HUMECOAL PROJECT

VOLUME 2A

Hume Coal Project and Berrima Rail Project

Response to Submissions

Appendices 1 to 2

Prepared for Hume Coal Pty Limited
June 2018

EMM

Appendix 1

Register of submitters

Type	Submitter	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Water resources	Rejects management	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
Government	DPE Division of Resources and Geoscience (DRG)					✓	✓			✓			✓	✓							
Government	Department of Primary Industries (DPI) - Agriculture			✓		✓	✓			✓	✓				✓		✓				
Government	Department of Primary Industries (DPI) - Water and Fisheries			✓	✓	✓				✓											
Government	Environment Protection Authority (EPA)	✓		✓	✓			✓	✓	✓			✓			✓					
Government	Forestry Corporation of NSW (FCNSW)	✓				✓															
Government	Office of Environment and Heritage (OEH)			✓			✓			✓								✓			
Government	NSW Health			✓				✓	✓												
Government	Roads and Maritime Services (RMS)			✓					✓		✓										
Government	Heritage Council of NSW			✓					✓	✓		✓							✓		
Government	Subsidence Advisory (NSW)									✓											
Government	Transport for NSW (TfNSW)										✓										
Government	Water NSW			✓	✓					✓											
Government	Wingecarribee Shire Council			✓			✓	✓		✓	✓	✓		✓	✓		✓		✓		✓

Type	Submitter	DPE Identification Number	Objects/Supports	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
Special interest group	350 Australia	I19	Objects			✓	✓							✓				✓						✓	
Special interest group	Alan Lindsay	I15.2	Objects	✓			✓	✓	✓					✓				✓							✓
Special interest group	Aurora Southern Highlands Steiner School	I2	Objects	✓							✓								✓	✓					✓
Special interest group	Australian Garden History Society, Southern Highlands Branch	I20	Objects	✓			✓				✓		✓	✓		✓							✓		
Special interest group	Australian Stock Horse Society - Moss Vale Branch	I3	Objects	✓			✓																		
Special interest group	Berrima District Acclimatisation Society	I4	Objects			✓					✓										✓			✓	✓
Special interest group	Berrima Residents Association, Eric Savage	I18	Objects	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓		✓		✓
Special interest group	Bruce Robertson	I15.3	Objects	✓			✓	✓						✓			✓	✓							✓
Special interest group	CFSH: Cultural Landscape Assessment	I15.1	Objects																				✓		
Special interest group	Climate Action Now Wingecarribee	I16	Objects			✓							✓					✓		✓				✓	✓
Special interest group	Coal-Free Southern Highlands	I15	Objects	✓	✓	✓	✓	✓			✓			✓				✓	✓						✓
Special interest group	Collen Morris "STATEMENT OF HERITAGE IMPACT For Berrima, Sutton Forest and Exeter Cultural Landscape"	P2	Objects	✓		✓	✓			✓		✓	✓	✓	✓	✓		✓			✓	✓	✓		✓
Special interest group	Exeter Village Association	I6	Objects			✓	✓	✓					✓	✓	✓			✓	✓	✓	✓			✓	✓
Special interest group	Farmers for Climate Action	I7	Objects	✓			✓			✓														✓	✓
Special interest group	Groundswell Gloucester	I8	Objects																						✓
Special interest group	Hydroilex	I15.9	Objects			✓	✓		✓	✓				✓	✓	✓		✓	✓						✓
Special interest group	Institute for Energy Economics and Financial Analysis	I15.13	Objects															✓	✓					✓	
Special interest group	Jewell and Associates	I15.10	Objects			✓	✓	✓						✓											
Special interest group	John Conolly	I15.7	Objects				✓							✓					✓						✓
Special interest group	Lock the Gate Alliance	I9	Objects	✓		✓	✓	✓			✓			✓	✓			✓	✓						✓
Special interest group	Macquarie Uni	I15.12	Objects									✓	✓		✓					✓					✓
Special interest group	MaryLou Potts pty ltd	I15.11	Objects	✓			✓		✓					✓											
Special interest group	National Trust Southern Highlands Branch	I10	Objects	✓			✓	✓						✓		✓					✓		✓		✓
Special interest group	Nature Conservation Council of NSW	I11	Objects	✓			✓				✓				✓			✓				✓		✓	✓
Special interest group	Pells and Pan 2017, Pells Consulting	I15.14	Objects				✓																		
Special interest group	Perica and Associates Urban Planning Pty Ltd and Battle for Berrima	I17	Objects	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Special interest group	Raymond A Binns	I15.5	Objects	✓						✓				✓		✓	✓	✓	✓						✓
Special interest group	Regional Development Australia - Southern Inland	I12	Supports	✓										✓		✓		✓	✓						
Special interest group	Ryall Environmental Pty Limited	I15.8	Objects				✓	✓						✓											
Special interest group	Southern Highlands Food and Wine Association	I13	Objects							✓								✓							✓
Special interest group	Southern Highlands Greens	P1	Objects	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓
Special interest group	T Romburg	I15.4	Objects	✓			✓	✓						✓				✓							✓
Special interest group	The Australia Institute	I15	Objects	✓			✓			✓			✓	✓	✓	✓		✓	✓	✓				✓	✓
Special interest group	The Australia Institute's Submission on Economic assessment of the Hume Coal project	I15	Objects			✓	✓		✓		✓		✓	✓	✓			✓			✓		✓	✓	
Special interest group	The Australia Institute's Submission on Environmental Impact Statement of the Hume Coal Project	I15	Objects	✓									✓	✓				✓			✓				✓
Special interest group	The National Trust of Australia (NSW)	I14	Objects	✓		✓	✓						✓	✓		✓		✓			✓		✓		✓
Special interest group	The Quit Coal Collective	I1	Objects			✓	✓				✓							✓	✓		✓			✓	✓
Special interest group	The United Mineworkers South Western District (CFEMU)	I5	Supports				✓						✓	✓	✓			✓	✓				✓		
Special interest group	UNSW water lab	I15.6	Objects				✓																		✓

Type	Submitter	Objects/Supports	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Water resources	Reject management	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
Business	5th Chapter	Objects	✓		✓				✓	✓		✓	✓		✓		✓					
Business	AMPCONTROL	Supports									✓				✓	✓						
Business	Anna King Landscape Architects	Objects			✓			✓	✓	✓		✓	✓	✓	✓							
Business	ARTC	Supports										✓			✓							
Business	B3 Mining Service	Supports													✓	✓						
Business	Berrima Bakehouse Motel	Objects							✓	✓					✓							
Business	Bulwarra Bees	Objects			✓		✓	✓		✓		✓			✓			✓				
Business	Cheery Tree Hill	Objects			✓					✓		✓			✓	✓	✓	✓		✓		
Business	Crookes (via Hawes & Swan)	Objects	✓		✓		✓		✓	✓												
Business	Dredging System	Supports													✓	✓						
Business	EXGS	Objects			✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
Business	Feast at Berrima licensed restaurant	Objects			✓					✓		✓	✓		✓	✓		✓				
Business	Fenugreek Investments	Objects	✓		✓										✓	✓						
Business	Filetron Pty Ltd	Objects			✓																	
Business	Fitzroy Equestrian Centre Pty Ltd	Objects			✓							✓						✓				
Business	Free Bear Import and Trade Pty Ltd	Supports													✓	✓						
Business	Gumuny Holdings Pty Ltd	Objects			✓											✓		✓				
Business	Heart Springs Pty Ltd	Objects			✓										✓							
Business	Highland Workwear	Supports																				
Business	Jessmondeen Pastoral Co	Supports					✓									✓						
Business	Lenlin Australia	Supports	✓		✓				✓	✓	✓	✓	✓		✓	✓						
Business	Magpie Cafe	Objects					✓								✓			✓				
Business	Nibico	Objects			✓		✓			✓					✓	✓	✓	✓				
Business	Palaris	Supports									✓	✓			✓							
Business	Port Kembla Coal Terminal	Supports	✓								✓				✓	✓						
Business	Port Kembla Gateway Pty Ltd	Supports										✓			✓	✓						
Business	Princess Pastoral Company	Supports			✓		✓		✓	✓	✓	✓			✓	✓						
Business	Red Cow Farm	Objects			✓																	
Business	Resolve Coal Pty Ltd	Supports									✓				✓	✓						
Business	RG properties	Objects					✓											✓				
Business	Robertson Inn	Objects								✓		✓						✓				
Business	SF Drafting	Supports																				
Business	Treekeeper Nursery	Objects			✓					✓						✓		✓				
Business	Vitrinite Pty Ltd	Supports	✓														✓					
Business	Wylarah Pastoral Co	Objects			✓		✓	✓		✓	✓				✓					✓		
Business	Zen Oasis	Objects	✓		✓				✓				✓			✓						

