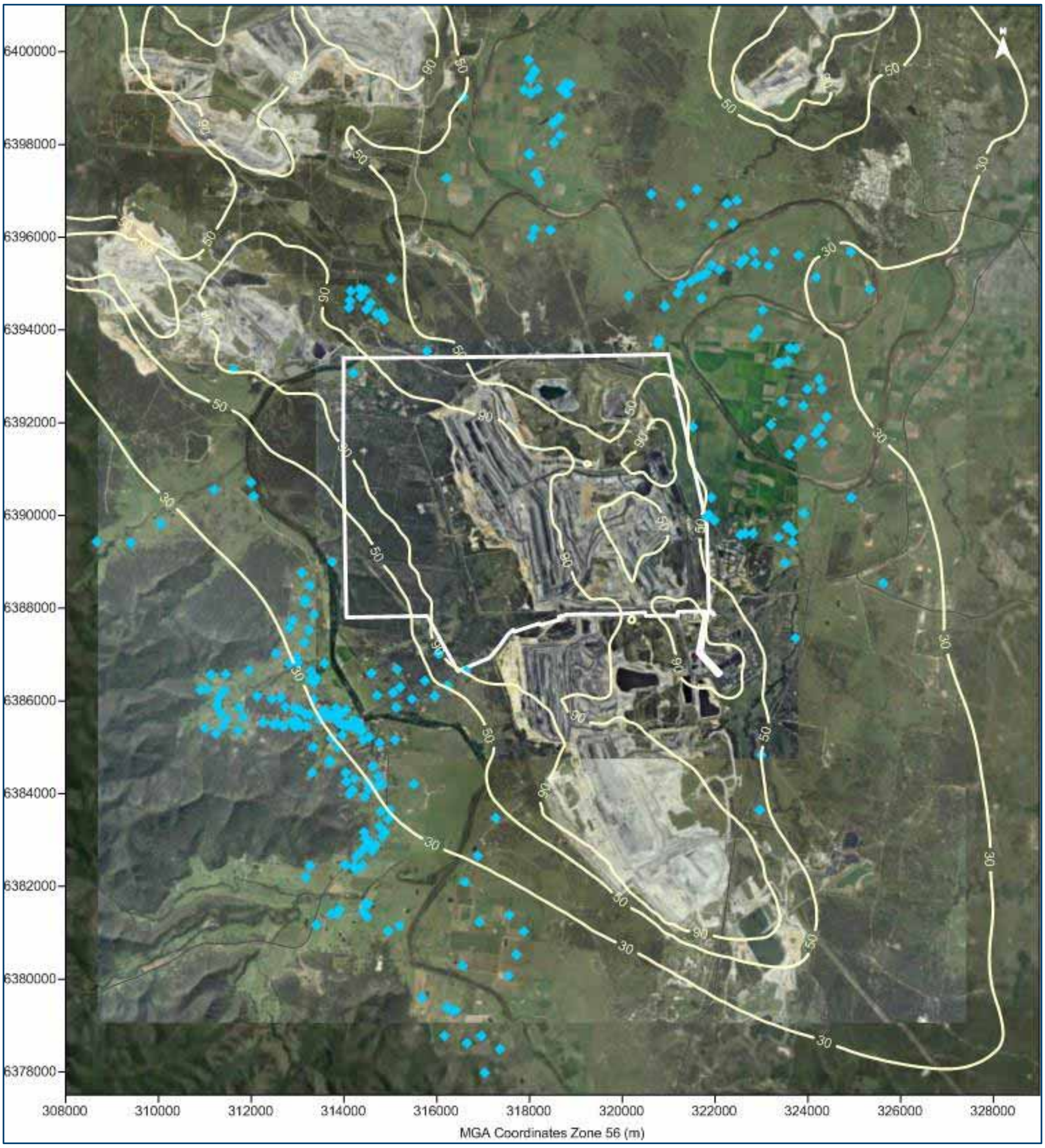

Figure E-25: Predicted annual average TSP concentrations due to emissions from the proposal and other sources in Year 14 (µg/m³)

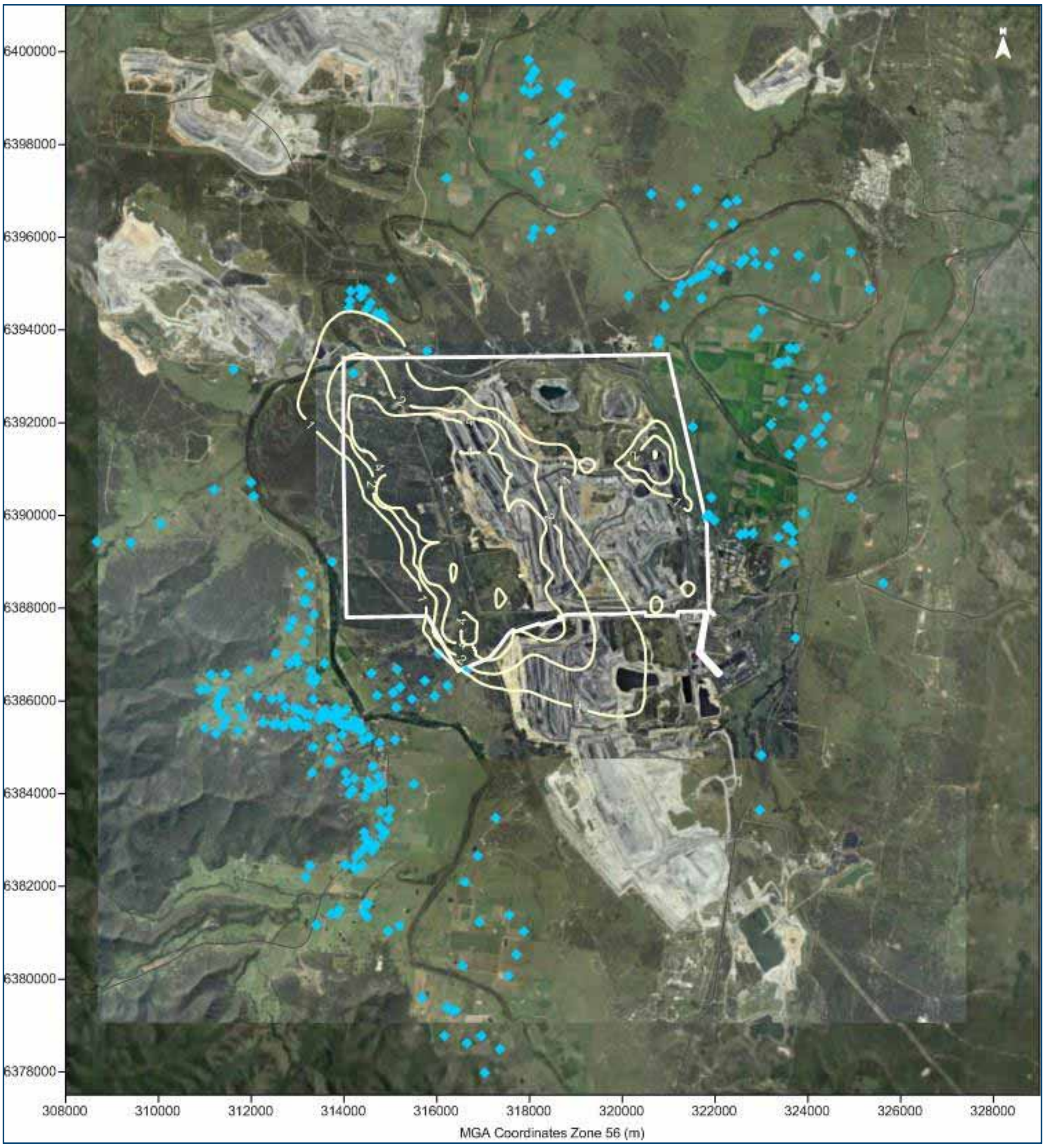

Figure E-26: Predicted annual average dust deposition levels due to emissions from the proposal in Year 14 (g/m²/month)

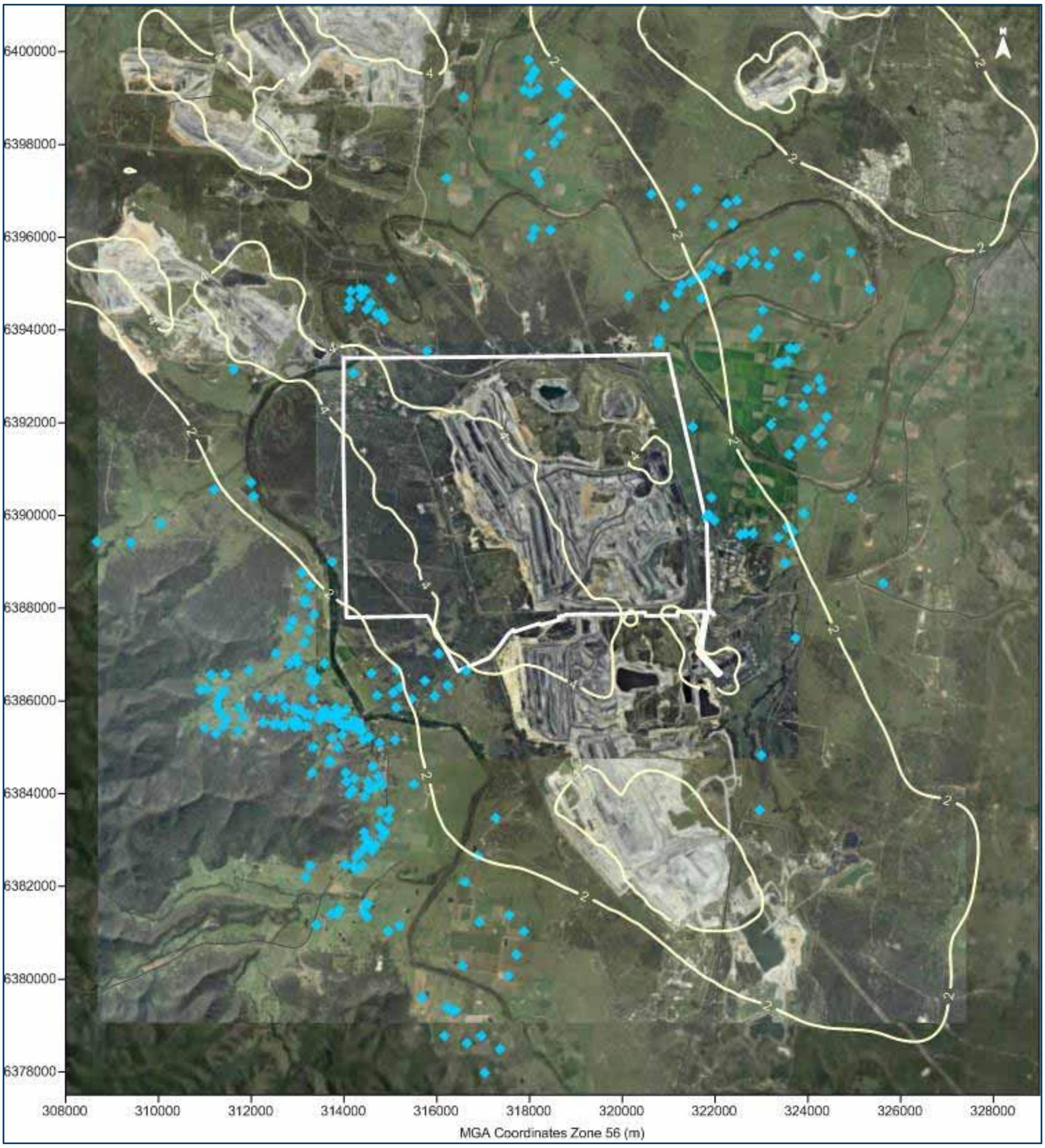

Figure E-27: Predicted annual average dust deposition levels due to emissions from the proposal and other sources in Year 14 (g/m²/month)

Appendix F

Further detail regarding 24-hour PM_{10} analysis

Table F-1: Bulga – Year 3

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
27/11/2012	56.1	-0.7	55.4	14/06/2012	ND	5.2	5.2
7/10/2012	40.9	-4.1	36.8	4/03/2012	9.8	4.3	14.2
29/09/2012	39.2	0.0	39.2	16/03/2012	ND	3.0	3.0
8/11/2012	38.7	0.3	39.0	22/04/2012	9.1	2.9	12.1
2/12/2012	37.4	-1.9	35.6	15/10/2012	11.4	2.6	14.0
22/10/2012	34.5	0.0	34.5	21/03/2012	8.3	2.0	10.3
9/01/2012	33.7	1.4	35.0	17/05/2012	13.7	1.9	15.5
6/01/2012	33.4	0.0	33.4	14/04/2012	12.1	1.8	13.9
18/08/2012	32.8	0.0	32.8	2/05/2012	15.3	1.7	17.0
19/12/2012	32.6	-0.9	31.6	25/05/2012	14.0	1.7	15.7

ND – No data

Table F-2: Wallaby Scrub Road – Year 3

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
18/10/2012	46.0	-7.0	39.0	8/06/2012	ND	7.9	7.9
7/09/2012	45.0	0.0	45.0	14/06/2012	ND	7.0	7.0
29/09/2012	44.0	0.0	44.0	1/04/2012	14.0	5.1	19.1
7/10/2012	41.0	0.5	41.5	8/07/2012	8.0	4.2	12.2
2/12/2012	41.0	1.2	42.2	22/04/2012	13.0	3.8	16.8
6/09/2012	37.0	0.0	37.0	3/09/2012	19.0	3.8	22.8
25/08/2012	36.0	0.1	36.1	22/02/2012	8.0	3.8	11.8
18/08/2012	35.0	0.0	35.0	3/04/2012	13.0	3.4	16.4
27/11/2012	34.0	-3.9	30.1	4/05/2012	10.0	3.0	13.0
19/12/2012	34.0	-2.0	32.0	8/04/2012	27.0	2.9	29.9

ND – No data

Table F-3: Warkworth – Year 3

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
19/12/2012	41.2	2.1	43.3	10/12/2012	31.7	19.0	50.7
7/11/2012	40.0	-0.4	39.6	11/12/2012	ND	11.4	11.4
7/09/2012	38.0	0.0	38.0	28/03/2012	15.9	11.3	27.2
23/10/2012	37.8	3.1	40.9	1/02/2012	12.9	11.3	24.2
27/10/2012	37.6	-0.8	36.8	13/06/2012	6.7	10.7	17.4
29/09/2012	37.3	0.0	37.3	2/06/2012	12.2	10.2	22.4
7/10/2012	36.3	1.2	37.5	5/01/2012	21.2	9.9	31.1
18/10/2012	35.9	-1.5	34.4	2/01/2012	17.8	9.2	27.0
8/11/2012	35.3	0.9	36.2	13/01/2012	ND	9.2	9.2
2/11/2012	34.7	0.5	35.2	3/01/2012	19.5	9.1	28.6

ND – No data

Table F-4: Knodlers Lane – Year 3

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
29/09/2012	56.3	0.0	56.3	2/06/2012	6.7	4.4	11.1
2/11/2012	54.5	0.0	54.5	1/03/2012	ND	3.1	3.1
26/10/2012	49.7	0.1	49.8	18/04/2012	16.0	3.0	19.0
27/10/2012	48.7	0.4	49.0	11/03/2012	14.0	3.0	17.0
17/10/2012	47.7	0.0	47.7	7/01/2012	10.5	3.0	13.5
6/10/2012	47.1	0.4	47.4	11/11/2012	14.9	2.5	17.4
18/10/2012	43.6	0.2	43.8	9/02/2012	ND	2.4	2.4
5/10/2012	42.8	0.0	42.8	14/11/2012	31.0	2.4	33.3
6/09/2012	42.3	0.0	42.3	24/01/2012	ND	2.3	2.3
21/10/2012	41.1	0.4	41.5	3/01/2012	12.0	2.2	14.2

ND – No data

Table F-5: MTIE – Year 3

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
2/11/2012	77.0	1.3	78.3	15/06/2012	19.0	9.1	28.1
14/09/2012	76.0	-2.1	73.9	17/07/2012	11.0	7.4	18.4
6/10/2012	73.0	-0.1	72.9	29/06/2012	17.0	6.4	23.4
27/10/2012	72.0	0.9	72.9	21/05/2012	35.0	5.6	40.6
18/08/2012	68.0	-0.7	67.3	21/08/2012	37.0	5.6	42.6
31/08/2012	65.0	-3.0	62.0	8/05/2012	35.0	5.3	40.3
5/10/2012	63.0	0.7	63.7	4/05/2012	10.0	5.3	15.3
4/09/2012	62.0	1.0	63.0	29/07/2012	18.0	5.1	23.1
23/08/2012	59.0	-1.6	57.4	27/09/2012	ND	5.1	5.1
6/09/2012	59.0	-12.1	46.9	22/08/2012	23.0	5.0	28.0

ND – No data

Table F-6: Bulga – Year 9

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
27/11/2012	56.1	-1.7	54.4	14/06/2012	ND	14.8	14.8
7/10/2012	40.9	-6.0	34.9	8/06/2012	5.9	12.8	18.7
29/09/2012	39.2	0.0	39.2	22/04/2012	9.1	12.3	21.5
8/11/2012	38.7	2.8	41.5	4/03/2012	9.8	11.8	21.6
2/12/2012	37.4	-1.9	35.5	16/03/2012	ND	10.8	10.8
22/10/2012	34.5	0.0	34.5	3/04/2012	11.9	9.2	21.1
9/01/2012	33.7	-0.4	33.3	17/05/2012	13.7	9.1	22.8
6/01/2012	33.4	0.3	33.7	14/04/2012	12.1	8.9	21.0
18/08/2012	32.8	0.0	32.8	30/10/2012	16.3	8.2	24.5
19/12/2012	32.6	-3.8	28.8	15/10/2012	11.4	8.0	19.4

ND – No data

Table F-7: Wallaby Scrub Road – Year 9

PM10 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
18/10/2012	46.0	-4.8	41.2	8/06/2012	ND	16.9	16.9
7/09/2012	45.0	0.0	45.0	3/09/2012	19.0	16.7	35.7
29/09/2012	44.0	0.0	44.0	8/07/2012	8.0	11.3	19.3
7/10/2012	41.0	3.8	44.8	22/04/2012	13.0	11.1	24.1
2/12/2012	41.0	3.3	44.3	1/04/2012	14.0	10.2	24.2
6/09/2012	37.0	0.0	37.0	4/05/2012	10.0	10.0	20.0
25/08/2012	36.0	0.0	36.0	13/01/2012	18.0	9.7	27.7
18/08/2012	35.0	0.0	35.0	19/02/2012	22.0	8.6	30.6
27/11/2012	34.0	-0.6	33.4	20/04/2012	9.0	8.3	17.3
19/12/2012	34.0	1.1	35.1	6/10/2012	20.0	7.6	27.6

ND – No data

Table F-8: Warkworth – Year 9

PM10 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
19/12/2012	41.2	-11.5	29.7	10/12/2012	31.7	56.3	88.0
7/11/2012	40.0	0.2	40.2	11/12/2012	ND	50.1	50.1
7/09/2012	38.0	0.0	38.0	12/06/2012	6.6	45.7	52.3
23/10/2012	37.8	14.9	52.7	17/04/2012	23.7	44.6	68.3
27/10/2012	37.6	-2.2	35.4	12/08/2012	10.6	41.9	52.5
29/09/2012	37.3	0.0	37.3	11/06/2012	11.5	38.5	50.0
7/10/2012	36.3	-1.7	34.6	10/07/2012	12.0	38.0	50.0
18/10/2012	35.9	-15.5	20.4	21/07/2012	10.5	35.5	46.0
8/11/2012	35.3	-0.6	34.7	6/07/2012	11.0	34.5	45.5
2/11/2012	34.7	0.8	35.5	7/03/2012	17.1	34.0	51.1