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
30.1-30.180	Form submission - with comments	Individual	Objects	Hume Coal Project			✓	✓			✓					✓			✓					✓		✓
1.1-1.155	Form letter 1	Individual	Objects	Hume Coal Project											✓				✓							
4.1-4.479	Form letter 1	Individual	Objects	Hume Coal Project											✓				✓							
12.1-12.1479	Form letter 1	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
10.1-10.779	Form letter 1	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
5.1-5.1311	Form letter 2	Individual	Objects	Hume Coal Project				✓			✓		✓	✓					✓							
13.1-13.885	Form letter 2	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
2.1-2.701	Form letter 2	Individual	Objects	Hume Coal Project				✓			✓		✓	✓					✓							
11.1-11.658	Form letter 2	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
6.1-6.751	Form letter 3	Individual	Objects	Hume Coal Project			✓	✓	✓																	
15.1-15.826	Form letter 3	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
3.1-3.614	Form letter 3	Individual	Objects	Hume Coal Project			✓	✓	✓																	
14.1-14.283	Form letter 3	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
7.1-7.9	Form letter 4	Individual	Objects	Hume Coal Project				✓								✓		✓	✓	✓						✓
8.1-8.562	Form letter 4	Individual	Objects	Hume Coal Project				✓								✓		✓	✓	✓						✓
7.1-7.160	Form letter 4	Individual	Objects	Hume Coal Project				✓								✓		✓	✓	✓						✓
23.1-23.13	Form letter 5	Individual	Objects	Both projects			✓	✓	✓					✓		✓			✓		✓					✓
9.1-9.300	Form letter 5	Individual	Objects	Hume Coal Project			✓	✓	✓					✓		✓			✓		✓					✓
22.1-22.4	Form letter 5	Individual	Objects	Both projects			✓	✓	✓							✓			✓		✓					✓
20.1-20.199	Form letter 6	Individual	Objects	Both projects			✓	✓			✓			✓		✓			✓		✓			✓		✓
26.1-26.30	Form letter 6	Individual	Objects	Both projects			✓	✓			✓					✓			✓	✓	✓	✓		✓		✓
31.1-31.552	Form letter 6	Individual	Objects	Hume Coal Project			✓	✓			✓					✓			✓		✓			✓		✓
25.1-25.213	Form letter 7	Individual	Objects	Hume Coal Project	✓												✓					✓		✓		
24.1-24.108	Form letter 7	Individual	Objects	Hume Coal Project	✓												✓					✓		✓		
198114	Individual - Unique	Individual	Supports	Hume Coal Project				✓							✓		✓			✓						✓
198118	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓							✓	✓	✓			✓					✓	✓
198262	Individual - Unique	Individual	Supports	Hume Coal Project			✓	✓			✓	✓			✓	✓			✓	✓			✓	✓		
199260	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
199276	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
199379	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
199665	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
199735	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
200106	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
200233	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
200474	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
200782	Individual - Unique	Individual	Supports	Hume Coal Project																						
200901	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
200908	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
200910	Individual - Unique	Individual	Supports	Hume Coal Project				✓						✓	✓											
200915	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
200919	Individual - Unique	Individual	Supports	Hume Coal Project							✓		✓		✓				✓	✓						
200921	Individual - Unique	Individual	Supports	Hume Coal Project											✓											✓
200925	Individual - Unique	Individual	Supports	Hume Coal Project				✓						✓	✓											
200940	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
201042	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓						✓			✓				✓	✓						✓
201048	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓		✓		✓	✓		✓		✓	✓	✓		✓	✓			✓	✓	✓	✓
201083	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
201118	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
201122	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
201152	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
201154	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓							
201166	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
201251	Individual - Unique	Individual	Supports	Hume Coal Project														✓		✓						
201270	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓							✓	✓	✓		✓	✓						✓
201342	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓	✓	✓		✓		✓	✓						✓
201396	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
201483	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓							✓				✓	✓						✓
201633	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
201646	Individual - Unique	Individual	Supports	Hume Coal Project										✓	✓				✓	✓						
201764	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
201766	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
201775	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
201777	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
201808	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
201830	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓					✓			✓	✓	✓	✓		✓	✓	✓
201892	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	
201965	Individual - Unique	Individual	Supports	Hume Coal Project				✓							✓				✓	✓						
201969	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
202072	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓		✓				✓	✓				✓	✓						✓
202074	Individual - Unique	Individual	Supports	Hume Coal Project				✓			✓				✓				✓	✓						
202081	Individual - Unique	Individual	Supports	Hume Coal Project		✓													✓	✓						✓
202087	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓							
202104	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
202108	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
202118	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
202248	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓						✓						✓
202325	Individual - Unique	Individual	Supports	Hume Coal Project											✓	✓			✓	✓						✓
202351	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓	✓	✓	✓			✓								✓
202395	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
202397	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
202399	Individual - Unique	Individual	Supports	Hume Coal Project											✓											✓
202403	Individual - Unique	Individual	Supports	Hume Coal Project			✓													✓		✓				
202411	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
202485	Individual - Unique	Individual	Supports	Hume Coal Project											✓											✓
202513	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
202537	Individual - Unique	Individual	Supports	Hume Coal Project							✓				✓					✓						✓
202541	Individual - Unique	Individual	Supports	Hume Coal Project							✓				✓					✓						✓
202654	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓				✓				✓	✓	✓				✓	✓
203302	Individual - Unique	Individual	Supports	Hume Coal Project	✓										✓											✓
203420	Individual - Unique	Individual	Objects	Hume Coal Project	✓						✓			✓			✓			✓	✓					✓
203424	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
203690	Individual - Unique	Individual	Supports	Hume Coal Project	✓										✓											
203784	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓		✓								✓		
203821	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
203970	Individual - Unique	Individual	Supports	Hume Coal Project																						
204146	Individual - Unique	Individual	Supports	Hume Coal Project	✓										✓				✓							
204154	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓														✓
204216	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓									✓									✓
204229	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓	✓					✓		✓		✓	✓				✓
204309	Individual - Unique	Individual	Objects	Hume Coal Project				✓							✓							✓			✓	✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
204352	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓								✓			✓	✓
204382	Individual - Unique	Individual	Supports	Hume Coal Project											✓		✓		✓	✓						
204392	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
204431	Individual - Unique	Individual	Supports	Hume Coal Project							✓				✓					✓						
204475	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓										✓		
204477	Individual - Unique	Individual	Supports	Hume Coal Project														✓		✓						
204528	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓					✓	✓	✓					✓	✓		✓	✓	✓		✓
204616	Individual - Unique	Individual	Objects	Hume Coal Project		✓		✓						✓					✓	✓						✓
204620	Individual - Unique	Individual	Objects	Hume Coal Project															✓			✓				
204622	Individual - Unique	Individual	Objects	Hume Coal Project													✓		✓							✓
204652	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓														✓
204698	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓									✓							✓		
204753	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓																		✓
204755	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓														✓
204813	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓							✓	✓			✓			✓	✓
204877	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
204969	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓									✓		✓							✓
204988	Individual - Unique	Individual	Supports	Hume Coal Project	✓														✓							
204990	Individual - Unique	Individual	Supports	Hume Coal Project	✓														✓	✓						✓
204992	Individual - Unique	Individual	Supports	Hume Coal Project														✓		✓						
204996	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓					✓									✓
205014	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
205020	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
205024	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
205079	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
205089	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
205209	Individual - Unique	Individual	Objects	Hume Coal Project		✓		✓											✓	✓	✓	✓				✓
205371	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓					✓								✓		✓
205434	Individual - Unique	Individual	Supports	Hume Coal Project																						
205536	Individual - Unique	Individual	Objects	Hume Coal Project	✓															✓			✓			✓
205755	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓								✓			✓					✓		
205788	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓			✓		✓	✓		✓			✓	✓
205837	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
205850	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓											✓							
205858	Individual - Unique	Individual	Comments	Hume Coal Project									✓	✓		✓	✓			✓		✓				
205867	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓						✓		✓				
206497	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓	✓					✓	✓	✓		✓			✓	✓
206524	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓			✓									
206933	Individual - Unique	Individual	Supports	Hume Coal Project				✓									✓		✓	✓						✓
207018	Individual - Unique	Individual	Supports	Hume Coal Project				✓									✓			✓						
207032	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
207140	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓					✓			✓							✓
207164	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓			✓	✓						✓
207168	Individual - Unique	Individual	Objects	Hume Coal Project												✓			✓			✓				✓
207178	Individual - Unique	Individual	Objects	Hume Coal Project	✓														✓	✓					✓	✓
207215	Individual - Unique	Individual	Supports	Hume Coal Project											✓	✓			✓							✓
207315	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓		✓					✓	✓						✓
207406	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓																		✓
207467	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓								✓	✓		✓	✓	✓	✓				✓
207487	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓						✓				

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
207489	Individual - Unique	Individual	Objects	Hume Coal Project	✓															✓	✓					✓
207513	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓			✓			✓	✓	✓	✓		✓				✓
207674	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓		✓	✓			✓			✓	✓
207840	Individual - Unique	Individual	Supports	Hume Coal Project		✓													✓	✓						✓
207894	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓	✓					✓	✓		✓			✓	✓	✓	✓				✓
208558	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓						✓	✓					✓
208605	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓												✓
208642	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓								✓		✓			✓				
208734	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
209191	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
209377	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓	✓				✓							✓
209519	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓	✓	✓							✓					✓
209739	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
209796	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
209846	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓								✓						✓				✓
209848	Individual - Unique	Individual	Objects	Hume Coal Project																		✓	✓			✓
209870	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓	✓	✓												✓
209891	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓	✓	✓	✓	✓		✓	✓						✓
209896	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
209900	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓	✓	✓					✓	✓				
210030	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓	✓	✓		✓					✓					✓						✓
210053	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓			✓	✓	✓	✓		✓				✓
210077	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓							✓											
210108	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓		✓	✓		✓						✓				✓
210166	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓	✓	✓		✓					✓				✓							✓
210233	Individual - Unique	Individual	Objects	Hume Coal Project															✓	✓		✓				
210297	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓		✓
210359	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
210418	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
210420	Individual - Unique	Individual	Objects	Hume Coal Project													✓				✓					
210431	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓				✓			✓	✓	✓		✓				✓
210443	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓	✓	✓	✓		✓				✓
210445	Individual - Unique	Individual	Objects	Hume Coal Project				✓																	✓	✓
210451	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓			✓			✓		✓	✓						✓
210474	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓	✓											✓		✓
210488	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
210491	Individual - Unique	Individual	Objects	Hume Coal Project							✓			✓		✓	✓			✓		✓				
210493	Individual - Unique	Individual	Supports	Hume Coal Project				✓						✓							✓				✓	✓
210495	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓						✓											
210497	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓										✓								✓
210841	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓							✓					✓	✓
210852	Individual - Unique	Individual	Objects	Hume Coal Project																				✓		
210859	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓	✓				✓					✓
210882	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓		✓	✓	✓	✓					✓	✓		✓				✓
210889	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓											✓		✓	✓				✓
210900	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
210903	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓		✓			✓			✓						✓
210925	Individual - Unique	Individual	Supports	Hume Coal Project				✓								✓				✓						
210930	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓			✓		✓			✓				✓
210943	Individual - Unique	Individual	Objects	Hume Coal Project																						✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
210949	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
210951	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
210966	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓																		✓	✓
210970	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
211005	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓					✓			✓				✓
211007	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
211011	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓									✓		✓	✓	✓	✓			✓	✓
211013	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓		✓								✓	✓						✓
211036	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓			✓		✓	✓		✓				✓
211047	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					✓
211053	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
211071	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																		
211075	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
211090	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓	✓	✓	✓	✓				✓	✓					
211103	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓			✓		✓		✓				✓	✓		✓
211115	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓						✓				✓			✓				
211121	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓		✓	✓	✓	✓				✓
211144	Individual - Unique	Individual	Objects	Hume Coal Project																✓		✓				✓
211149	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓			✓		✓		✓	✓		✓	✓	✓
211207	Individual - Unique	Individual	Objects	Hume Coal Project										✓												
211209	Individual - Unique	Individual	Objects	Hume Coal Project												✓										
211235	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓		✓			✓	✓	✓	✓		✓		✓
211243	Individual - Unique	Individual	Objects	Hume Coal Project																✓						✓
211250	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓		✓			✓	✓	✓			✓		✓
211252	Individual - Unique	Individual	Objects	Hume Coal Project				✓														✓				
211262	Individual - Unique	Individual	Objects	Hume Coal Project													✓			✓				✓		✓
211271	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓	✓					
211281	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓										✓
211285	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓				✓	✓				✓	✓	✓
211328	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓			✓				✓		✓
211330	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓	✓				✓							
211342	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓		✓	✓					✓	✓						✓
211388	Individual - Unique	Individual	Objects	Hume Coal Project										✓												✓
211421	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓		✓						✓					✓				✓
211425	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓	✓	✓		✓	✓		✓	✓	✓	✓		✓		✓
211429	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓						✓		✓	✓		✓				✓
211437	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
211439	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
211443	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
211445	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
211451	Individual - Unique	Individual	Supports	Hume Coal Project	✓														✓	✓					✓	
211457	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211459	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211461	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211463	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
211465	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
211469	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
211471	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
211473	Individual - Unique	Individual	Supports	Hume Coal Project																						
211477	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓			✓		✓							✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
211479	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211487	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211489	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211493	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211495	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓						✓						
211497	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
211499	Individual - Unique	Individual	Objects	Hume Coal Project																✓						✓
211501	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓					✓	✓				✓		✓	✓				✓
211503	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓														✓		✓		✓
211519	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓					✓					✓	✓						✓
211521	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓					✓			✓				
211534	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓						✓				✓
211551	Individual - Unique	Individual	Supports	Hume Coal Project													✓		✓	✓						
211557	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓						✓						✓
211559	Individual - Unique	Individual	Objects	Hume Coal Project															✓							✓
211602	Individual - Unique	Individual	Supports	Hume Coal Project												✓			✓	✓						✓
211705	Individual - Unique	Individual	Objects	Hume Coal Project																✓						
211713	Individual - Unique	Individual	Objects	Hume Coal Project													✓		✓							✓
211719	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
211725	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓									✓						
211741	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓					✓
211745	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓		✓							✓	✓				
211747	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓						✓		✓		✓		✓
211757	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓						
211789	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓									✓				✓	✓						✓
211801	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓		✓						✓				
211816	Individual - Unique	Individual	Objects	Hume Coal Project	✓																	✓			✓	✓
211821	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓		✓	✓	✓			✓	✓		✓		✓		✓
211824	Individual - Unique	Individual	Supports	Hume Coal Project												✓			✓	✓						
211828	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓						✓						✓
211834	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓		✓	✓						✓
211845	Individual - Unique	Individual	Supports	Hume Coal Project								✓								✓						✓
211849	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
211851	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
211861	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓			✓									✓
211863	Individual - Unique	Individual	Objects	Hume Coal Project			✓												✓			✓				✓
211889	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓	✓	✓					✓		✓		✓			✓						✓
211894	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓	✓		✓		✓			✓							✓
211901	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓								✓	✓						✓
211909	Individual - Unique	Individual	Supports	Hume Coal Project	✓										✓				✓	✓						
211923	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓								✓	✓	✓					✓
211980	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																		✓
211988	Individual - Unique	Individual	Supports	Hume Coal Project				✓												✓						
212027	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓		✓			✓		✓			✓							✓
212029	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓											✓				✓
212031	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓								✓		✓	✓	✓					✓
212042	Individual - Unique	Individual	Supports	Hume Coal Project														✓	✓	✓	✓					
212083	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓				✓				✓							
212090	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
212106	Individual - Unique	Individual	Supports	Hume Coal Project									✓		✓	✓				✓		✓				✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
212108	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓										✓		✓	✓				✓
212116	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
212118	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓		✓	✓									✓
212120	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓				✓	✓	✓	✓	✓				✓		✓
212122	Individual - Unique	Individual	Objects	Hume Coal Project				✓																✓		✓
212124	Individual - Unique	Individual	Objects	Hume Coal Project				✓														✓		✓		
212128	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓							✓					✓	✓	✓			✓		✓
212132	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓							✓				✓				
212134	Individual - Unique	Individual	Objects	Hume Coal Project	✓								✓	✓					✓	✓		✓				
212143	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
212147	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓	✓									✓
212149	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓											✓	
212153	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓		✓			✓	✓		✓				✓
212155	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓					✓			✓			✓			✓
212157	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓														✓
212159	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓														✓
212161	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓				✓
212163	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓				✓
212165	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓							✓	✓			✓	✓	✓	✓	✓	✓		✓
212167	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓			✓		✓	✓	✓					✓
212173	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓								✓			✓				✓
212175	Individual - Unique	Individual	Comments	Hume Coal Project				✓				✓								✓		✓				
212180	Individual - Unique	Individual	Objects	Hume Coal Project										✓						✓						✓
212182	Individual - Unique	Individual	Objects	Hume Coal Project				✓													✓					✓
212186	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212192	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓	✓		✓							✓					
212198	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓							✓			✓	✓						✓
212203	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓			✓			✓				✓	✓						✓
212244	Individual - Unique	Individual	Objects	Hume Coal Project			✓									✓										✓
212259	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓					✓							✓
212261	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓						✓			✓			✓	✓		✓		✓	✓	✓
212265	Individual - Unique	Individual	Objects	Hume Coal Project															✓							✓
212272	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓		✓	✓	✓				✓							✓
212274	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓																✓		✓
212325	Individual - Unique	Individual	Objects	Hume Coal Project	✓														✓	✓		✓				✓
212327	Individual - Unique	Individual	Objects	Hume Coal Project			✓												✓							
212331	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓					✓							✓
212337	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																✓		
212351	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓			✓		✓				✓	✓
212362	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
212397	Individual - Unique	Individual	Objects	Hume Coal Project	✓									✓	✓	✓										✓
212401	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓								✓	✓	✓			✓	✓
212403	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
212407	Individual - Unique	Individual	Objects	Hume Coal Project							✓				✓	✓			✓							
212409	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓				✓		✓			✓		✓			✓	✓
212417	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓		✓		✓								✓	✓				✓	✓
212419	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓						✓	✓	✓		✓		✓
212432	Individual - Unique	Individual	Supports	Hume Coal Project				✓							✓				✓							
212438	Individual - Unique	Individual	Objects	Hume Coal Project															✓			✓				✓
212440	Individual - Unique	Individual	Objects	Hume Coal Project													✓									✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
212442	Individual - Unique	Individual	Objects	Hume Coal Project										✓		✓									✓	✓
212466	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓	✓	✓		✓	✓		✓	✓	✓	✓				✓
212468	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓				✓	✓		✓				✓	✓
212471	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓							✓											✓
212482	Individual - Unique	Individual	Supports	Hume Coal Project											✓	✓	✓		✓	✓						
212502	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
212535	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
212566	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓				✓	✓	✓	✓			✓		✓	✓	✓	✓			✓	✓
212589	Individual - Unique	Individual	Objects	Hume Coal Project												✓		✓	✓						✓	✓
212592	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓			✓	✓	✓	✓	✓		✓	✓	✓
212594	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓				✓						✓
212596	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212598	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212600	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212602	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212604	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓				✓	✓	✓						✓
212610	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212612	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212616	Individual - Unique	Individual	Objects	Hume Coal Project			✓										✓									
212621	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																		
212626	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																		
212630	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓	✓	✓	✓				✓
212632	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓	✓	✓	✓				✓
212644	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓			✓		✓			✓			✓	✓
212650	Individual - Unique	Individual	Objects	Hume Coal Project				✓														✓		✓		✓
212652	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓			✓		✓		✓					✓
212654	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓		✓					✓					✓
212660	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓			✓		✓							✓
212664	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓			✓												✓
212666	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓				✓		✓	✓	✓					✓	✓
212668	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓								✓				
212676	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓		✓	✓	✓	✓		✓	✓	✓	✓				✓
212680	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓											✓	✓
212682	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓		✓									✓		✓	✓		✓				✓
212684	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓									✓		✓	✓						✓
212686	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓											✓	✓
212692	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓		✓	✓		✓	✓			✓		✓		✓		✓
212694	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓		✓	✓								✓	✓		✓				✓
212696	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓						✓									✓
212698	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
212700	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓					✓			✓	✓	✓	✓						✓
212704	Individual - Unique	Individual	Objects	Hume Coal Project										✓												
212706	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓									✓			✓				✓		✓
212708	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓		✓			✓	✓		✓				✓
212710	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓								✓	✓		✓	✓	✓	✓				✓
212717	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓											✓							
212719	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
212723	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			
212725	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓					✓	✓						
212727	Individual - Unique	Individual	Supports	Hume Coal Project												✓				✓						✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
212731	Individual - Unique	Individual	Objects	Hume Coal Project												✓					✓					✓
212735	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓		✓								✓			✓	✓
212738	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓											✓			✓			✓	✓
212740	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓								✓		✓							✓
212744	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓			✓									✓
212746	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓		✓			✓			✓			✓	✓
212748	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212750	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓			✓				✓
212752	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																		
212754	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓		✓			✓		✓	✓				✓
212758	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓			✓								✓				✓
212760	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓											✓	✓
212762	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
212766	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓			✓		✓			✓				✓
212768	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓	✓										✓								✓
212774	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓					✓			✓		✓		
212776	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓		✓			✓			✓		✓		
212778	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
212784	Individual - Unique	Individual	Objects	Hume Coal Project														✓	✓			✓				✓
212796	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓								✓				
212800	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓		✓			✓				✓
212802	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓		✓	✓			✓		✓	✓		✓		✓		✓
212804	Individual - Unique	Individual	Objects	Hume Coal Project		✓		✓			✓			✓					✓	✓		✓				✓
212813	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓				✓	✓			✓									
212825	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓							✓
212834	Individual - Unique	Individual	Objects	Hume Coal Project			✓									✓										
212837	Individual - Unique	Individual	Objects	Hume Coal Project			✓									✓										
212849	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓				✓	✓	✓	✓		✓	✓	✓			✓			✓
212853	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
212857	Individual - Unique	Individual	Objects	Hume Coal Project				✓		✓									✓						✓	
212886	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
212892	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓						
212894	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓												✓
212911	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓	✓	✓	✓	✓			✓		✓					
212913	Individual - Unique	Individual	Objects	Hume Coal Project															✓							
212915	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓		✓	✓	✓				✓					
212931	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓	✓					
212940	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓						
212950	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓						✓			✓	✓	✓			✓	✓	✓	✓
212954	Individual - Unique	Individual	Objects	Hume Coal Project													✓		✓							
212956	Individual - Unique	Individual	Objects	Hume Coal Project				✓							✓			✓							✓	✓
212958	Individual - Unique	Individual	Objects	Hume Coal Project															✓		✓					
212966	Individual - Unique	Individual	Supports	Hume Coal Project																						
212970	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
212972	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																	✓	
212977	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
212983	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
212985	Individual - Unique	Individual	Supports	Hume Coal Project																						
213016	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
213042	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓							✓					