ND – No data

Table F-9: Knodlers Lane – Year 9

PM10 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
29/09/2012	56.3	0.0	56.3	1/05/2012	17.1	3.2	20.3
2/11/2012	54.5	0.8	55.3	9/06/2012	8.6	3.2	11.8
26/10/2012	49.7	0.9	50.6	27/10/2012	48.7	3.2	51.8
27/10/2012	48.7	3.2	51.8	28/05/2012	12.6	2.9	15.5
17/10/2012	47.7	0.0	47.7	30/04/2012	18.1	2.7	20.9
6/10/2012	47.1	0.1	47.2	24/09/2012	24.3	2.2	26.4
18/10/2012	43.6	-0.1	43.5	26/06/2012	10.0	2.2	12.2
5/10/2012	42.8	0.1	42.8	9/07/2012	15.9	2.2	18.1
6/09/2012	42.3	0.0	42.3	31/07/2012	6.0	2.1	8.1
21/10/2012	41.1	0.3	41.4	30/03/2012	16.1	2.0	18.1

Table F-10: MTIE – Year 9

PM$_{10}$ 24-hour average (µg/m^3)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
2/11/2012	77.0	5.2	82.2	26/07/2012	18.0	10.4	28.4
14/09/2012	76.0	-2.8	73.2	22/09/2012	45.0	10.1	55.1
6/10/2012	73.0	0.0	73.0	31/07/2012	36.0	9.4	45.4
27/10/2012	72.0	2.3	74.3	30/07/2012	17.0	9.2	26.2
18/08/2012	68.0	-3.5	64.5	10/03/2012	21.0	8.7	29.7
31/08/2012	65.0	-4.6	60.4	24/05/2012	47.0	8.6	55.6
5/10/2012	63.0	-9.1	53.9	5/05/2012	18.0	8.3	26.3
4/09/2012	62.0	2.0	64.0	3/07/2012	20.0	7.3	27.3
23/08/2012	59.0	-6.0	53.0	13/09/2012	42.0	7.3	49.3
6/09/2012	59.0	-13.6	45.4	11/07/2012	36.0	7.1	43.1

Table F-11: Bulga – Year 14

PM$_{10}$ 24-hour average (µg/m^3)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
27/11/2012	56.1	-3.0	53.1	4/03/2012	9.8	18.9	28.7
7/10/2012	40.9	-10.7	30.1	14/06/2012	ND	18.9	18.9
29/09/2012	39.2	0.0	39.2	8/06/2012	5.9	17.0	22.9
8/11/2012	38.7	3.3	42.0	30/10/2012	16.3	16.6	32.8
2/12/2012	37.4	-5.6	31.8	20/09/2012	10.8	15.3	26.1
22/10/2012	34.5	0.0	34.4	17/05/2012	13.7	14.8	28.5
9/01/2012	33.7	-3.2	30.4	16/03/2012	ND	14.7	14.7
6/01/2012	33.4	0.3	33.7	22/04/2012	9.1	14.2	23.3
18/08/2012	32.8	0.0	32.8	3/04/2012	11.9	11.1	23.0
19/12/2012	32.6	-8.3	24.2	20/04/2012	ND	10.9	10.9

ND – No data

Table F-12: Wallaby Scrub Road – Year 14

PM$_{10}$ 24-hour average (µg/m^3)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
18/10/2012	46.0	-13.4	32.6	8/06/2012	ND	23.3	23.3
7/09/2012	45.0	0.0	45.0	22/04/2012	13.0	18.5	31.5
29/09/2012	44.0	0.0	44.0	3/09/2012	19.0	17.7	36.7
7/10/2012	41.0	4.9	45.9	4/05/2012	10.0	16.1	26.1
2/12/2012	41.0	4.6	45.6	8/07/2012	8.0	15.2	23.2
6/09/2012	37.0	0.0	37.0	20/04/2012	9.0	13.2	22.2
25/08/2012	36.0	0.0	36.0	13/01/2012	18.0	12.5	30.5
18/08/2012	35.0	0.0	35.0	1/04/2012	14.0	12.3	26.3
27/11/2012	34.0	-4.3	29.7	30/10/2012	17.0	11.9	28.9
19/12/2012	34.0	-1.8	32.2	27/04/2012	13.0	10.7	23.7

ND – No data

Table F-13: Warkworth – Year 14

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
19/12/2012	41.2	-12.4	28.8	6/06/2012	6.9	65.4	72.3
7/11/2012	40.0	-1.1	38.9	10/12/2012	31.7	57.3	89.0
7/09/2012	38.0	0.0	38.0	11/12/2012	ND	45.0	45.0
23/10/2012	37.8	-1.4	36.4	26/06/2012	9.1	37.2	46.3
27/10/2012	37.6	-2.2	35.4	5/07/2012	9.8	37.1	46.9
29/09/2012	37.3	0.0	37.3	21/07/2012	10.5	35.1	45.6
7/10/2012	36.3	-0.8	35.5	11/06/2012	11.5	34.1	45.6
18/10/2012	35.9	-17.1	18.8	21/02/2012	13.7	33.1	46.8
8/11/2012	35.3	-0.9	34.4	12/08/2012	10.6	32.5	43.1
2/11/2012	34.7	2.8	37.5	11/04/2012	12.3	31.9	44.2

ND – No data

Table F-14: Knodlers Lane – Year 14

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
29/09/2012	56.3	0.0	56.4	27/10/2012	48.7	4.1	52.8
2/11/2012	54.5	0.3	54.8	20/07/2012	12.1	3.5	15.6
26/10/2012	49.7	0.3	50.0	31/07/2012	6.0	1.4	7.4
27/10/2012	48.7	4.1	52.8	7/10/2012	27.3	1.1	28.5
17/10/2012	47.7	0.0	47.7	1/11/2012	28.9	1.0	29.9
6/10/2012	47.1	0.2	47.3	10/01/2012	ND	0.9	0.9
18/10/2012	43.6	-0.1	43.5	28/05/2012	12.6	0.9	13.5
5/10/2012	42.8	0.1	42.9	20/05/2012	25.0	0.9	25.9
6/09/2012	42.3	0.0	42.3	15/09/2012	11.6	0.7	12.4
21/10/2012	41.1	-0.1	41.0	6/12/2012	24.7	0.6	25.3

ND – No data

Table F-15: MTIE – Year 14

PM$_{10}$ 24-hour average (µg/m³)							
Date	Background	Predicted increment	Total	Date	Background	Highest predicted increment	Total
2/11/2012	77.0	-0.1	76.9	2/06/2012	19.0	1.6	20.6
14/09/2012	76.0	-9.9	66.1	31/05/2012	13.0	1.4	14.4
6/10/2012	73.0	-0.4	72.6	8/10/2012	34.0	1.2	35.2
27/10/2012	72.0	0.3	72.3	16/09/2012	51.0	0.9	51.9
18/08/2012	68.0	-4.0	64.0	30/05/2012	12.0	0.8	12.8
31/08/2012	65.0	-12.2	52.8	4/02/2012	5.0	0.8	5.8
5/10/2012	63.0	-9.7	53.3	12/02/2012	16.0	0.8	16.8
4/09/2012	62.0	-6.2	55.8	1/05/2012	24.0	0.7	24.7
23/08/2012	59.0	-7.9	51.1	14/03/2012	17.0	0.7	17.7
6/09/2012	59.0	-16.1	42.9	13/03/2012	21.0	0.7	21.7

Appendix G

Isopleth Diagrams – Diesel emissions

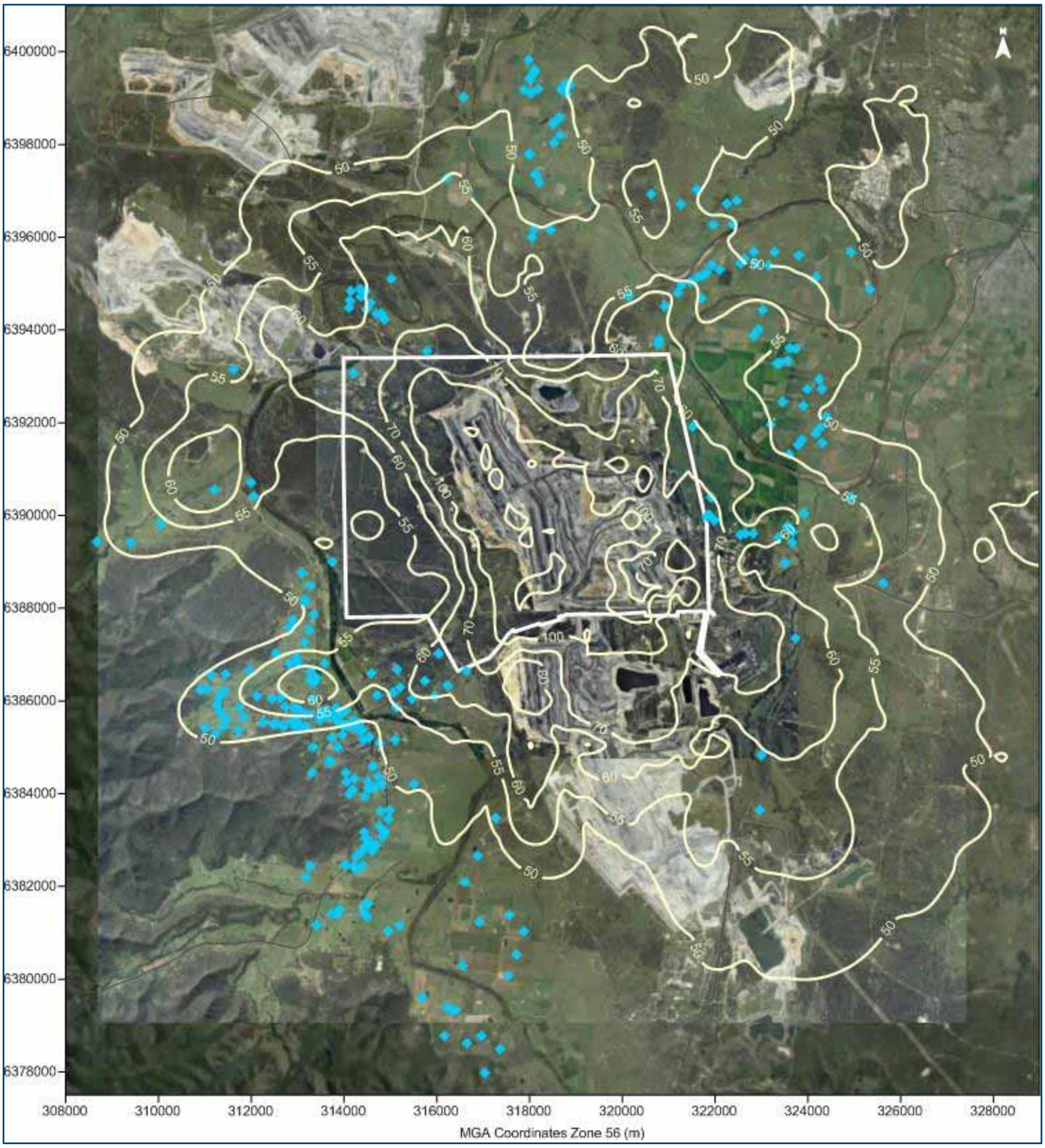

Figure G-1: Predicted 1-hour average NO_2 concentrations due to emissions from the proposal in Year 3 (µg/m³)

©

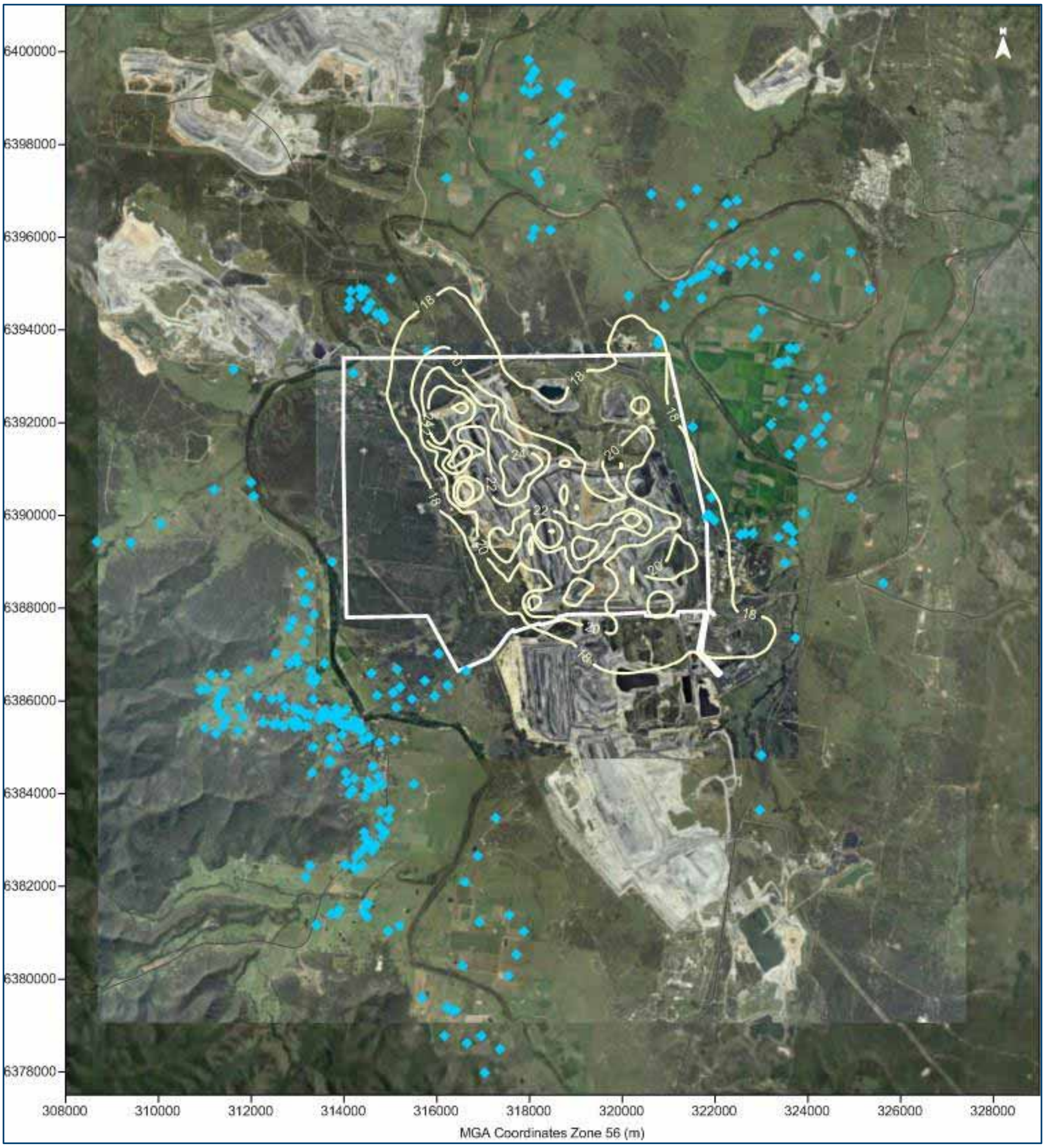

Figure G-2: Predicted annual average NO_2 concentrations due to emissions from the proposal in Year 3 (µg/m³)

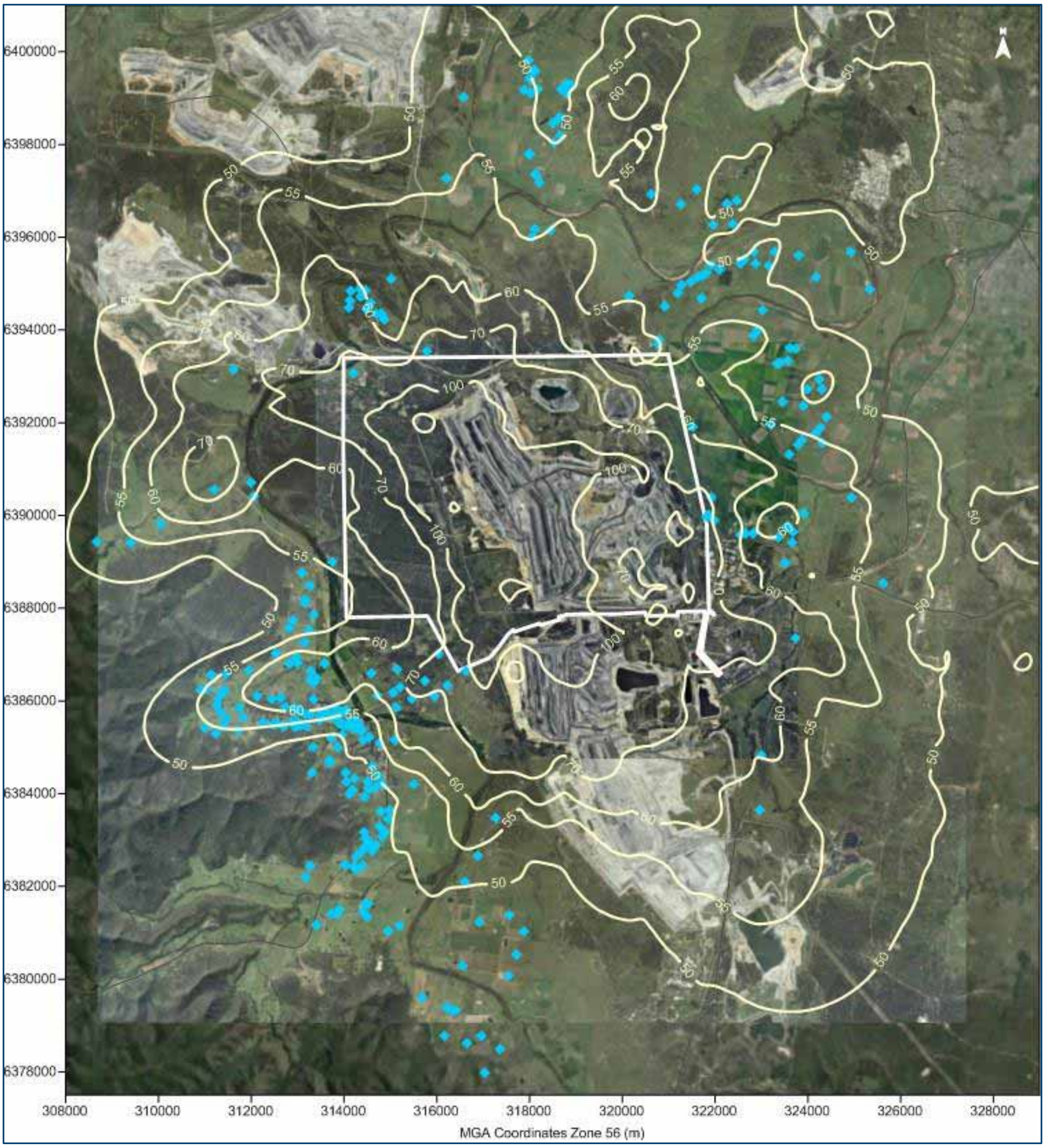

Figure G-3: Predicted 1-hour average NO_2 concentrations due to emissions from the proposal in Year 9 (µg/m³)