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
213102	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213104	Individual - Unique	Individual	Objects	Hume Coal Project											✓				✓							✓
213106	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓		✓				✓	✓				✓	✓	✓			✓	✓	✓
213112	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓		✓					✓		✓					
213124	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓	✓					✓	✓	✓				
213151	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213159	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213161	Individual - Unique	Individual	Supports	Hume Coal Project																						
213167	Individual - Unique	Individual	Supports	Hume Coal Project																						
213176	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓		✓					✓	✓				✓		✓
213178	Individual - Unique	Individual	Supports	Hume Coal Project																						
213180	Individual - Unique	Individual	Objects	Hume Coal Project																✓	✓	✓				✓
213186	Individual - Unique	Individual	Supports	Hume Coal Project																						
213196	Individual - Unique	Individual	Supports	Hume Coal Project																						
213204	Individual - Unique	Individual	Supports	Hume Coal Project											✓		✓			✓						
213216	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213224	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213226	Individual - Unique	Individual	Objects	Hume Coal Project				✓		✓					✓			✓	✓						✓	✓
213228	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓					✓	✓		✓				✓
213232	Individual - Unique	Individual	Supports	Hume Coal Project																						
213238	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
213240	Individual - Unique	Individual	Supports	Hume Coal Project																						
213242	Individual - Unique	Individual	Supports	Hume Coal Project																					✓	
213248	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
213254	Individual - Unique	Individual	Supports	Hume Coal Project				✓																		
213262	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
213268	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213270	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213276	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213282	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
213286	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓			✓				
213292	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213294	Individual - Unique	Individual	Supports	Hume Coal Project				✓											✓	✓						
213298	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
213306	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
213308	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
213312	Individual - Unique	Individual	Supports	Hume Coal Project																					✓	
213316	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213323	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓	✓												
213325	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓									✓				✓	✓					✓	✓
213335	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓							
213338	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213342	Individual - Unique	Individual	Supports	Hume Coal Project											✓		✓		✓							
213348	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
213356	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213358	Individual - Unique	Individual	Supports	Hume Coal Project																					✓	✓
213364	Individual - Unique	Individual	Supports	Hume Coal Project							✓				✓											
213370	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
213375	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓	✓												
213393	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
213395	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213397	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
213401	Individual - Unique	Individual	Supports	Hume Coal Project												✓			✓	✓						
213405	Individual - Unique	Individual	Supports	Hume Coal Project									✓	✓	✓		✓		✓	✓						
213407	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓					✓	✓		✓			✓	
213411	Individual - Unique	Individual	Supports	Hume Coal Project	✓	✓														✓						✓
213415	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓			✓	✓		✓
213419	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓							
213431	Individual - Unique	Individual	Supports	Hume Coal Project											✓	✓			✓							
213433	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
213441	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213447	Individual - Unique	Individual	Supports	Hume Coal Project			✓	✓			✓			✓	✓			✓	✓	✓		✓				
213451	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓					✓					✓	✓		✓		✓		✓
213455	Individual - Unique	Individual	Supports	Hume Coal Project			✓				✓				✓	✓			✓	✓		✓	✓	✓		
213457	Individual - Unique	Individual	Objects	Hume Coal Project	✓																				✓	✓
213462	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓		✓				✓							
213465	Individual - Unique	Individual	Supports	Hume Coal Project											✓											
213469	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓		✓	✓		✓		✓		✓					✓
213473	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213475	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓									✓						✓
213479	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓		✓				✓		✓				✓
213481	Individual - Unique	Individual	Supports	Hume Coal Project																						
213485	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213489	Individual - Unique	Individual	Supports	Hume Coal Project											✓	✓			✓	✓						
213491	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
213493	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
213497	Individual - Unique	Individual	Objects	Hume Coal Project										✓								✓			✓	
213511	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓					✓	
213517	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
213537	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓								✓				
213539	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓			✓	✓	✓	✓	✓			✓	✓		✓		✓		
213547	Individual - Unique	Individual	Supports	Hume Coal Project																						
213549	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213551	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓	✓				✓	✓				✓							✓
213553	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓					✓	
213557	Individual - Unique	Individual	Supports	Hume Coal Project															✓						✓	
213563	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓												✓						
213569	Individual - Unique	Individual	Supports	Hume Coal Project																						
213573	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓					✓			✓				
213579	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓	✓	✓	✓									
213581	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓			✓	✓	✓		✓			✓	✓		✓				✓
213585	Individual - Unique	Individual	Objects	Hume Coal Project											✓				✓							✓
213587	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓						✓									✓
213589	Individual - Unique	Individual	Supports	Hume Coal Project	✓														✓	✓						
213593	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓			✓						✓	
213597	Individual - Unique	Individual	Objects	Hume Coal Project			✓									✓				✓						
213599	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓			✓												✓
213607	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓					✓			✓				
213609	Individual - Unique	Individual	Objects	Hume Coal Project											✓		✓									
213613	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓					✓			✓				

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
213615	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
213617	Individual - Unique	Individual	Objects	Hume Coal Project															✓	✓	✓					✓
213619	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓			✓					✓	✓						
213623	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓					✓			✓	✓						
213627	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓					✓	✓						
213629	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓		✓	✓	✓	✓		✓		✓					
213631	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓												
213633	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓		✓					✓					✓
213635	Individual - Unique	Individual	Objects	Hume Coal Project							✓								✓	✓		✓			✓	
213641	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						
213645	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓					✓	✓						✓
213651	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓												✓		✓				
213667	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓						✓					✓	
213669	Individual - Unique	Individual	Objects	Hume Coal Project												✓										
213680	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213688	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213690	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓														✓	
213692	Individual - Unique	Individual	Objects	Hume Coal Project							✓											✓				
213698	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓				✓				✓	✓	✓	✓				
213705	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓						✓			✓	✓	✓		✓				
213713	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓			✓		✓			✓				
213721	Individual - Unique	Individual	Comments	Hume Coal Project		✓		✓							✓											✓
213723	Individual - Unique	Individual	Objects	Hume Coal Project				✓																	✓	
213725	Individual - Unique	Individual	Supports	Hume Coal Project				✓					✓	✓	✓	✓	✓		✓	✓						
213727	Individual - Unique	Individual	Supports	Hume Coal Project	✓										✓					✓						✓
213729	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓		✓	✓					✓				
213731	Individual - Unique	Individual	Supports	Hume Coal Project	✓		✓	✓					✓	✓	✓				✓	✓						
213733	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
213735	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓					✓					✓	✓	✓			✓		✓
213739	Individual - Unique	Individual	Supports	Hume Coal Project													✓		✓	✓						✓
213743	Individual - Unique	Individual	Objects	Hume Coal Project													✓									✓
213745	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	
213747	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
213749	Individual - Unique	Individual	Supports	Hume Coal Project	✓															✓						
213753	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						✓
213756	Individual - Unique	Individual	Objects	Hume Coal Project								✓	✓	✓			✓			✓					✓	✓
213761	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓							
213765	Individual - Unique	Individual	Supports	Hume Coal Project																✓						✓
213767	Individual - Unique	Individual	Objects	Hume Coal Project												✓		✓	✓							✓
213769	Individual - Unique	Individual	Objects	Hume Coal Project				✓									✓					✓				✓
213773	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓						✓		✓							
213777	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																		✓
213795	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓																		✓	
213807	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓		✓	✓		✓	✓		✓	✓						✓
213813	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓															
213821	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓					✓		✓		✓				✓	✓			✓		✓
213823	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
213828	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓		✓	✓	✓	✓		✓	✓	✓			✓			✓
213830	Individual - Unique	Individual	Supports	Hume Coal Project	✓															✓						✓
213836	Individual - Unique	Individual	Objects	Hume Coal Project																						✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
213838	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓			✓					✓		✓	✓				
213839	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓							
213840	Individual - Unique	Individual	Objects	Hume Coal Project															✓							
213841	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
213842	Individual - Unique	Individual	Objects	Hume Coal Project												✓										
213843	Individual - Unique	Individual	Objects	Hume Coal Project										✓												
213844	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
213845	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓											✓	✓						✓
213847	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓	✓				✓	✓		✓				✓
213849	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓											✓			✓				
213853	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓		✓	✓	✓		✓				✓
213855	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
213875	Individual - Unique	Individual	Supports	Hume Coal Project	✓		✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓		✓		✓		✓
213879	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓							✓					✓				✓		
213881	Individual - Unique	Individual	Supports	Hume Coal Project	✓		✓	✓							✓											✓
213883	Individual - Unique	Individual	Supports	Hume Coal Project																						
213889	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
213898	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓								✓		✓			✓				
213904	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓				✓			✓				✓		✓		✓		✓	✓	✓
213906	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓			✓		✓	✓	✓					
213909	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓	✓	✓	✓		✓				✓		✓		✓		✓
213911	Individual - Unique	Individual	Supports	Hume Coal Project																						
213921	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓															
213925	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓						✓		✓		✓	✓	✓
213931	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓			✓	✓			✓				✓		✓
213934	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓				✓	✓		✓		✓		✓
213938	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓	✓				✓	✓	✓				✓	
213940	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓												✓					✓	
213942	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓	✓			✓	✓				✓	✓		✓		✓
213944	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓	✓				✓			✓				✓
213946	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓	✓									✓			✓	✓	✓				✓
213948	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓				✓							
213950	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓										✓	✓							
213956	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓	✓	✓				✓	✓					✓
213958	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓						✓		✓			✓				
213960	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓			✓	✓			✓	✓	✓	✓			✓	✓
213962	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓									✓	✓			✓	✓				✓		✓
213964	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
213968	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓			✓		✓			✓				
213970	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
213972	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
213980	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓							✓	✓			✓			✓				✓
213982	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓						✓	✓			✓			✓				✓
213984	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓					✓		✓	✓						
213990	Individual - Unique	Individual	Objects	Hume Coal Project					✓			✓		✓					✓			✓			✓	✓
213992	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓			✓									
213993	Individual - Unique	Individual	Objects	Hume Coal Project																✓						✓
213994	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
213996	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓			✓		✓						✓	
213998	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓	✓	✓	✓				✓	✓	✓	✓		✓		✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
214003	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓			✓				✓		✓					✓
214007	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓	✓				✓			✓			✓	
214011	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓			✓		✓							
214015	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			
214019	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓					✓			✓									✓
214021	Individual - Unique	Individual	Objects	Hume Coal Project				✓												✓						✓
214023	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓		✓											✓	✓	✓					✓
214027	Individual - Unique	Individual	Supports	Hume Coal Project																						
214031	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓						✓						
214042	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓										✓								
214046	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓						✓						
214052	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓					✓
214056	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214066	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓	✓	✓			✓		✓	✓		✓				✓
214068	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓					✓	✓						✓
214070	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓											✓						
214087	Individual - Unique	Individual	Objects	Hume Coal Project												✓			✓	✓		✓				✓
214093	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
214106	Individual - Unique	Individual	Objects	Hume Coal Project				✓							✓										✓	
214124	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓				✓	
214130	Individual - Unique	Individual	Objects	Hume Coal Project														✓								
214139	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214141	Individual - Unique	Individual	Objects	Hume Coal Project			✓												✓	✓					✓	
214143	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214145	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214147	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓			✓		✓							
214157	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓											✓				
214159	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓	✓	✓	✓					✓				✓
214161	Individual - Unique	Individual	Supports	Hume Coal Project																						
214163	Individual - Unique	Individual	Objects	Hume Coal Project														✓	✓		✓					
214165	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓	✓	✓	✓		✓		✓	✓		✓		✓		
214169	Individual - Unique	Individual	Objects	Hume Coal Project															✓							✓
214171	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
214173	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
214177	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓	✓					✓	✓		✓	✓		✓		✓	✓				✓
214179	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓					✓
214181	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓										✓		
214195	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
214197	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
214215	Individual - Unique	Individual	Supports	Hume Coal Project																						
214217	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓					✓		✓										
214219	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓								✓			✓	✓	✓	✓			✓	✓
214235	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓		✓	✓		✓	✓	✓		✓		✓	✓						✓
214239	Individual - Unique	Individual	Comments	Hume Coal Project															✓							✓
214243	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓			✓		✓	✓						✓
214251	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓	✓	✓		✓			✓	✓	✓	✓			✓	✓
214258	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
214260	Individual - Unique	Individual	Objects	Hume Coal Project															✓							
214262	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓		✓						✓				
214264	Individual - Unique	Individual	Objects	Hume Coal Project																						✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
214266	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓						✓						✓
214270	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																		
214272	Individual - Unique	Individual	Objects	Hume Coal Project															✓	✓						
214274	Individual - Unique	Individual	Supports	Hume Coal Project			✓	✓	✓				✓	✓	✓	✓				✓	✓					
214280	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓		✓										✓
214284	Individual - Unique	Individual	Supports	Hume Coal Project	✓														✓	✓		✓				
214290	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓		✓	✓	✓	✓			✓	✓	✓	✓		✓	✓	✓
214307	Individual - Unique	Individual	Supports	Hume Coal Project															✓							
214312	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓			✓					✓			✓				
214316	Individual - Unique	Individual	Comments	Hume Coal Project								✓			✓	✓			✓						✓	
214318	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓												
214324	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓			✓		✓	✓						
214326	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓		✓		✓			✓	✓		✓				✓
214328	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓		✓				✓						✓
214331	Individual - Unique	Individual	Supports	Hume Coal Project											✓				✓	✓						
214333	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓					✓	✓	✓		✓		✓	✓						
214337	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓											✓						✓
214339	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓									✓		✓			✓		✓		✓
214341	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓	✓									✓
214345	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓						✓
214347	Individual - Unique	Individual	Objects	Hume Coal Project		✓																				✓
214349	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓								✓			✓				✓
214355	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓					✓						✓	✓
214359	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
214367	Individual - Unique	Individual	Objects	Hume Coal Project	✓							✓							✓		✓	✓				✓
214373	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓		✓			✓			✓				✓
214379	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓			✓					✓							✓
214390	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓			✓												✓
214392	Individual - Unique	Individual	Supports	Hume Coal Project																						
214396	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓				✓			✓	✓				✓	✓	✓				✓	✓
214400	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓					✓	✓
214404	Individual - Unique	Individual	Objects	Hume Coal Project													✓					✓				
214406	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓					✓		✓											✓	✓
214408	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓		✓			✓	✓			✓		✓	✓		✓		✓	✓	✓
214412	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓					✓	✓						✓
214414	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓							✓			✓	✓			✓		✓	✓	✓
214420	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓		✓										✓
214422	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓						✓	✓	✓				
214424	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓							✓	✓				✓
214430	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓				✓		✓		✓			✓				✓
214432	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓					✓	✓						✓
214436	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓		✓	✓			✓	✓	✓				
214438	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓					✓
214440	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓								✓	✓								✓	
214444	Individual - Unique	Individual	Objects	Hume Coal Project	✓									✓												✓
214450	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
214456	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓					✓		✓			✓	✓	✓	✓			✓	✓
214458	Individual - Unique	Individual	Supports	Hume Coal Project																						✓
214462	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					✓
214470	Individual - Unique	Individual	Objects	Hume Coal Project															✓			✓				✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
214472	Individual - Unique	Individual	Objects	Hume Coal Project								✓					✓					✓				✓
214474	Individual - Unique	Individual	Supports	Hume Coal Project																						
214476	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓								✓	✓	✓	✓		✓		✓
214478	Individual - Unique	Individual	Objects	Hume Coal Project				✓														✓				✓
214482	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓			✓				✓	✓				✓		✓
214484	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓						✓						✓	✓
214486	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
214492	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓					✓	✓			✓		✓	✓
214494	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓	✓				✓			✓				
214496	Individual - Unique	Individual	Objects	Hume Coal Project								✓		✓					✓	✓						✓
214498	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓		✓			✓	✓		✓			✓	✓
214500	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓					✓			✓				✓
214502	Individual - Unique	Individual	Objects	Hume Coal Project										✓												✓
214504	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓		✓				✓	✓	✓						✓						✓
214510	Individual - Unique	Individual	Comments	Hume Coal Project																						✓
214512	Individual - Unique	Individual	Objects	Hume Coal Project								✓										✓				✓
214516	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓			✓			✓	✓	✓				
214518	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓							✓	✓					✓	✓
214521	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓		✓	✓									
214533	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓												✓
214539	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓			✓	✓	✓		✓	✓						✓
214541	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓					✓	✓		✓			✓	✓
214546	Individual - Unique	Individual	Objects	Hume Coal Project				✓												✓		✓				✓
214548	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓								✓	✓	✓					✓
214550	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
214552	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓			✓	✓				✓	✓		✓		✓		✓
214554	Individual - Unique	Individual	Supports	Hume Coal Project																						
214560	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
214568	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
214577	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓			✓								✓	✓					✓
214581	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓	✓	✓			✓	✓	✓	✓		✓		✓
214585	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓			✓		✓	✓						
214587	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓															
214589	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓		✓						✓				✓
214593	Individual - Unique	Individual	Objects	Hume Coal Project	✓																	✓		✓		✓
214595	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓		✓				✓					✓	✓
214597	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓		✓	✓					✓		✓					✓
214599	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓							✓		✓	✓		✓		✓	✓
214601	Individual - Unique	Individual	Objects	Hume Coal Project	✓																	✓				✓
214607	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓				✓	✓						✓						✓
214609	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓				✓								✓	✓					✓	✓
214612	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
214618	Individual - Unique	Individual	Supports	Hume Coal Project				✓			✓	✓			✓	✓			✓	✓			✓	✓		
214622	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓															
214629	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓		✓										✓
214636	Individual - Unique	Individual	Objects	Hume Coal Project												✓						✓				✓
214646	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓						✓						✓
214648	Individual - Unique	Individual	Supports	Hume Coal Project		✓	✓	✓					✓	✓	✓				✓	✓					✓	✓
214662	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214664	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓						✓	✓				✓	