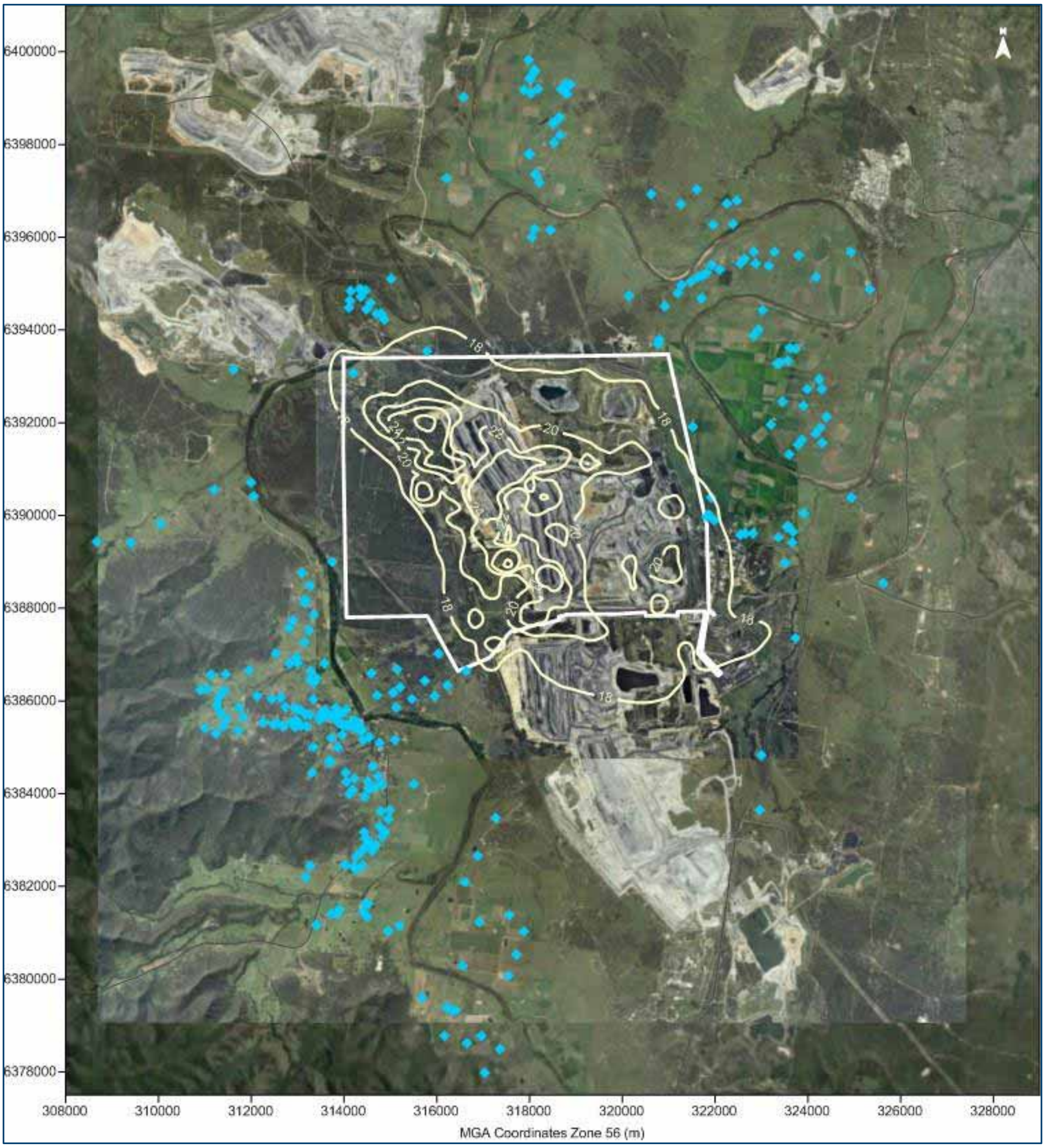

Figure G-4: Predicted annual average NO_2 concentrations due to emissions from the proposal in Year 9 (µg/m³)

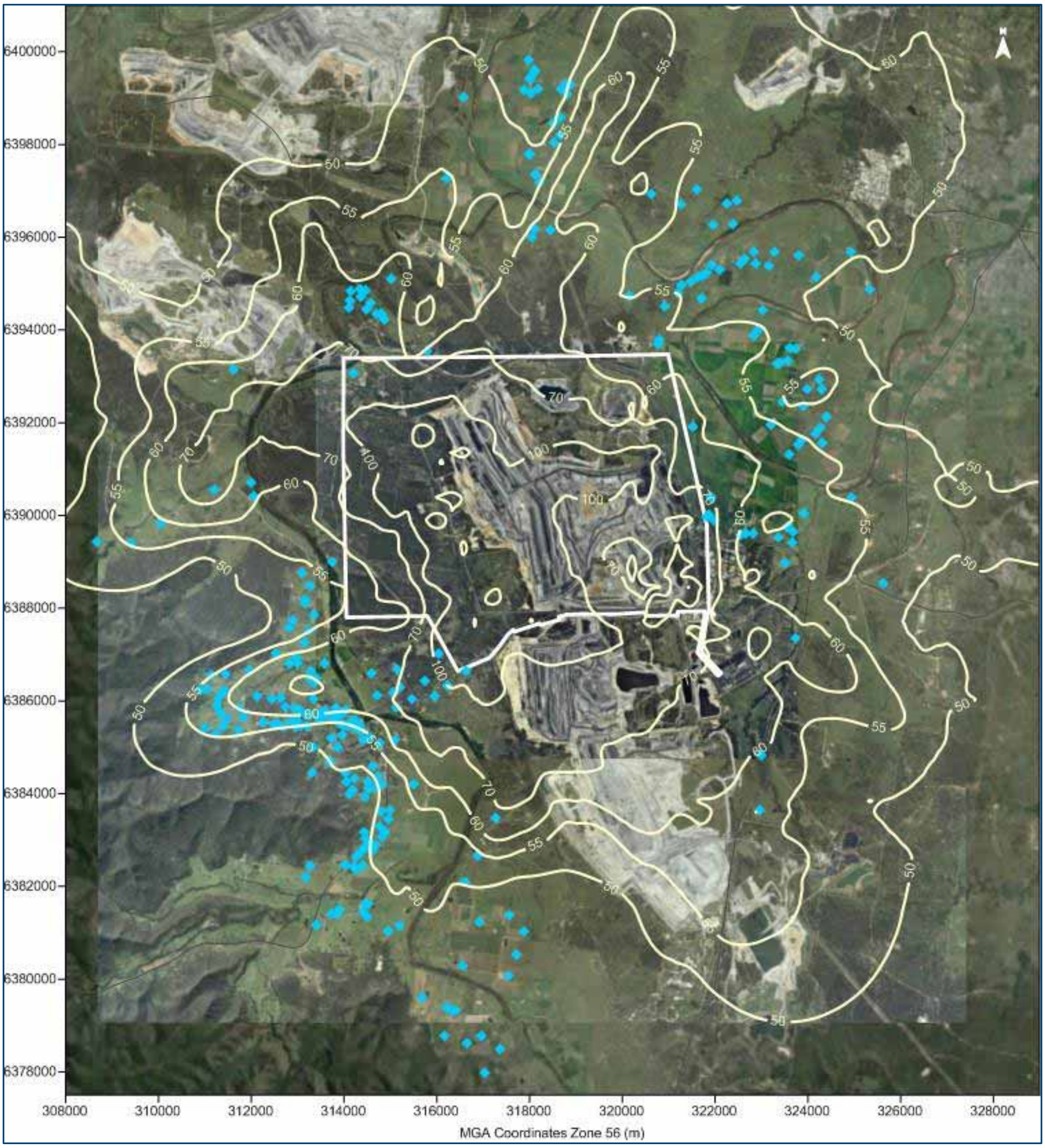

Figure G-5: Predicted 1-hour average NO_2 concentrations due to emissions from the proposal in Year 14 (µg/m³)

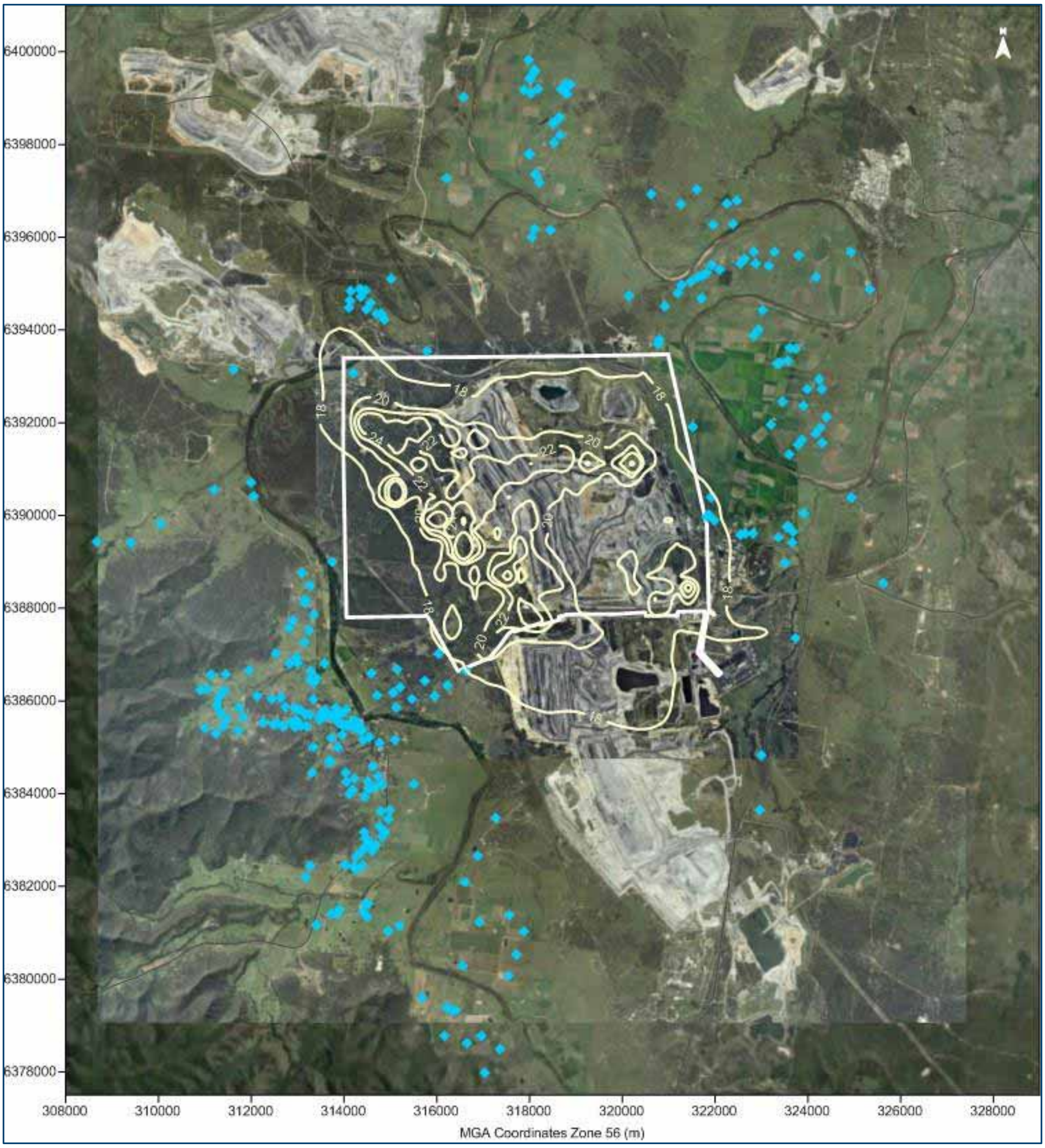

Figure G-6: Predicted annual average NO_2 concentrations due to emissions from the proposal in Year 14 (µg/m³)

Appendix H

Isopleth Diagrams – Blast emissions

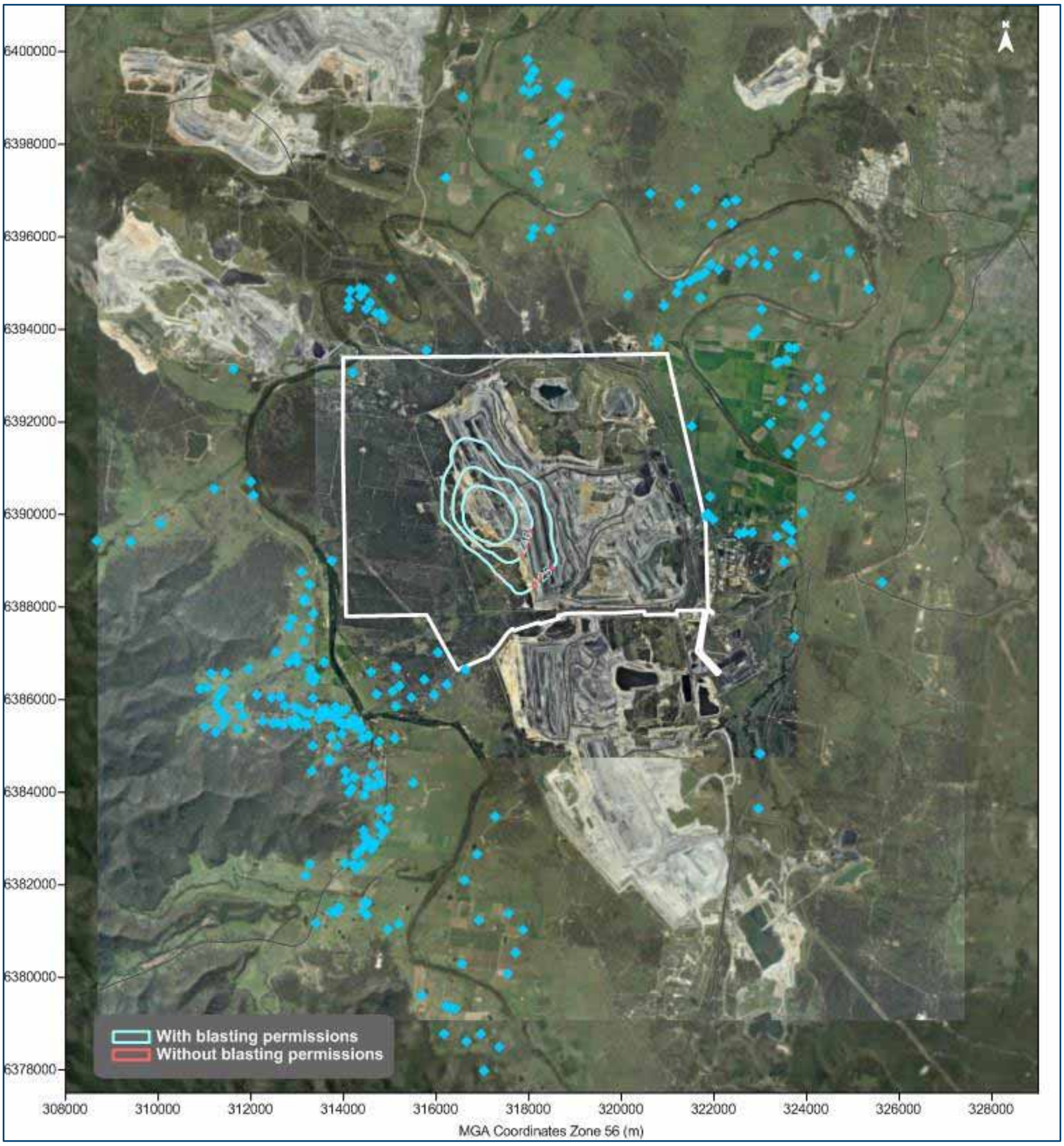

Figure H-1: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 09:00 (NO_2 concentrations µg/m³)

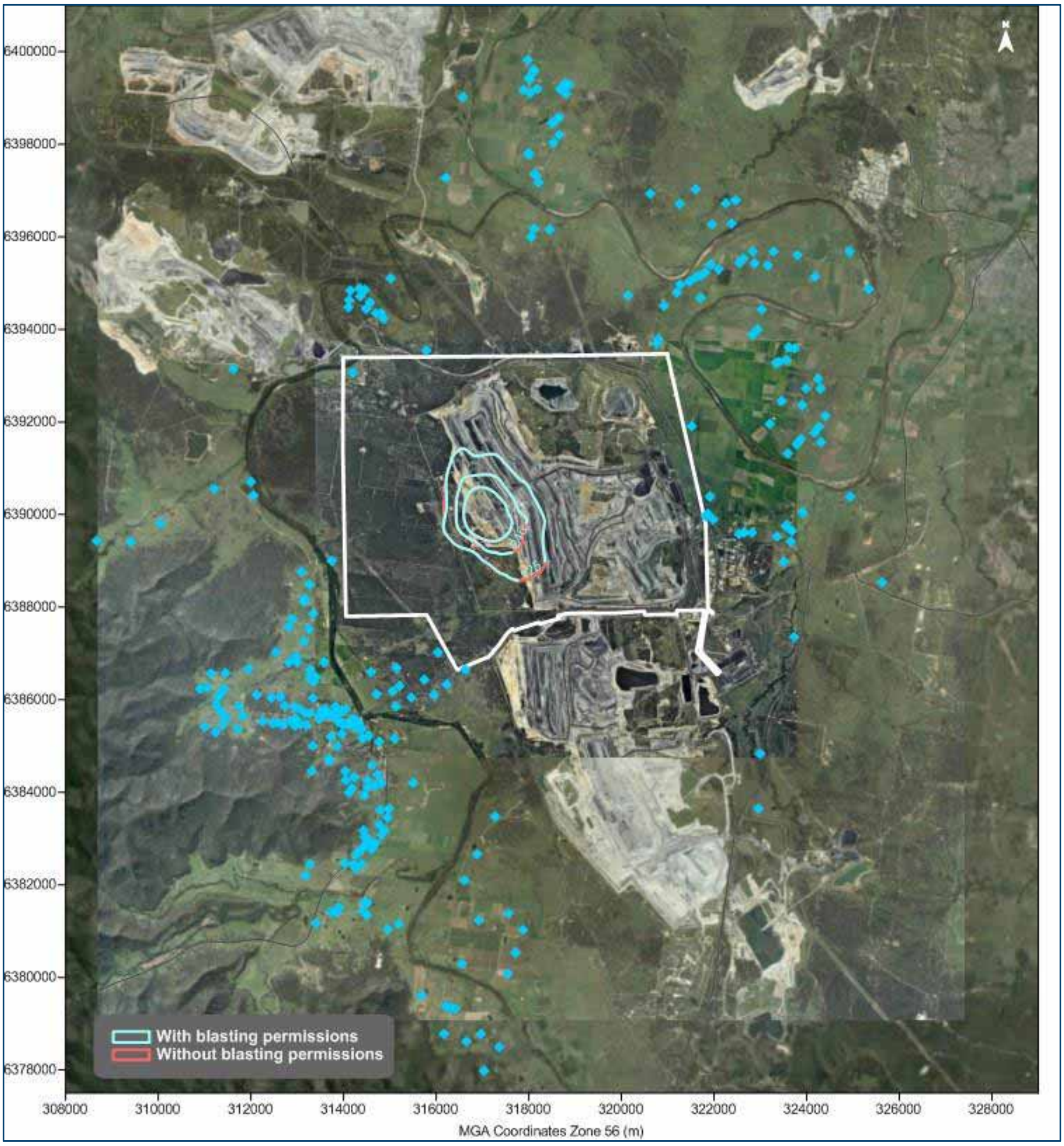

Figure H-2: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 10:00 (NO_2 concentrations μg/m³)

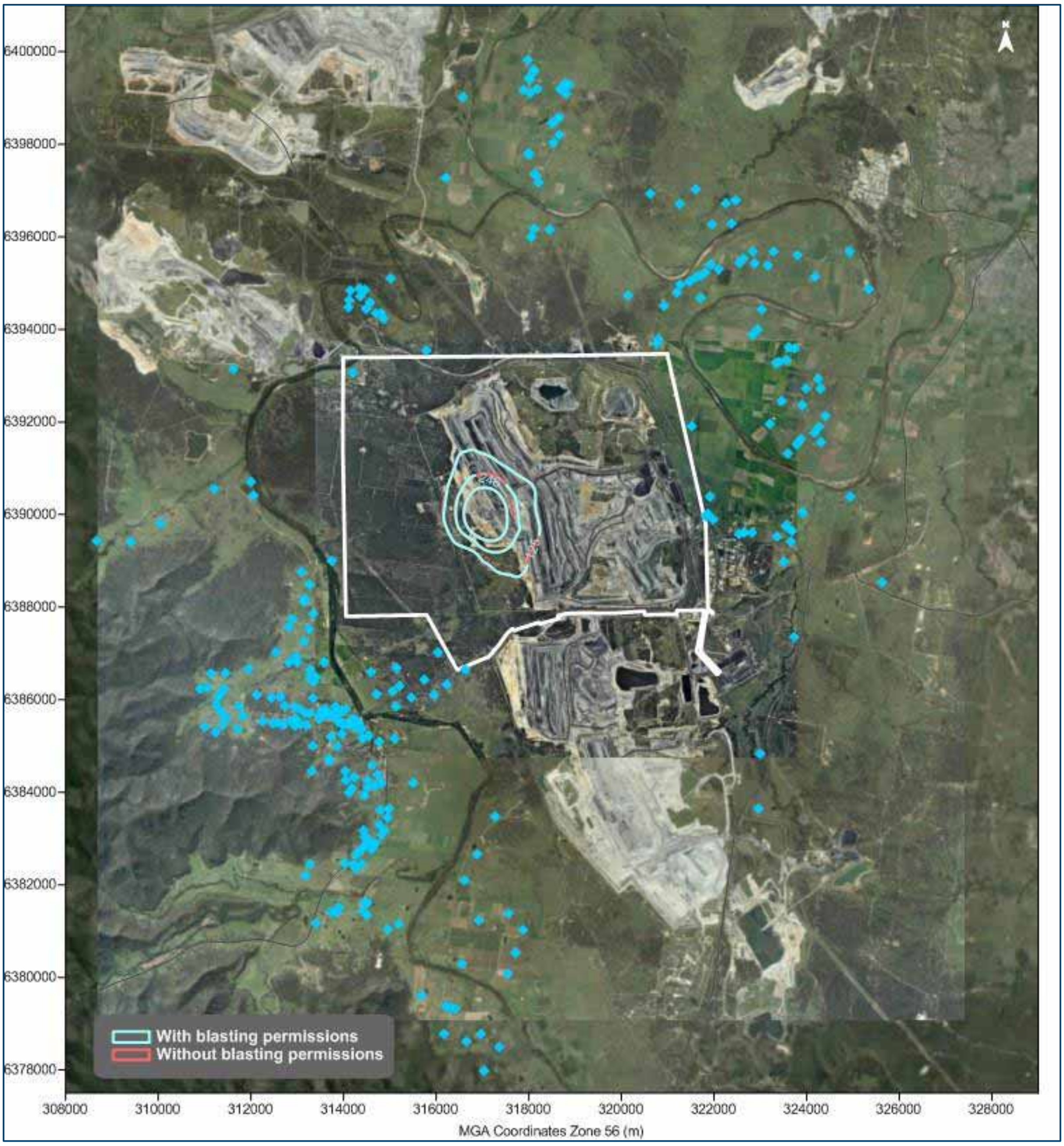

Figure H-3: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 11:00 (NO_2 concentrations µg/m³)

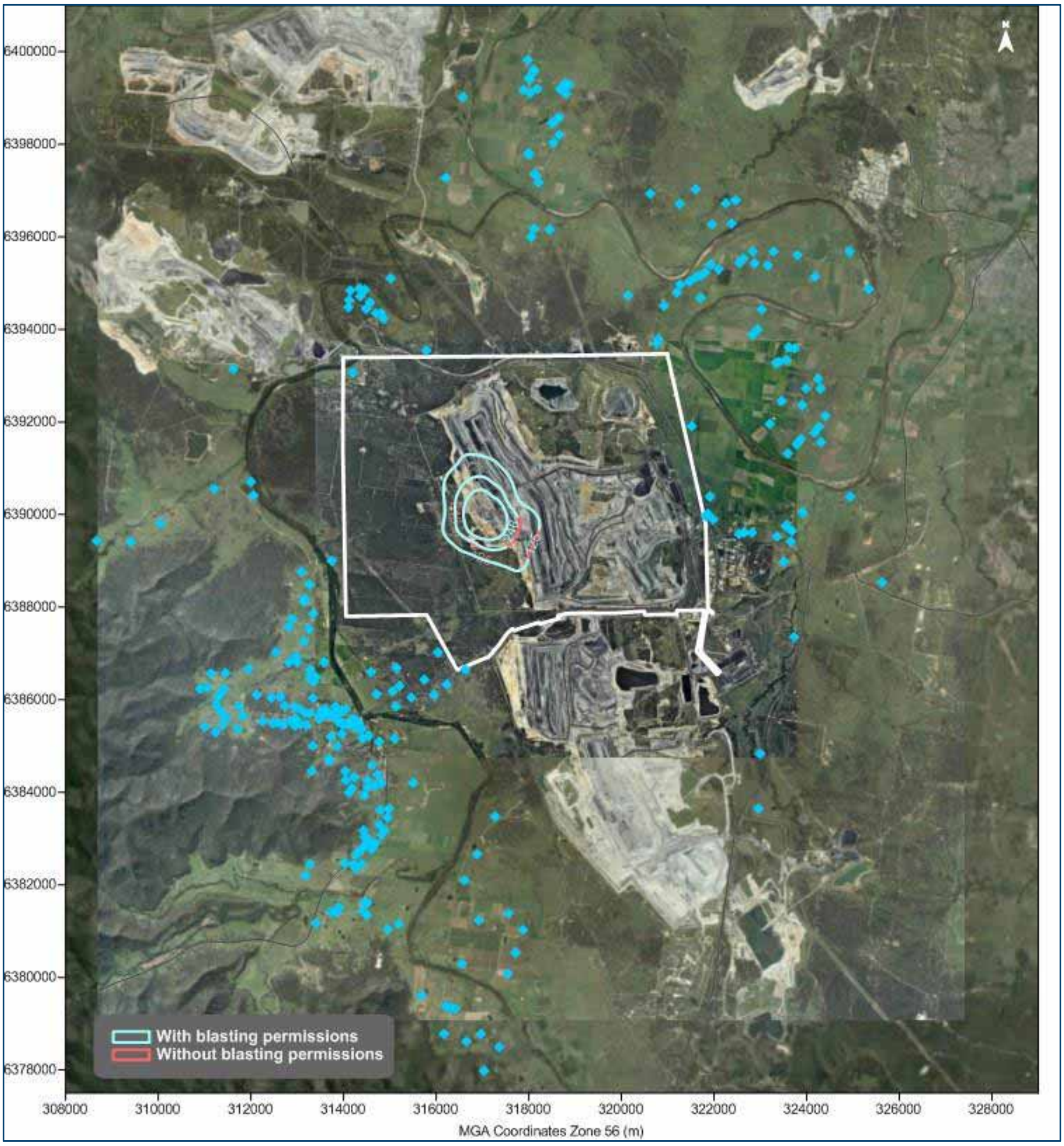

Figure H-4: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 12:00 (NO_2 concentrations µg/m³)

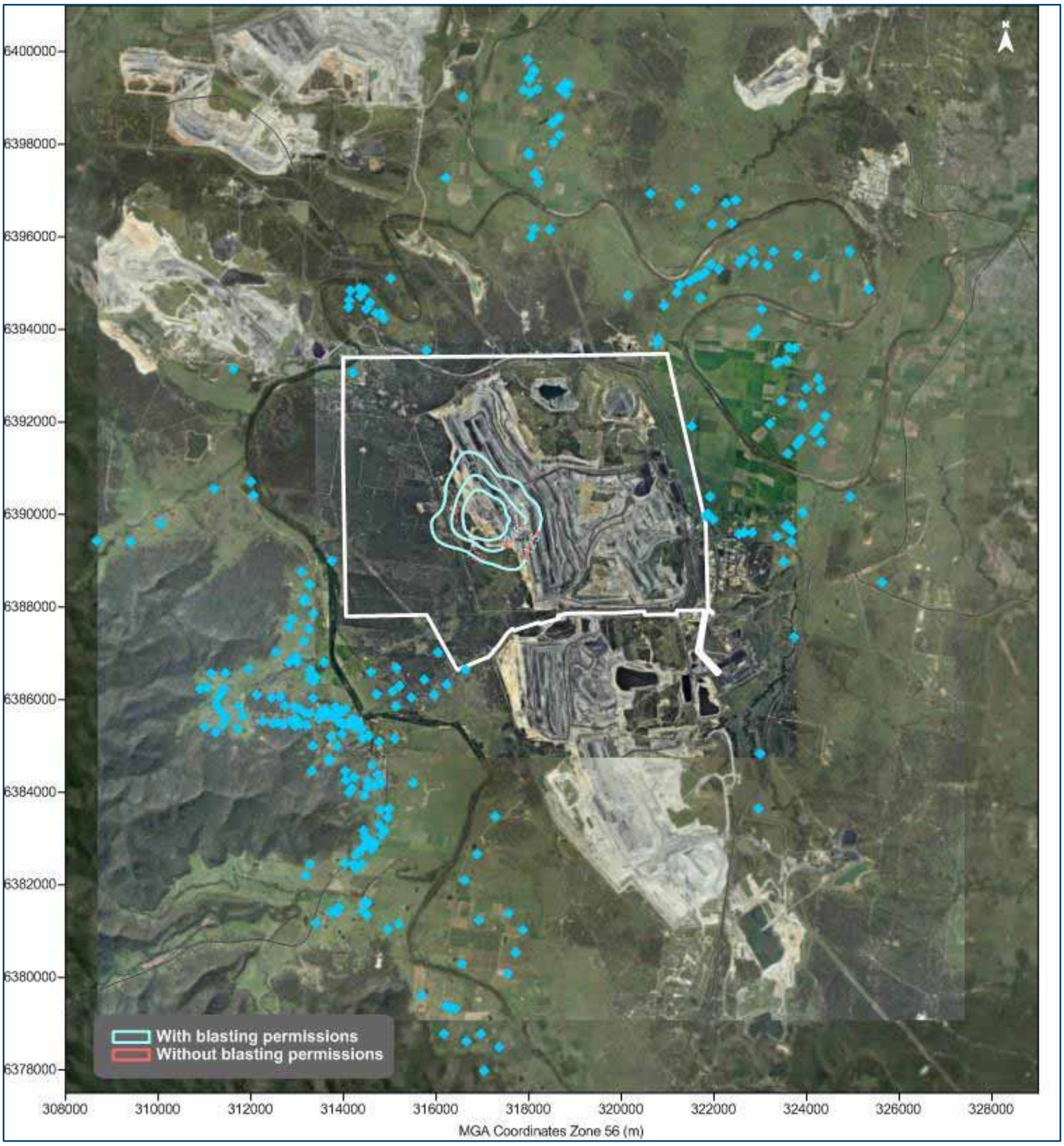

Figure H-5: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 13:00 (NO_2 concentrations µg/m³)

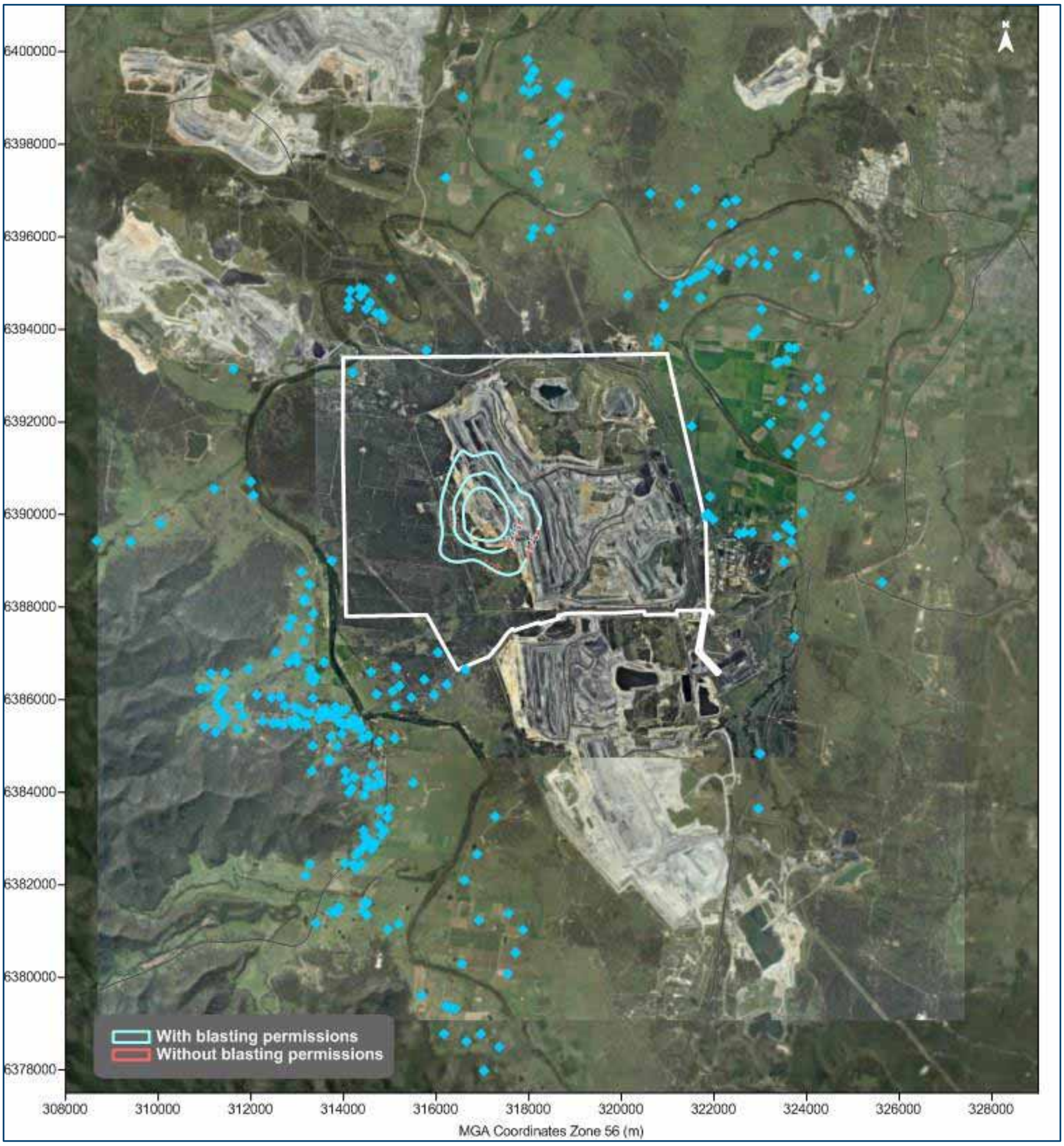

Figure H-6: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 14:00 (NO_2 concentrations µg/m³)

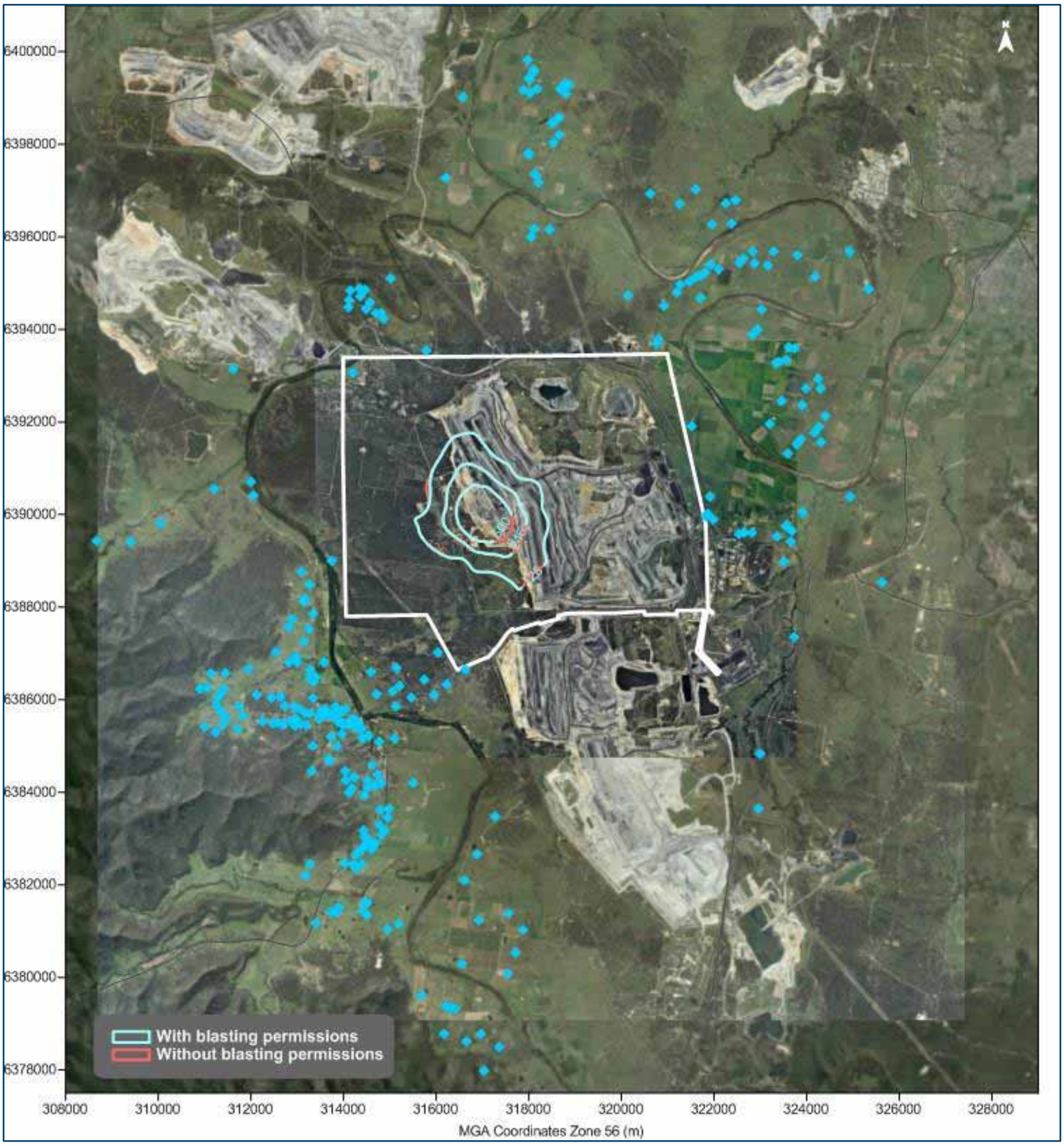

Figure H-7: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 15:00 (NO_2 concentrations µg/m³)