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
214668	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓	✓		✓						✓	✓	✓				✓
214670	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓			✓		✓	✓						✓
214674	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
214680	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓							✓
214688	Individual - Unique	Individual	Objects	Hume Coal Project							✓											✓			✓	✓
214692	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214698	Individual - Unique	Individual	Objects	Hume Coal Project		✓		✓			✓			✓		✓			✓	✓	✓	✓			✓	✓
214700	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓		✓	✓					✓	✓	✓	✓			✓	
214702	Individual - Unique	Individual	Objects	Hume Coal Project	✓						✓								✓			✓			✓	✓
214712	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓	✓		✓			✓				✓	✓				✓
214720	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓												✓							✓
214722	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓		✓		✓		✓	✓	✓	✓			✓	✓
214724	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓				✓	✓	✓	✓			✓	✓	✓	✓				✓
214728	Individual - Unique	Individual	Objects	Hume Coal Project															✓	✓	✓					✓
214730	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓					✓	✓						✓					✓	✓
214732	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓	✓	✓		✓	✓			✓		✓		✓		✓
214736	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓			✓				
214740	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓									✓		✓	✓					✓	✓
214742	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓			✓			✓	✓	✓		✓				✓
214746	Individual - Unique	Individual	Supports	Hume Coal Project	✓			✓					✓				✓									
214748	Individual - Unique	Individual	Objects	Hume Coal Project				✓												✓						
214752	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓		✓			✓			✓			✓	
214756	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓						✓			✓					✓				
214758	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
214760	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓		✓
214764	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
214766	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓								✓		✓				✓	✓
214769	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓				✓	✓	✓	✓	✓		✓	✓				✓	✓	✓
214772	Individual - Unique	Individual	Objects	Hume Coal Project	✓	✓	✓	✓												✓	✓	✓			✓	✓
214774	Individual - Unique	Individual	Objects	Hume Coal Project													✓								✓	✓
214780	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓						✓				✓	✓	✓	✓		✓	✓	
214782	Individual - Unique	Individual	Objects	Hume Coal Project		✓						✓			✓				✓	✓						✓
214794	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓				✓		✓			✓				
214798	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓			✓			✓						
214800	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓					✓		✓	✓			✓	
214806	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓	✓	✓					✓			✓			✓	
214808	Individual - Unique	Individual	Objects	Hume Coal Project				✓												✓	✓					
214810	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓						✓					✓						✓
214812	Individual - Unique	Individual	Objects	Hume Coal Project	✓							✓					✓		✓							✓
214814	Individual - Unique	Individual	Objects	Hume Coal Project									✓													
214818	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓			✓		✓			✓		✓			✓	✓
214822	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓						✓	✓					✓
214826	Individual - Unique	Individual	Objects	Hume Coal Project	✓							✓					✓		✓	✓	✓	✓				
214828	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓			✓		✓							
214830	Individual - Unique	Individual	Objects	Hume Coal Project				✓														✓		✓		
214832	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓		✓	✓			✓	✓			✓		✓
214840	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓	✓		✓				✓							✓			✓	✓
214842	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓		✓			✓			✓			✓	
214844	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓		✓			✓	✓	✓	✓				
214846	Individual - Unique	Individual	Objects	Hume Coal Project	✓												✓					✓				✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
214848	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓				✓		
214858	Individual - Unique	Individual	Objects	Hume Coal Project		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓				✓	✓
214860	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓					✓			✓			✓	
214862	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓								✓				
214864	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓	✓	✓				✓			✓	✓	✓		✓	✓	✓
214868	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓								✓						✓
214870	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓								✓										
214872	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓					✓		✓	✓				
214874	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214878	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓	✓	✓				✓
214880	Individual - Unique	Individual	Objects	Hume Coal Project															✓			✓			✓	✓
214884	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓	✓	✓	✓				✓	✓				✓	✓	✓
214888	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓		✓			✓		✓	✓		✓	✓	✓	✓		✓		✓
214890	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
214896	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓			✓				✓					✓						
214898	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓			✓	✓	✓	✓				✓	✓	✓			✓		✓
215029	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓											
215033	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓		✓		✓			✓		✓					✓
215044	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓	✓	✓			✓	✓					✓	✓
215048	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215050	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					
215054	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓		✓										
215060	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓										✓		✓					✓
215062	Individual - Unique	Individual	Objects	Hume Coal Project				✓												✓	✓					
215066	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓				✓											✓
215068	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓				✓	✓			✓				
215070	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓										
215076	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓							✓				✓	✓	✓				
215078	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓	✓		✓		✓	✓						✓
215080	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓				✓		✓					✓	✓		✓				✓
215082	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓				✓	✓						✓	
215084	Individual - Unique	Individual	Supports	Hume Coal Project			✓	✓					✓	✓	✓		✓		✓	✓						✓
215088	Individual - Unique	Individual	Objects	Hume Coal Project			✓						✓	✓		✓			✓							
215105	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓							✓											
215396	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
215398	Individual - Unique	Individual	Supports	Hume Coal Project															✓	✓						✓
215400	Individual - Unique	Individual	Supports	Hume Coal Project																						
215402	Individual - Unique	Individual	Supports	Hume Coal Project											✓					✓						
215404	Individual - Unique	Individual	Supports	Hume Coal Project																						
215408	Individual - Unique	Individual	Supports	Hume Coal Project																						
215410	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
215413	Individual - Unique	Individual	Supports	Hume Coal Project																						
215417	Individual - Unique	Individual	Supports	Hume Coal Project																						
215419	Individual - Unique	Individual	Supports	Hume Coal Project																						
215425	Individual - Unique	Individual	Supports	Hume Coal Project																						
215427	Individual - Unique	Individual	Supports	Hume Coal Project																						
215435	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓			✓		✓					✓
215437	Individual - Unique	Individual	Supports	Hume Coal Project																						
215439	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓														
215445	Individual - Unique	Individual	Objects	Hume Coal Project				✓																	✓	✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
215465	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215467	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓		✓					✓	✓	✓					✓
215471	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓		✓						✓							✓
215473	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			
215514	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓			✓		✓							
215516	Individual - Unique	Individual	Objects	Hume Coal Project																		✓				
215518	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓					✓		✓	✓		✓		✓					
215577	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215579	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
215581	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215583	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215587	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215589	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215591	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215593	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215595	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215597	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓					
215599	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215601	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓					✓			✓				
215603	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215605	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓					✓			✓				
215607	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215611	Individual - Unique	Individual	Objects	Hume Coal Project																✓	✓	✓				✓
215613	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215615	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓												✓						
215617	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			✓
215619	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓	✓						
215621	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215625	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓		✓						✓					
215627	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215631	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215637	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215639	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215641	Individual - Unique	Individual	Objects	Hume Coal Project				✓								✓			✓	✓	✓					
215643	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215649	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓									✓						
215651	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215653	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
215655	Individual - Unique	Individual	Objects	Hume Coal Project										✓				✓								
215657	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215661	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215663	Individual - Unique	Individual	Supports	Hume Coal Project																						
215665	Individual - Unique	Individual	Objects	Hume Coal Project																		✓				✓
215667	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓		✓										
215669	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215673	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓					
215675	Individual - Unique	Individual	Objects	Hume Coal Project				✓																	✓	✓
215677	Individual - Unique	Individual	Objects	Hume Coal Project										✓												✓
215679	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215683	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
215685	Individual - Unique	Individual	Objects	Hume Coal Project			✓								✓											
215687	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215689	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215691	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215693	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215695	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215697	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓																	
215699	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓													✓
215701	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓				✓	✓			✓									
215703	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓										✓	✓			✓				
215705	Individual - Unique	Individual	Objects	Hume Coal Project										✓					✓			✓				
215707	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓												
215709	Individual - Unique	Individual	Objects	Hume Coal Project										✓							✓					✓
215711	Individual - Unique	Individual	Objects	Hume Coal Project									✓		✓											
215713	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
215715	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓														
215717	Individual - Unique	Individual	Objects	Hume Coal Project				✓											✓		✓					
215719	Individual - Unique	Individual	Objects	Hume Coal Project																✓						
215724	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓	✓	✓			✓		✓		✓					
215756	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215760	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215762	Individual - Unique	Individual	Objects	Hume Coal Project									✓	✓		✓	✓		✓							✓
215764	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓	✓	✓	✓		✓	✓		✓				✓
215766	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓		✓	✓							
215770	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓						✓		✓				✓
215772	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓			✓							✓		✓
215774	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓			✓									✓
215776	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓					✓							✓
215778	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓									✓	✓	✓		✓					✓
215780	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓			✓		✓							✓
215782	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓								✓				✓
215784	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓		✓		✓	✓						✓	
215786	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓	✓		✓		✓	✓	✓	✓				✓
215788	Individual - Unique	Individual	Objects	Hume Coal Project		✓		✓					✓	✓	✓		✓		✓	✓		✓			✓	✓
215794	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓					✓	✓	✓				✓		✓					
215798	Individual - Unique	Individual	Objects	Hume Coal Project			✓														✓					
215800	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓					✓	✓		✓						✓				
215803	Individual - Unique	Individual	Supports	Hume Coal Project												✓										
215805	Individual - Unique	Individual	Supports	Hume Coal Project																						
215807	Individual - Unique	Individual	Supports	Hume Coal Project																						
215813	Individual - Unique	Individual	Supports	Hume Coal Project																						
215827	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215829	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215833	Individual - Unique	Individual	Objects	Hume Coal Project							✓											✓				✓
215835	Individual - Unique	Individual	Objects	Hume Coal Project	✓																				✓	✓
215839	Individual - Unique	Individual	Objects	Hume Coal Project							✓	✓														✓
215844	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215846	Individual - Unique	Individual	Objects	Hume Coal Project	✓																				✓	✓
215848	Individual - Unique	Individual	Objects	Hume Coal Project															✓						✓	✓
215852	Individual - Unique	Individual	Objects	Hume Coal Project													✓									✓