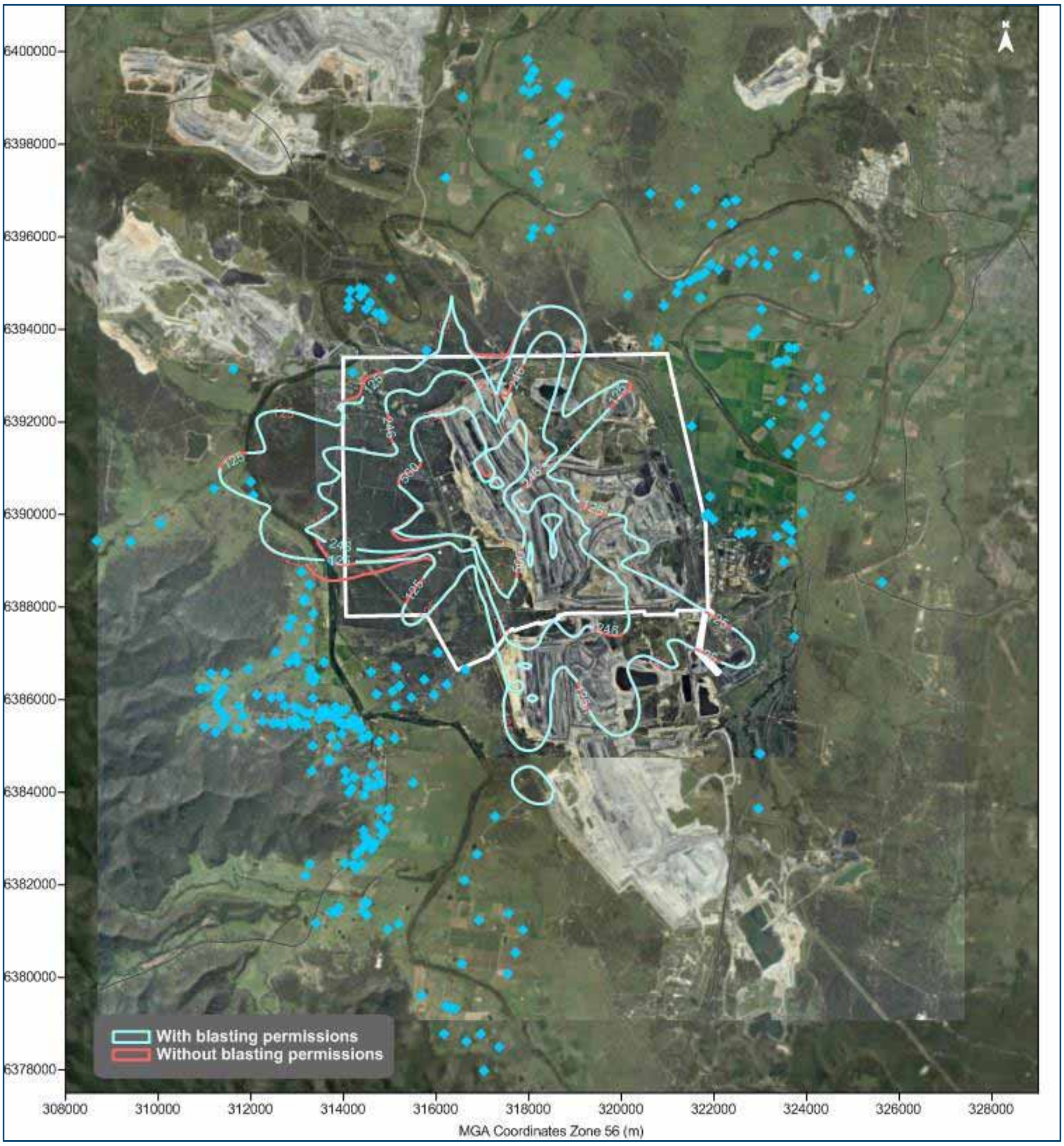

Figure H-8: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 16:00 (NO_2 concentrations µg/m³)

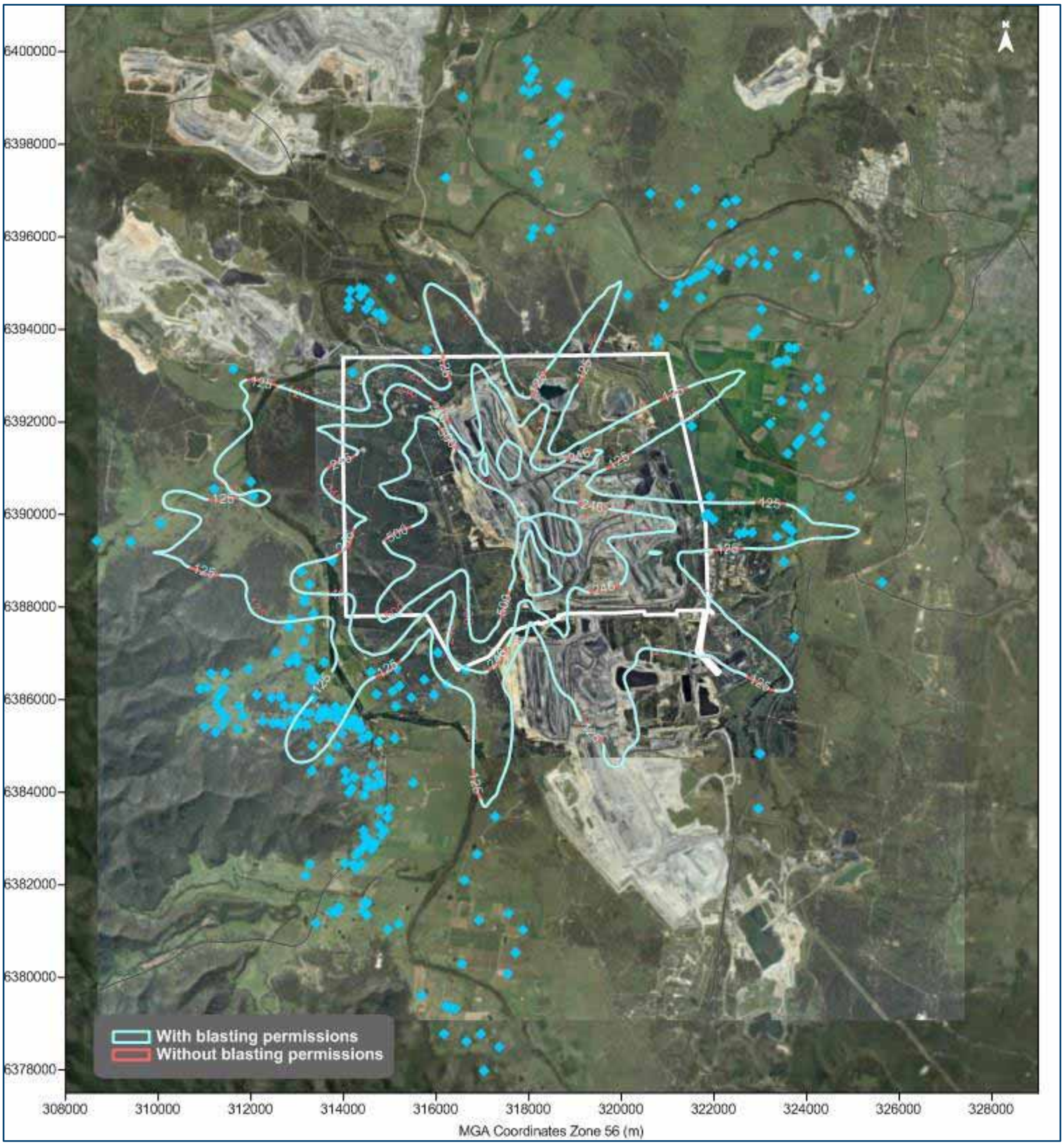

Figure H-9: Predicted maximum 1-hour average blast emissions from the proposal in Year 3 – 17:00 (NO_2 concentrations µg/m³)

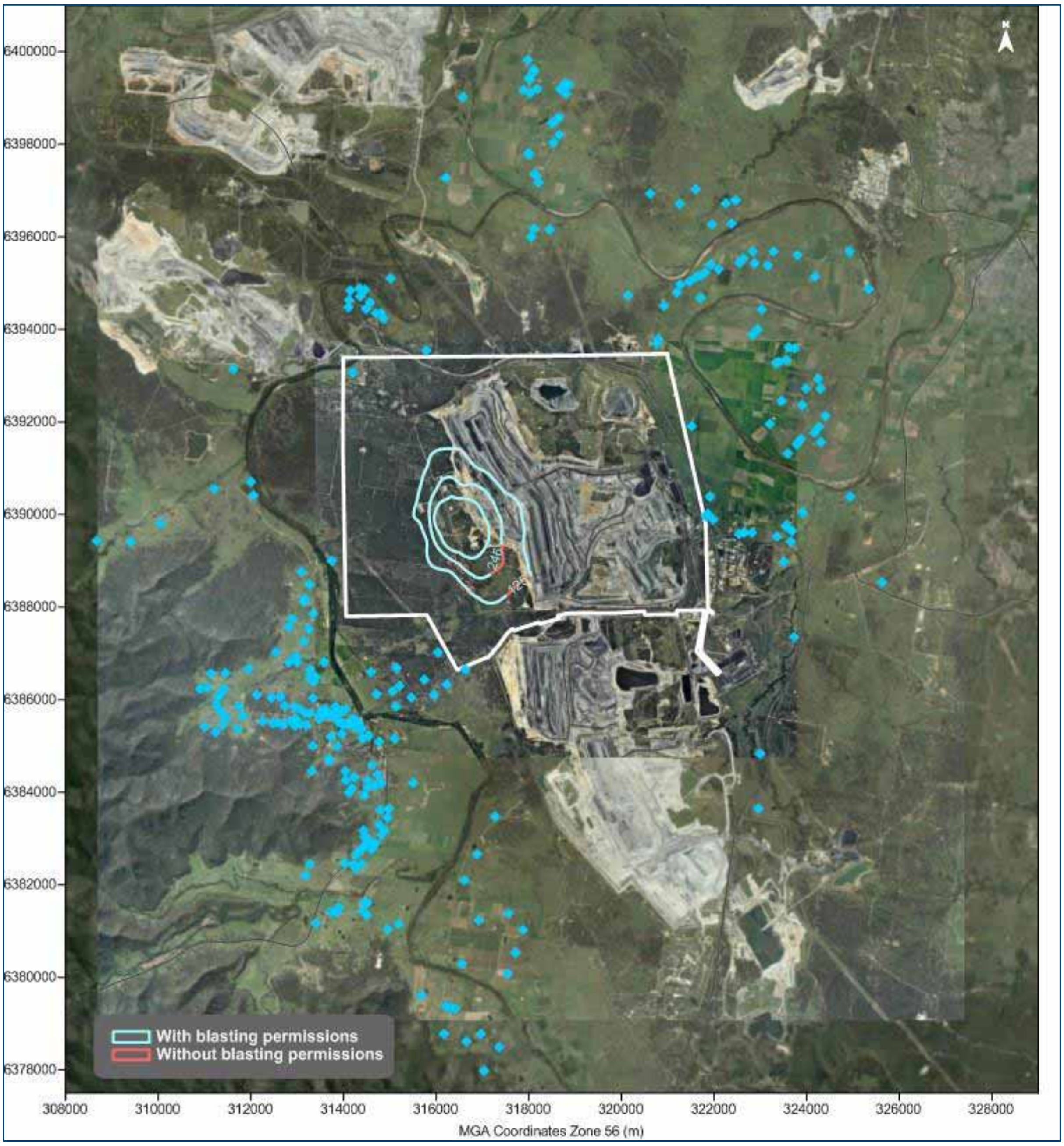

Figure H-10: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 09:00 (NO_2 concentrations µg/m³)

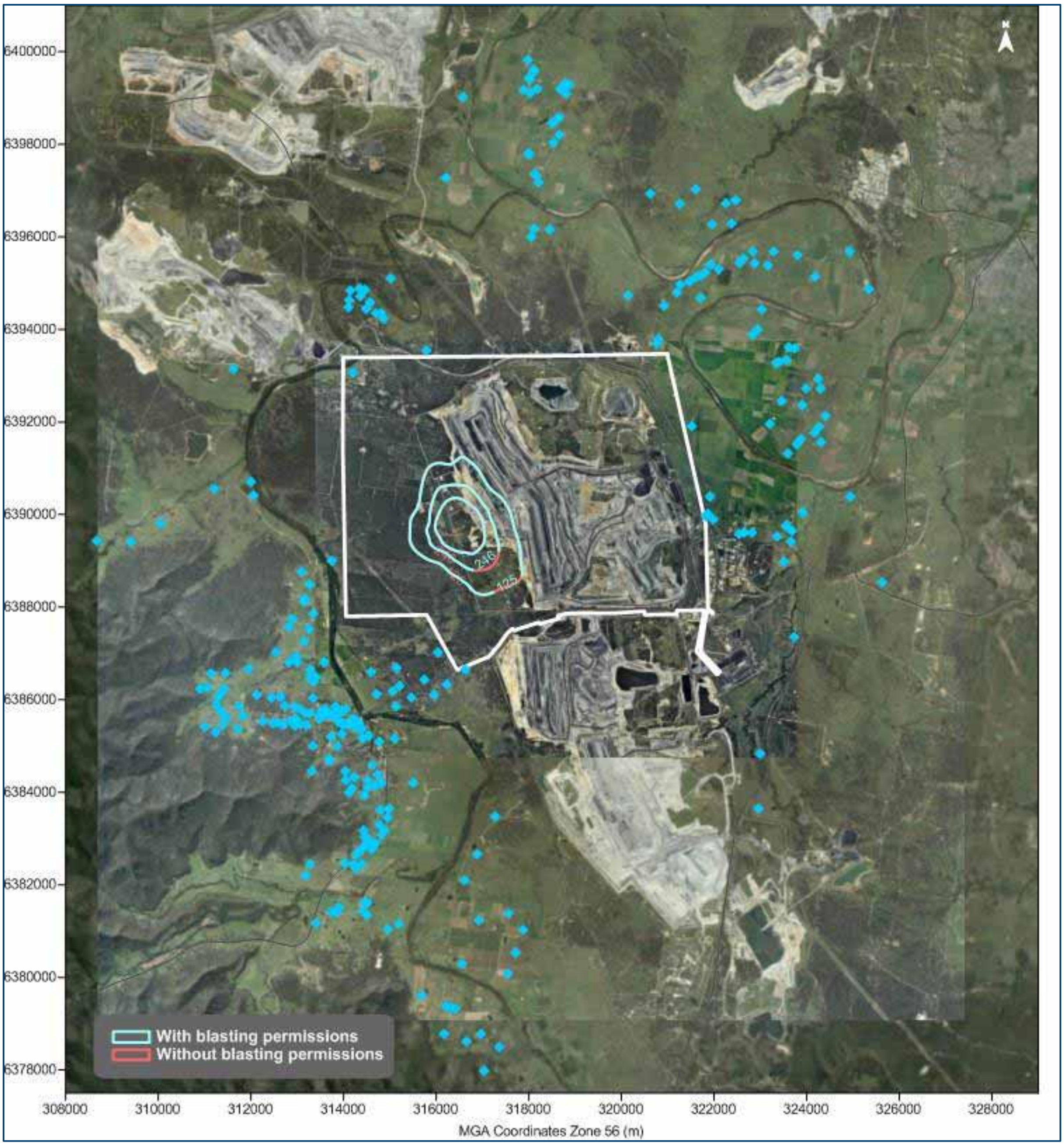

Figure H-11: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 10:00 (NO_2 concentrations µg/m³)

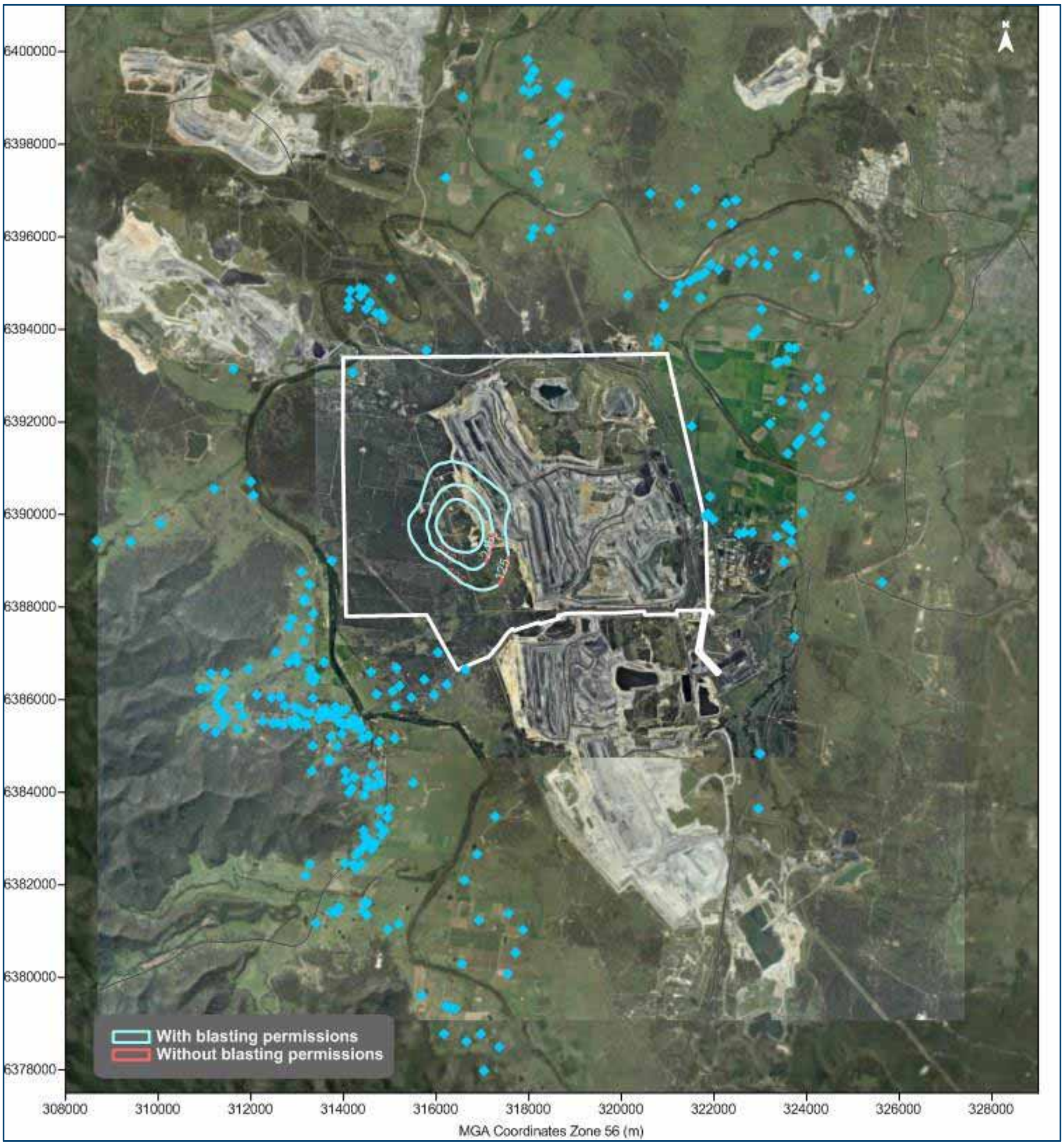

Figure H-12: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 11:00 (NO_2 concentrations µg/m³)

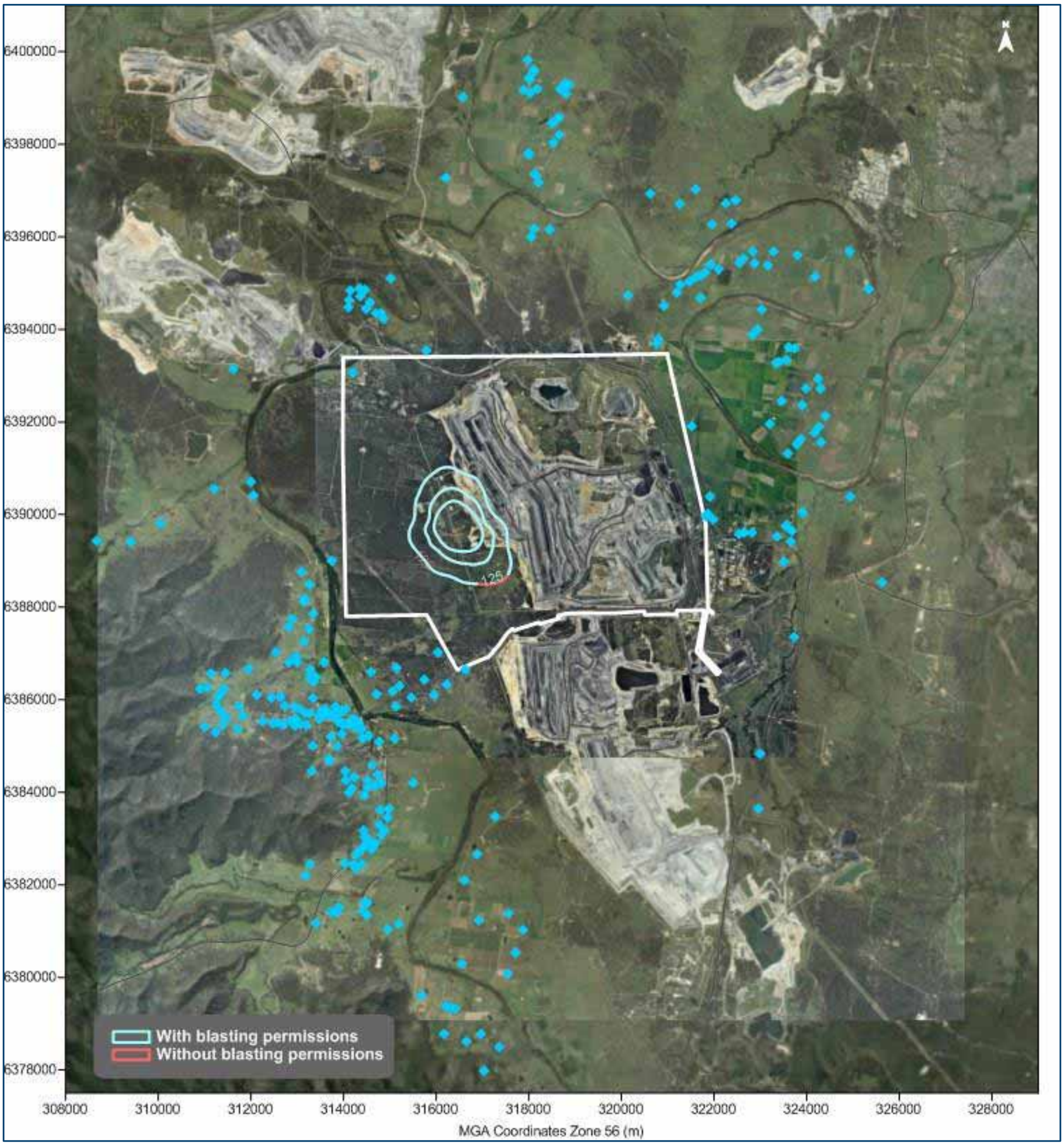

Figure H-13: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 12:00 (NO_2 concentrations μg/m³)

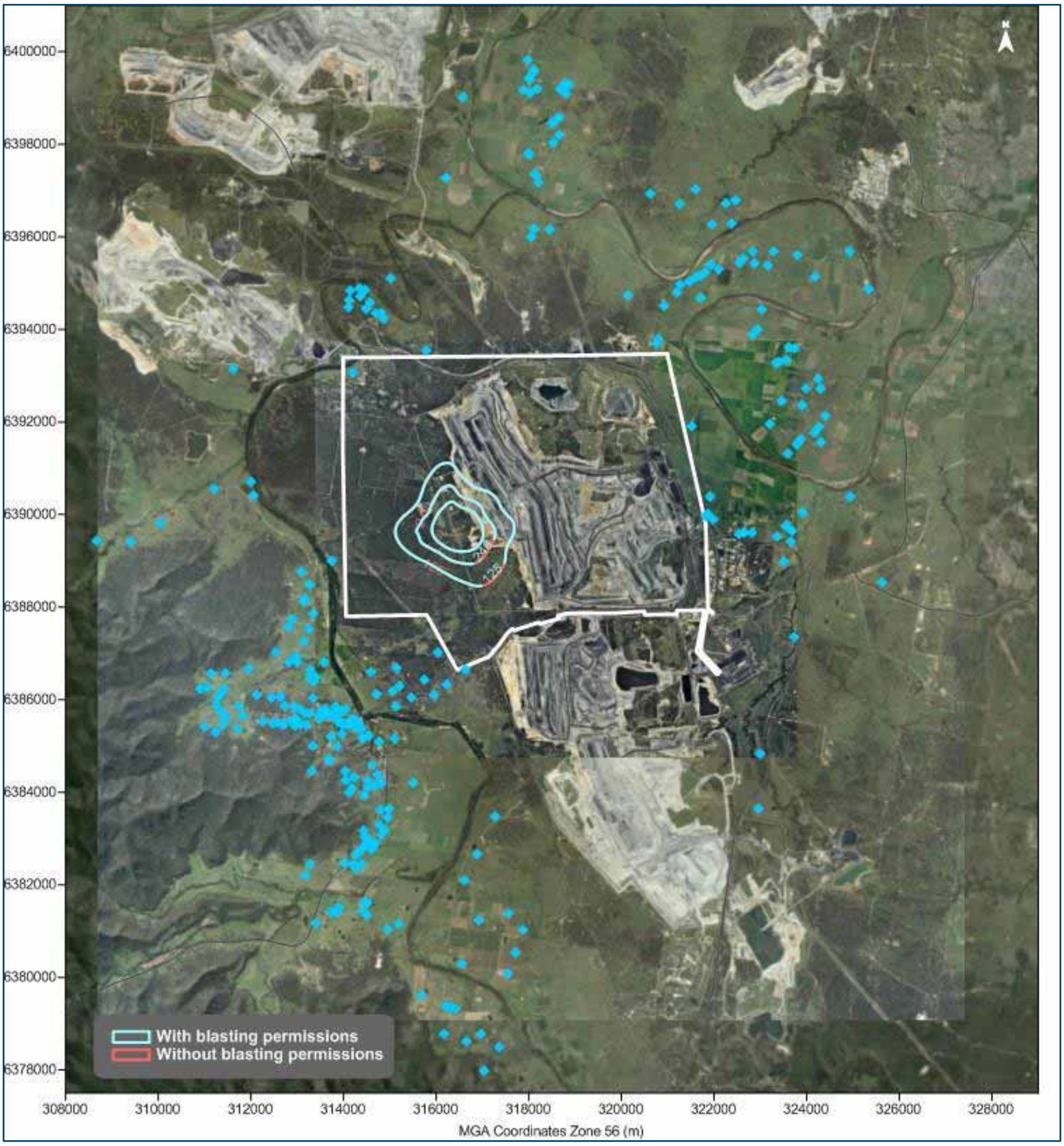

Figure H-14: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 13:00 (NO_2 concentrations µg/m³)

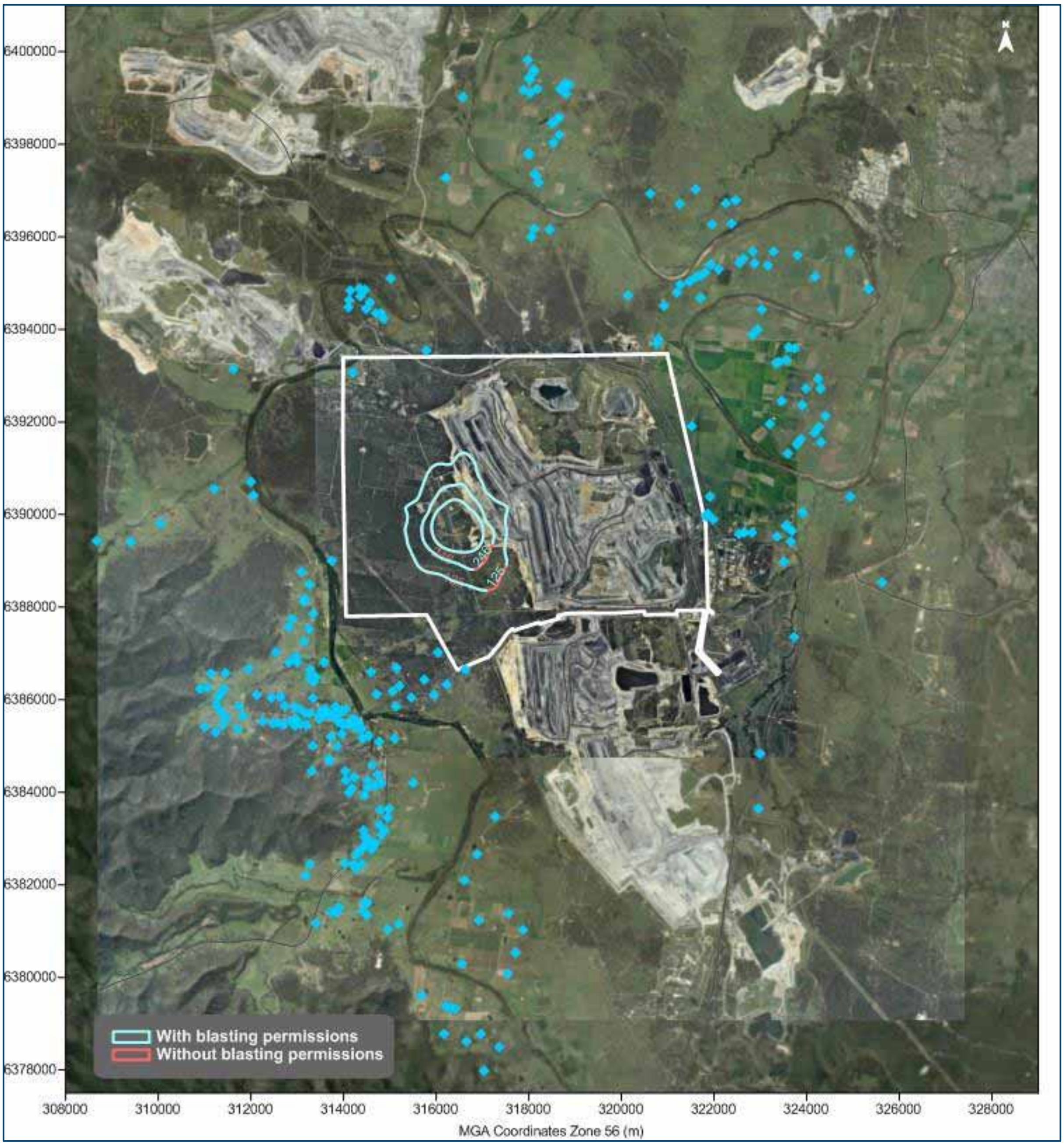

Figure H-15: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 14:00 (NO_2 concentrations µg/m³)

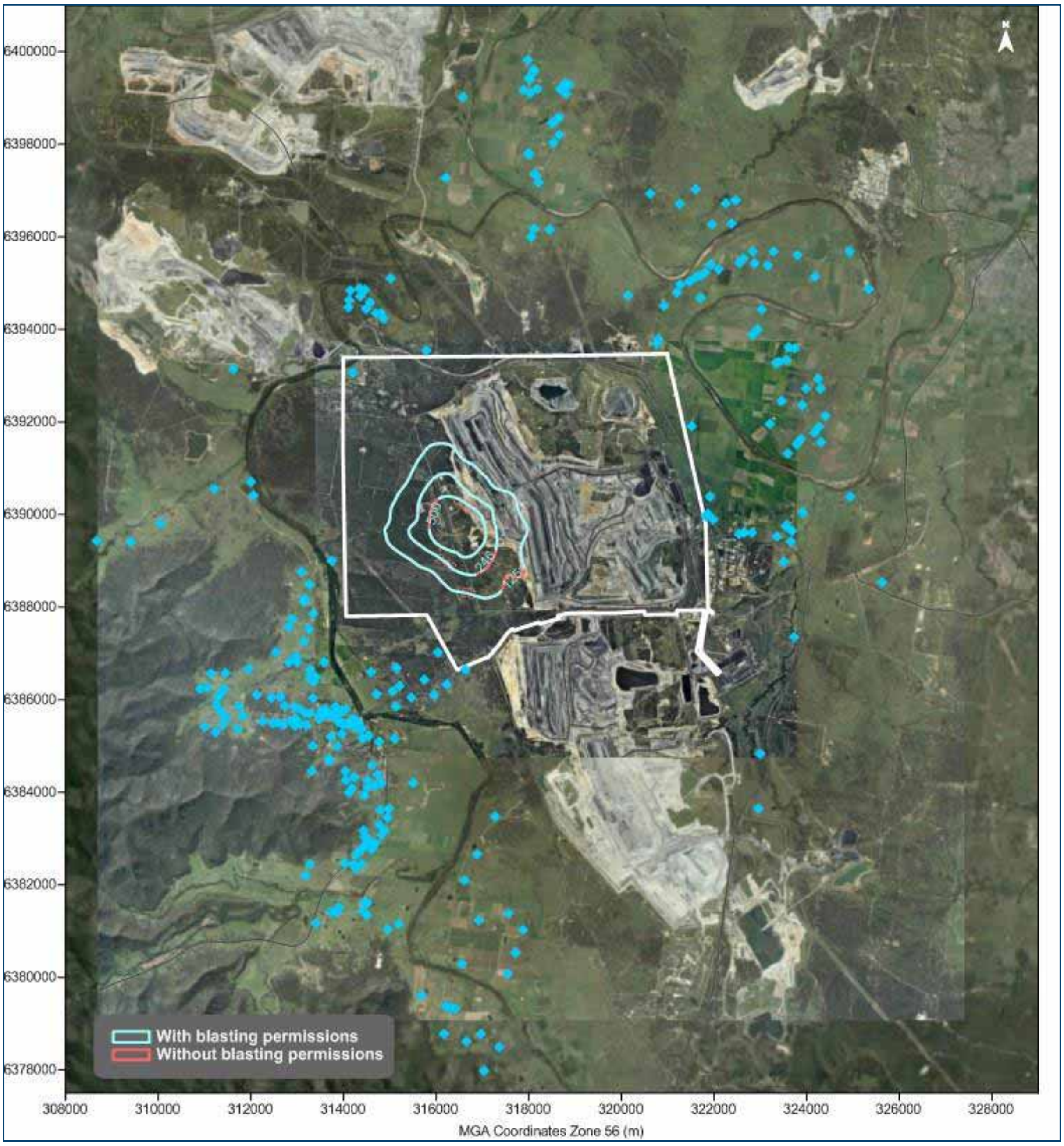

Figure H-16: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 15:00 (NO_2 concentrations µg/m³)

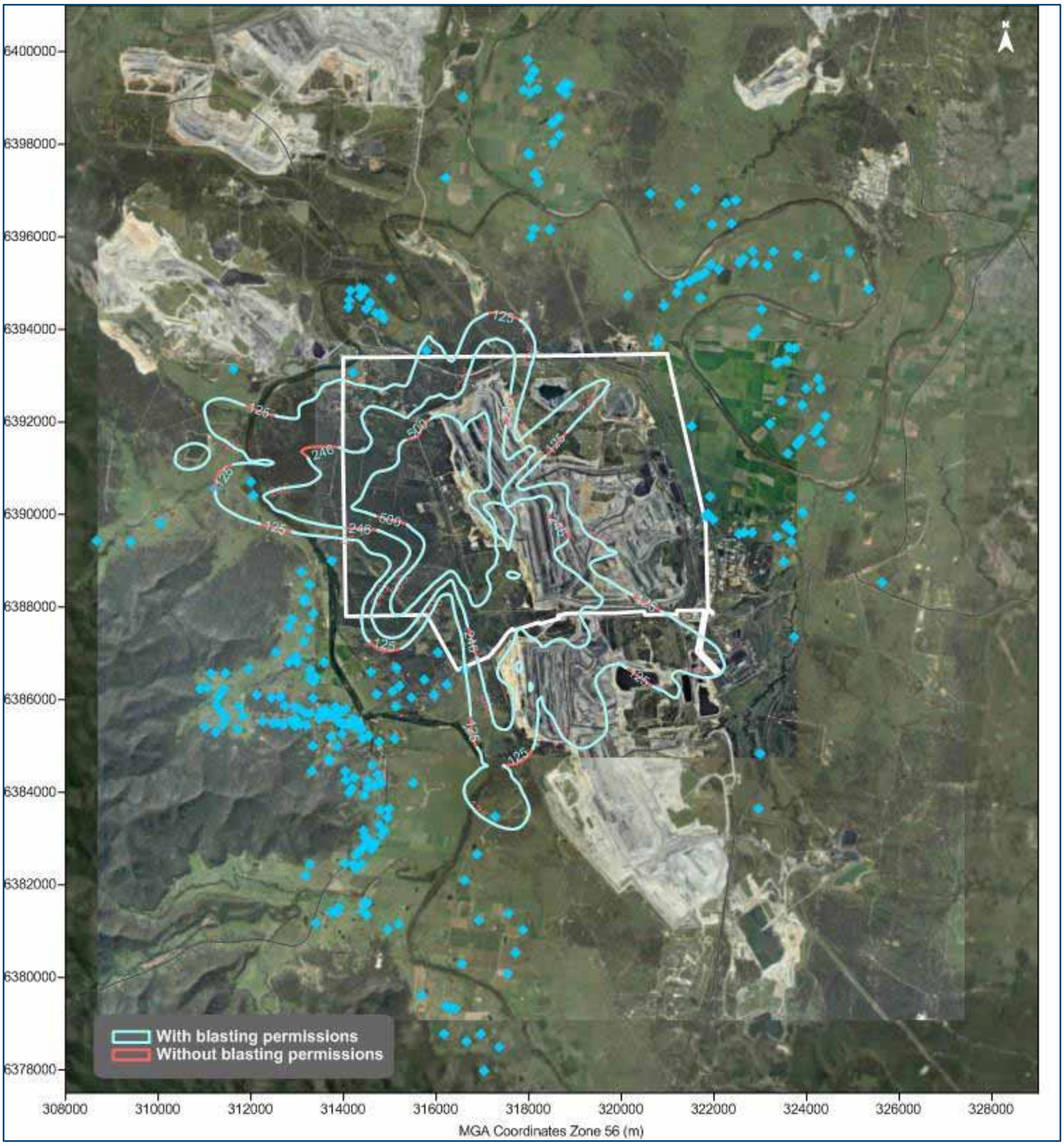

Figure H-17: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 16:00 (NO_2 concentrations µg/m³)