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
215854	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215857	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215859	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215861	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215866	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215868	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓															✓
215876	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215880	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215882	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215884	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215888	Individual - Unique	Individual	Objects	Hume Coal Project											✓											✓
215890	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			✓
215892	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215894	Individual - Unique	Individual	Objects	Hume Coal Project				✓				✓														✓
215896	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓								✓							✓
215898	Individual - Unique	Individual	Objects	Hume Coal Project			✓								✓											✓
215900	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215904	Individual - Unique	Individual	Objects	Hume Coal Project	✓																					✓
215906	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215908	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215910	Individual - Unique	Individual	Objects	Hume Coal Project			✓																			✓
215912	Individual - Unique	Individual	Objects	Hume Coal Project								✓														✓
215914	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215918	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215920	Individual - Unique	Individual	Objects	Hume Coal Project																					✓	✓
215922	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓									✓					✓
215924	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215926	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215930	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215933	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215938	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓							✓							✓
215940	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
215942	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓			✓												✓
215982	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓				✓		✓	✓	✓		✓	✓						✓
216014	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓	✓	✓	✓	✓			✓	✓			✓	✓		✓				✓
216195	Individual - Unique	Individual	Objects	Hume Coal Project			✓				✓		✓		✓	✓	✓		✓	✓						✓
216199	Individual - Unique	Individual	Supports	Hume Coal Project		✓									✓				✓	✓						✓
216201	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓					✓		
216205	Individual - Unique	Individual	Objects	Hume Coal Project				✓	✓					✓					✓							✓
216257	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓				✓														✓
216266	Individual - Unique	Individual	Objects	Hume Coal Project							✓		✓	✓		✓				✓						
216612	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓						✓	✓	✓		✓	✓		✓				✓	
216616	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓			✓						✓					✓
216618	Individual - Unique	Individual	Objects	Hume Coal Project																✓						✓
216622	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
216624	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
216632	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
216634	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
216636	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓												✓						
216642	Individual - Unique	Individual	Supports	Hume Coal Project																						