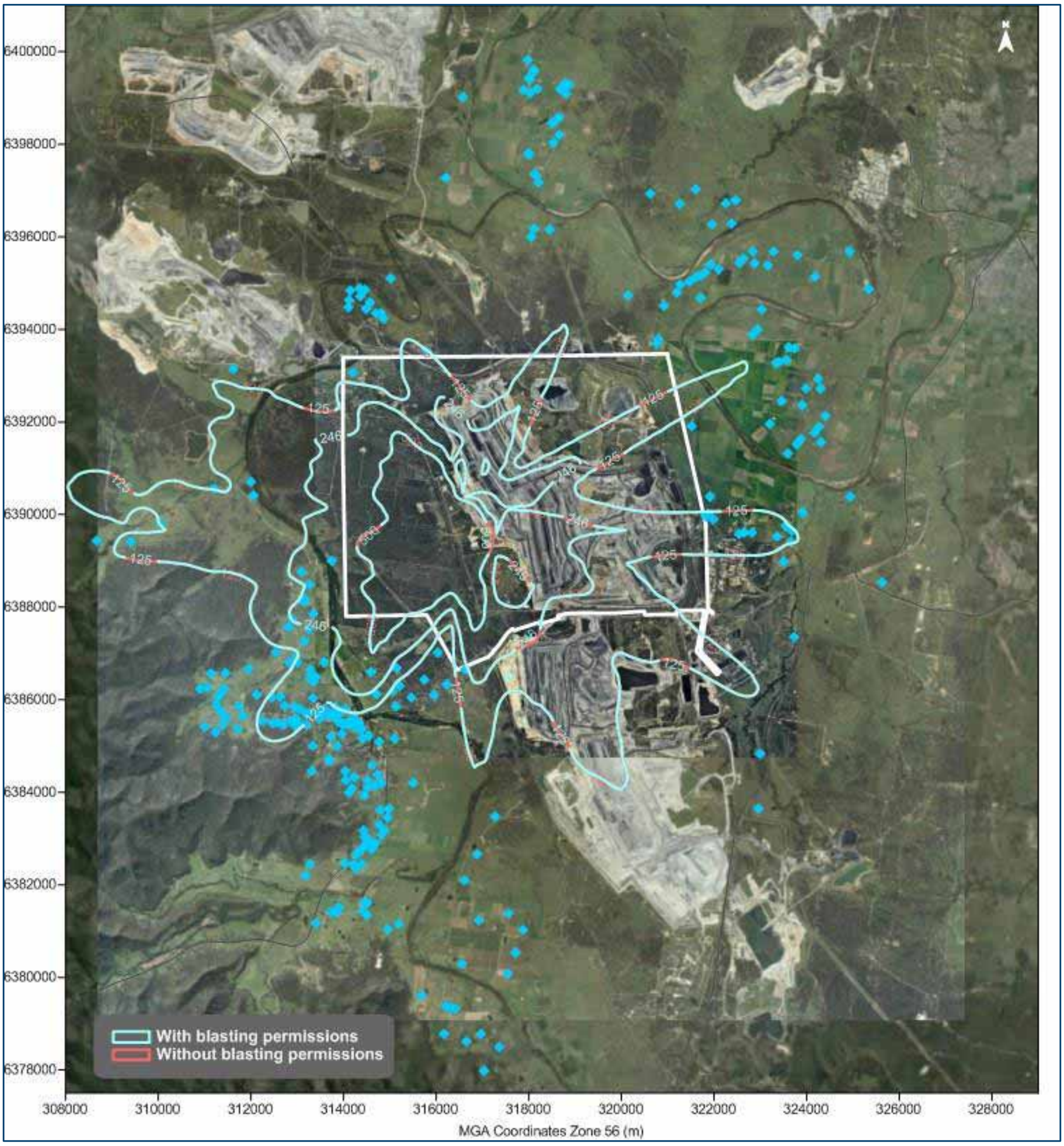

Figure H-18: Predicted maximum 1-hour average blast emissions from the proposal in Year 9 – 17:00 (NO_2 concentrations µg/m³)

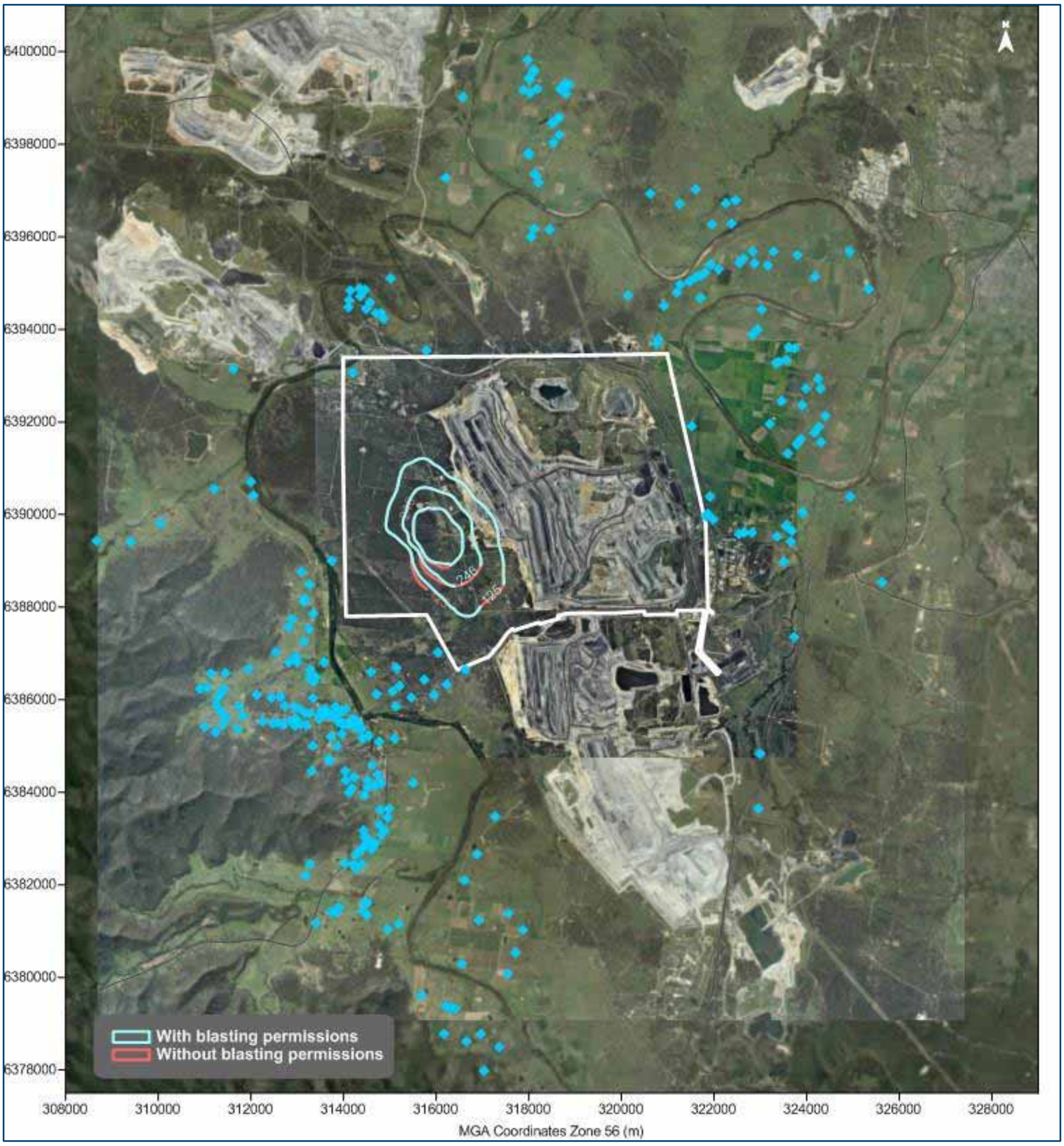

Figure H-19: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 09:00 (NO_2 concentrations µg/m³)

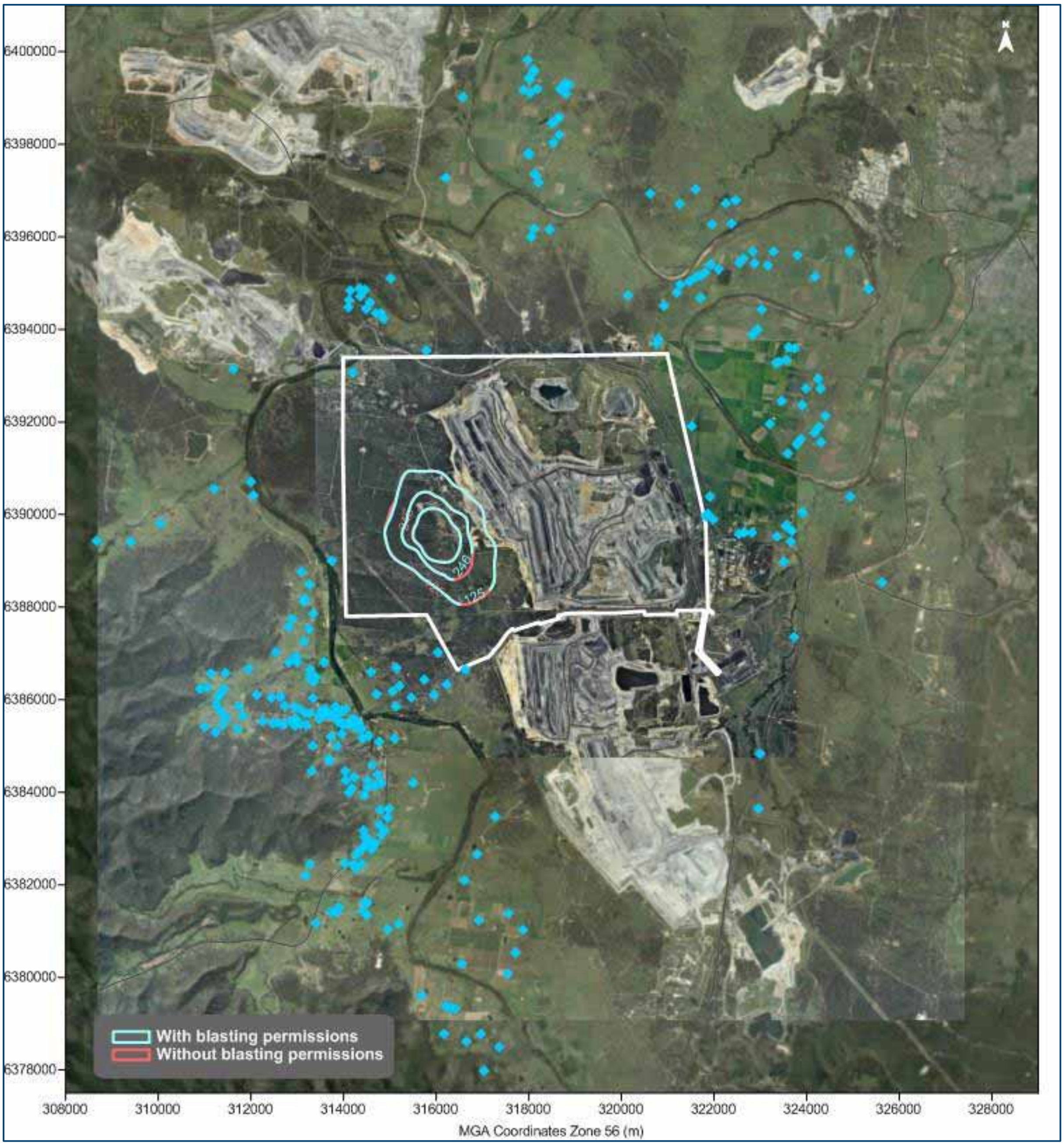

Figure H-20: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 10:00 (NO_2 concentrations µg/m³)

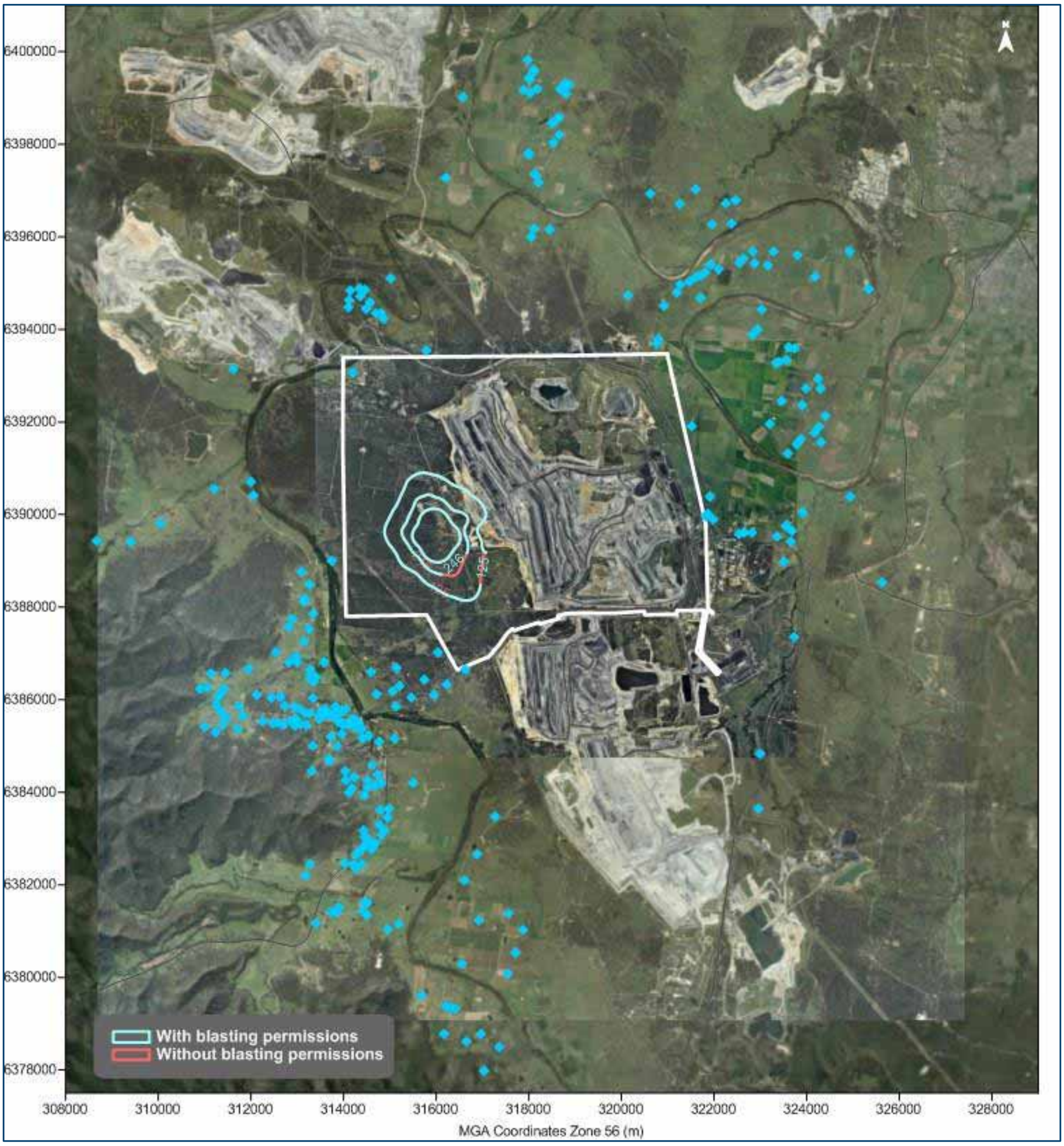

Figure H-21: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 11:00 (NO_2 concentrations µg/m³)

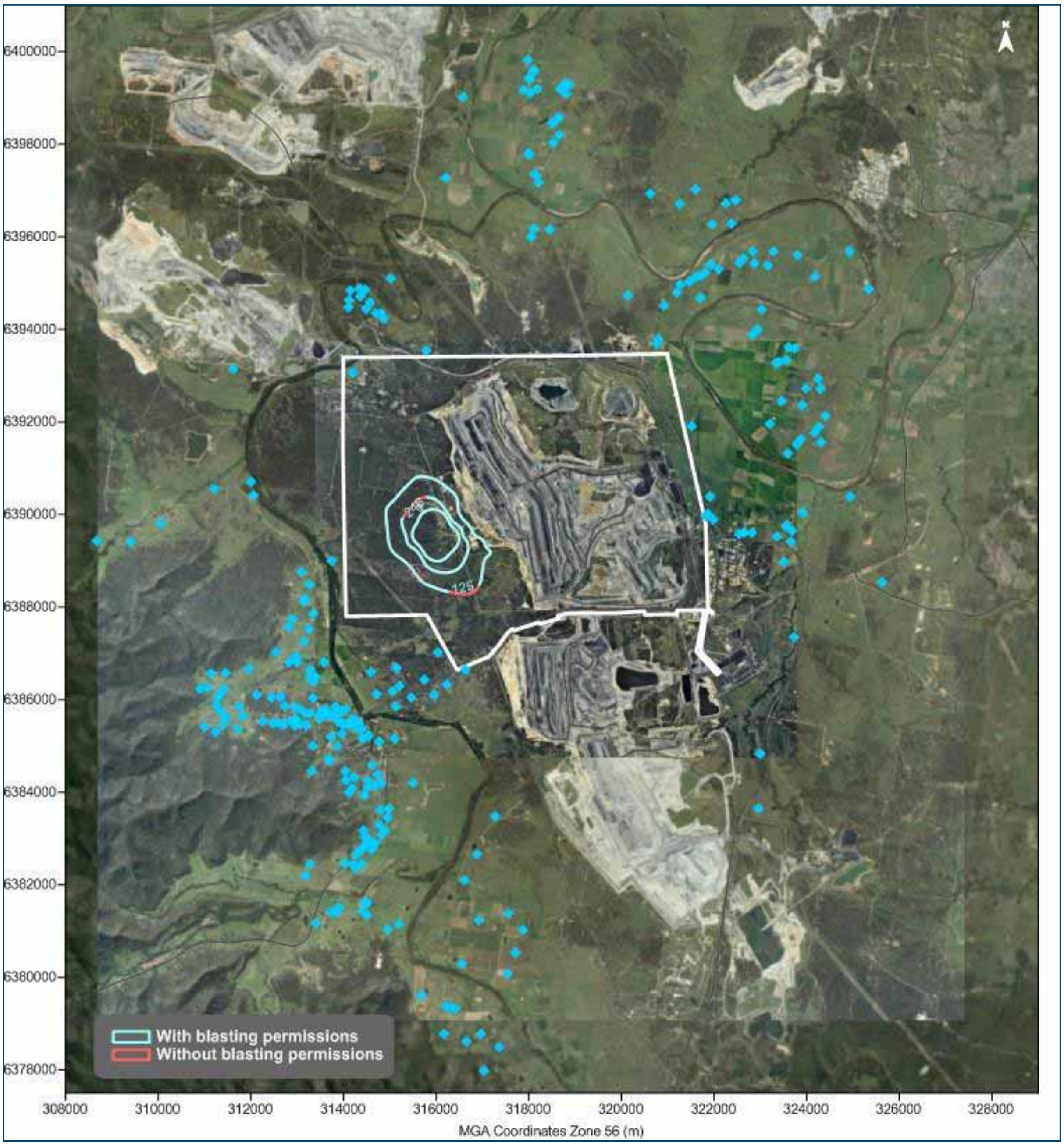

Figure H-22: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 12:00 (NO_2 concentrations µg/m³)

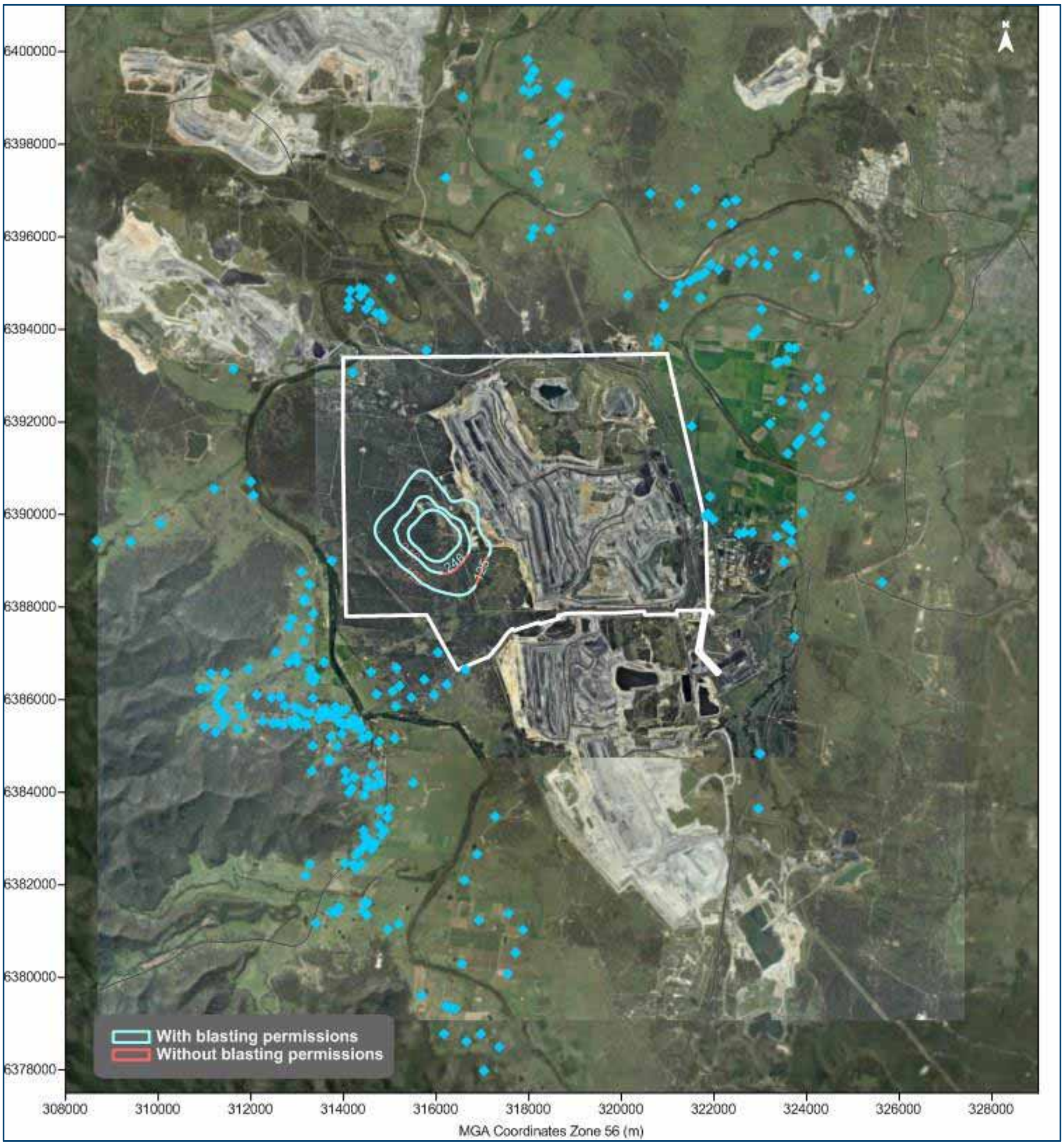

Figure H-23: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 13:00 (NO_2 concentrations µg/m³)

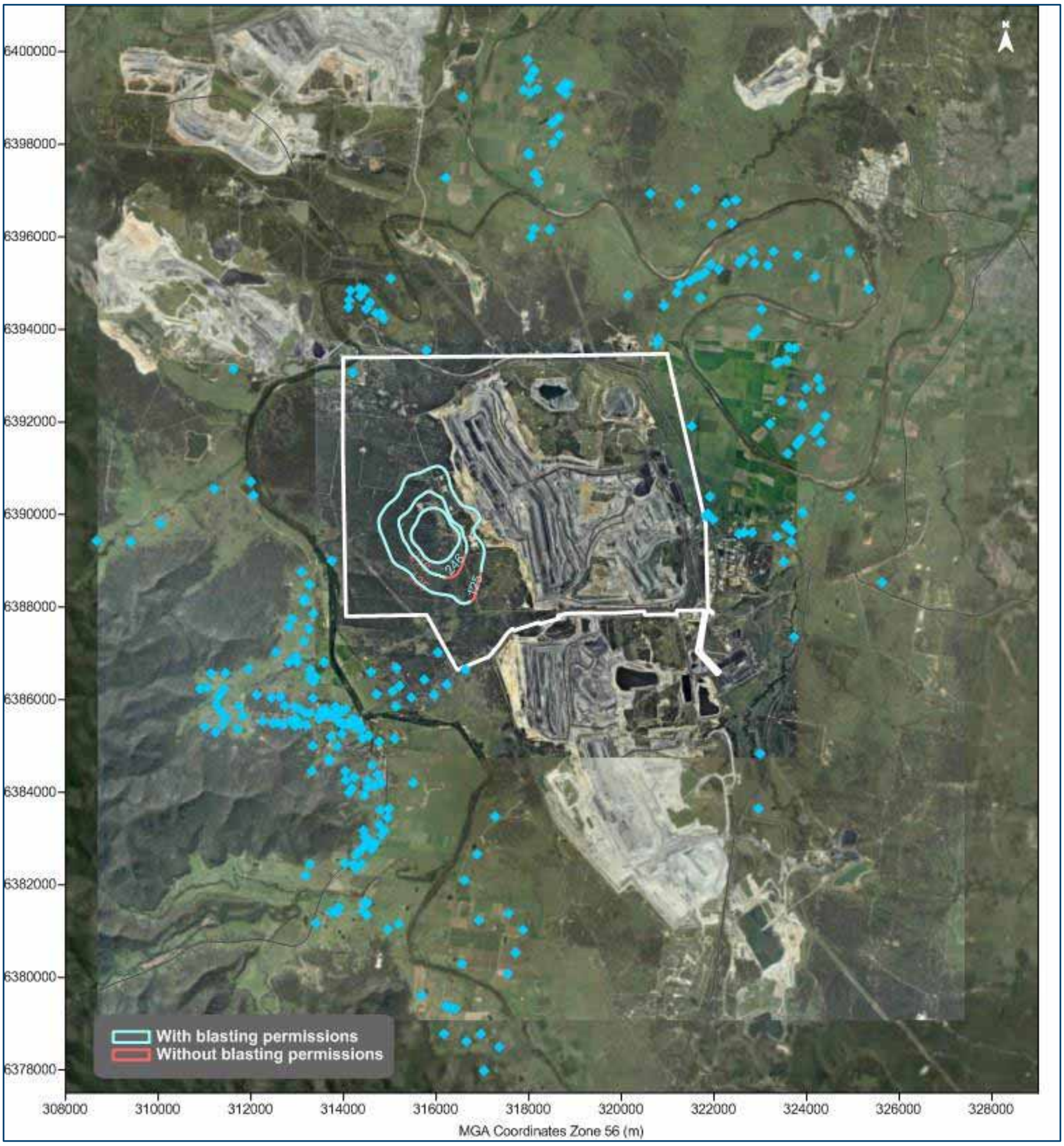

Figure H-24: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 14:00 (NO_2 concentrations µg/m³)

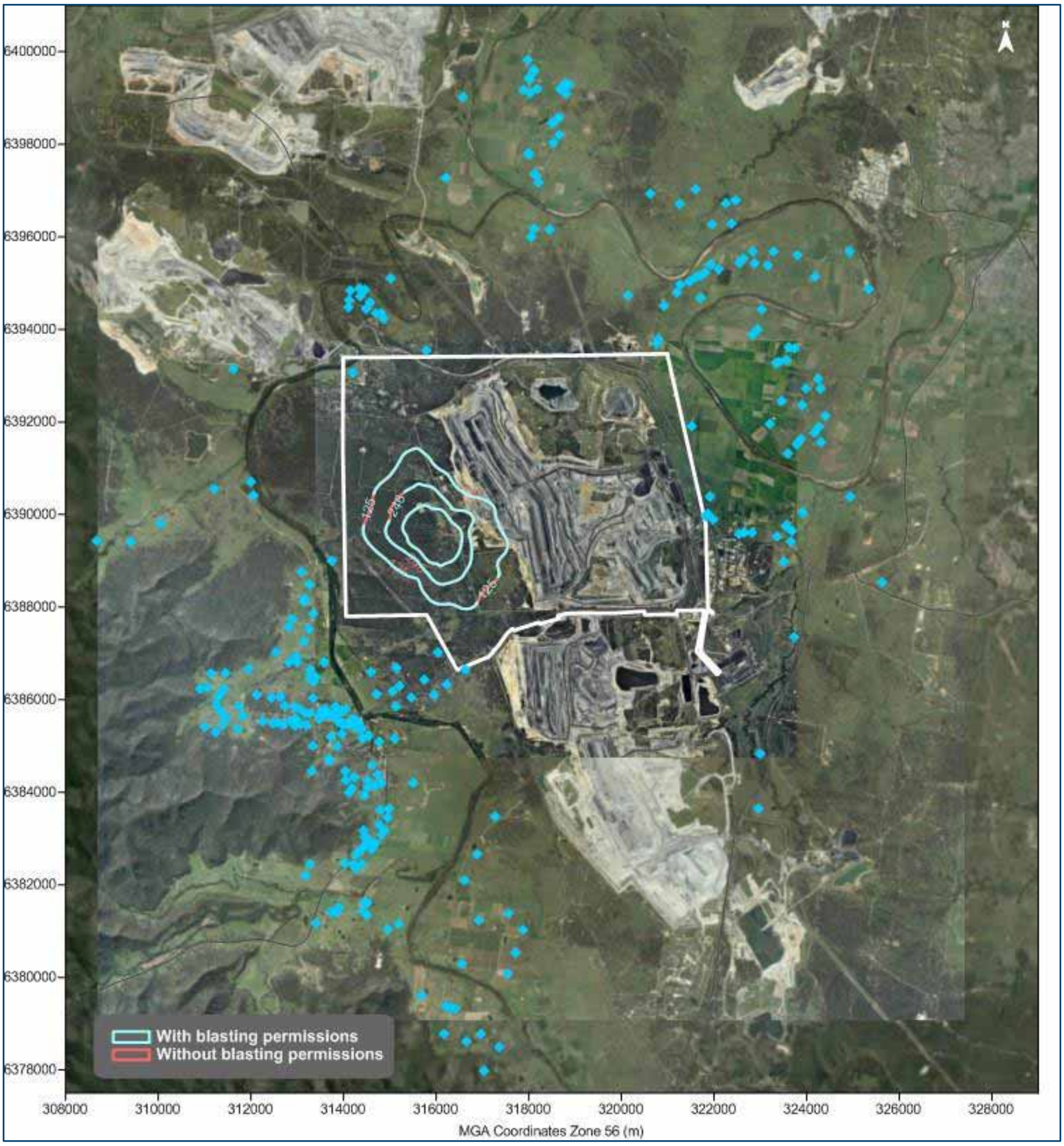

Figure H-25: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 15:00 (NO_2 concentrations µg/m³)

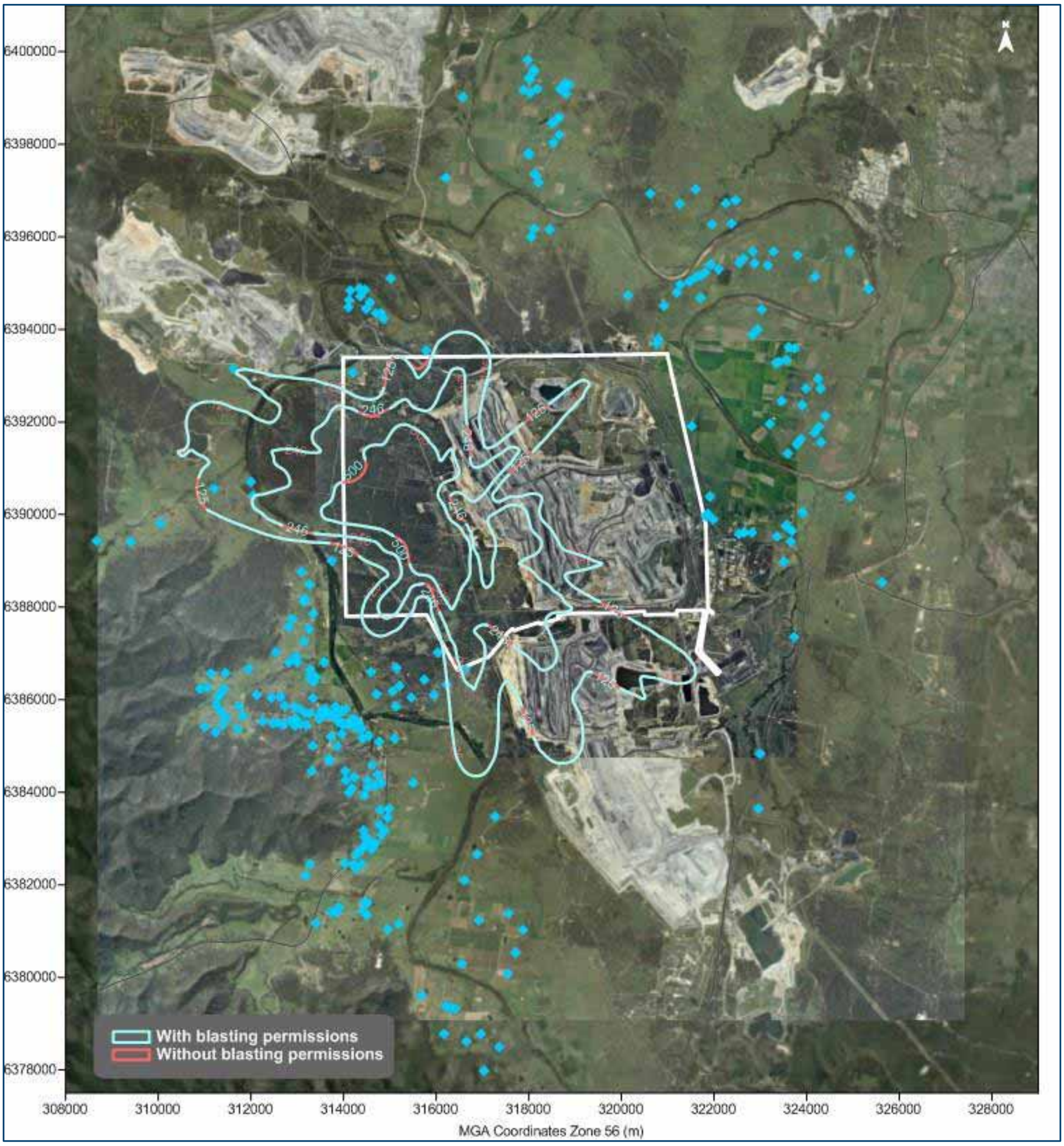

Figure H-26: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 16:00 (NO_2 concentrations µg/m³)

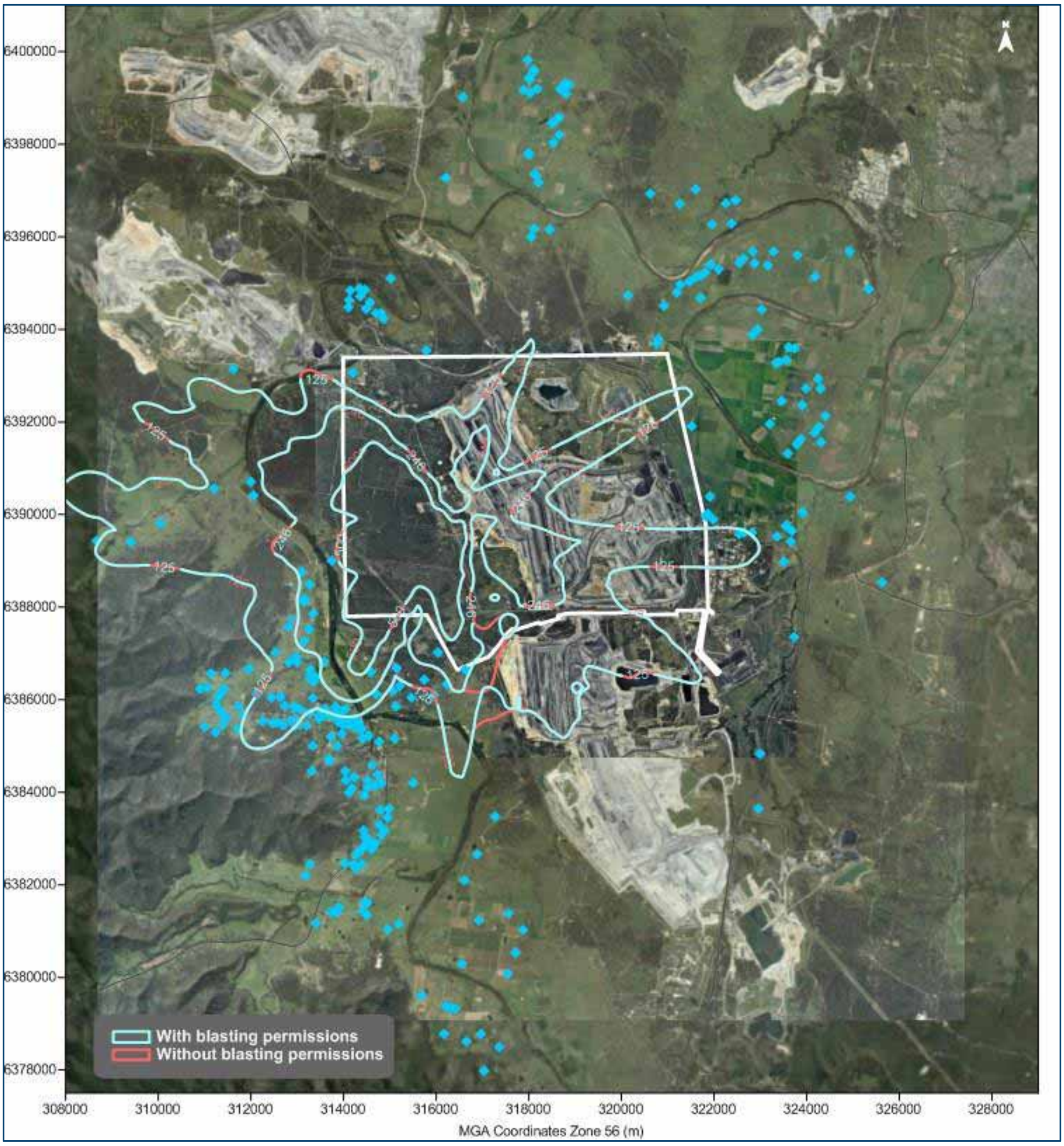

Figure H-27: Predicted maximum 1-hour average blast emissions from the proposal in Year 14 – 17:00 (NO_2 concentrations µg/m³)

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