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
216644	Individual - Unique	Individual	Objects	Hume Coal Project																	✓					✓
216648	Individual - Unique	Individual	Supports	Hume Coal Project																✓						
216650	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓	✓							✓					✓		
216652	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		
216654	Individual - Unique	Individual	Objects	Hume Coal Project	✓			✓							✓	✓	✓	✓	✓							✓
216660	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓	✓	✓						✓				
216666	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓			✓		✓	✓					✓		✓	✓				✓
216668	Individual - Unique	Individual	Objects	Hume Coal Project			✓							✓			✓		✓					✓		
216670	Individual - Unique	Individual	Objects	Hume Coal Project				✓			✓															✓
216672	Individual - Unique	Individual	Objects	Hume Coal Project				✓							✓				✓	✓						✓
216676	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓					✓							
216679	Individual - Unique	Individual	Objects	Hume Coal Project													✓									
216681	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																		
216687	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓																		
216690	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓						✓	✓			✓	✓	✓	✓	✓				
216696	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	
216702	Individual - Unique	Individual	Objects	Hume Coal Project			✓					✓	✓	✓								✓			✓	✓
216744	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓				✓		✓			✓		✓	✓	✓					✓
216746	Individual - Unique	Individual	Objects	Hume Coal Project				✓					✓	✓		✓	✓		✓					✓		✓
216759	Individual - Unique	Individual	Objects	Hume Coal Project																				✓		
216763	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
216783	Individual - Unique	Individual	Objects	Hume Coal Project				✓						✓		✓										
216785	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
216832	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
218833	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓			✓	✓	✓	✓	✓				✓		✓	✓		✓	
Anon - 1	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓						✓	✓			✓				✓					
Anon - 2	Individual - Unique	Individual	Objects	Hume Coal Project																						✓
Anon - 3	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓													✓	✓			✓	✓
Anon - 4	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓																		
Anon - 5	Individual - Unique	Individual	Objects	Hume Coal Project			✓	✓	✓										✓		✓	✓				✓
Anon - 6	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓						✓	✓	✓	✓		✓	✓				✓			
Anon - 7	Individual - Unique	Individual	Objects	Hume Coal Project	✓		✓	✓			✓	✓		✓					✓							
None	Individual - Unique	Individual	Objects	Hume Coal Project				✓																		✓
216771	Individual - Unique	Individual	Objects	Berrima Rail Project												✓					✓					✓
214657	Individual - Unique	Individual	Objects	Berrima Rail Project												✓				✓						✓
213477	Individual - Unique	Individual	Supports	Berrima Rail Project												✓										
213163	Individual - Unique	Individual	Supports	Berrima Rail Project																						
215477	Individual - Unique	Individual	Supports	Berrima Rail Project											✓				✓	✓						
215819	Individual - Unique	Individual	Supports	Berrima Rail Project																						
215506	Individual - Unique	Individual	Supports	Berrima Rail Project																						
215487	Individual - Unique	Individual	Supports	Berrima Rail Project																✓						
198175	Individual - Unique	Individual	Supports	Berrima Rail Project												✓			✓							
213250	Individual - Unique	Individual	Supports	Berrima Rail Project																						
211826	Individual - Unique	Individual	Supports	Berrima Rail Project												✓										
214227	Individual - Unique	Individual	Supports	Berrima Rail Project												✓										✓
213314	Individual - Unique	Individual	Supports	Berrima Rail Project																						✓
212430	Individual - Unique	Individual	Supports	Berrima Rail Project											✓				✓							
214361	Individual - Unique	Individual	Supports	Berrima Rail Project																✓						
214633	Individual - Unique	Individual	Objects	Berrima Rail Project	✓			✓						✓												✓
204935	Individual - Unique	Individual	Supports	Berrima Rail Project												✓			✓							

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
211853	Individual - Unique	Individual	Supports	Berrima Rail Project				✓									✓		✓	✓						✓
202487	Individual - Unique	Individual	Supports	Berrima Rail Project																						
199266	Individual - Unique	Individual	Supports	Berrima Rail Project																						
201971	Individual - Unique	Individual	Supports	Berrima Rail Project									✓			✓										
214231	Individual - Unique	Individual	Supports	Berrima Rail Project												✓										
213300	Individual - Unique	Individual	Supports	Berrima Rail Project								✓														
211045	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										
213331	Individual - Unique	Individual	Supports	Berrima Rail Project									✓			✓										
211855	Individual - Unique	Individual	Supports	Berrima Rail Project																✓						
215524	Individual - Unique	Individual	Objects	Berrima Rail Project																						✓
216658	Individual - Unique	Individual	Objects	Berrima Rail Project																						✓
202083	Individual - Unique	Individual	Supports	Berrima Rail Project																						
207896	Individual - Unique	Individual	Objects	Berrima Rail Project				✓			✓		✓	✓		✓			✓	✓	✓	✓				✓
211043	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										
211218	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
211505	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓	✓	✓										
211743	Individual - Unique	Individual	Objects	Berrima Rail Project										✓		✓			✓		✓					✓
212169	Individual - Unique	Individual	Objects	Berrima Rail Project										✓		✓			✓	✓	✓					
212171	Individual - Unique	Individual	Objects	Berrima Rail Project	✓								✓			✓	✓		✓		✓					✓
212360	Individual - Unique	Individual	Objects	Berrima Rail Project												✓			✓	✓						
212378	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
212798	Individual - Unique	Individual	Objects	Berrima Rail Project									✓				✓			✓		✓				
212819	Individual - Unique	Individual	Objects	Berrima Rail Project								✓				✓				✓	✓	✓				
212867	Individual - Unique	Individual	Objects	Berrima Rail Project										✓		✓	✓			✓		✓				
213377	Individual - Unique	Individual	Objects	Berrima Rail Project									✓			✓					✓					✓
213541	Individual - Unique	Individual	Objects	Berrima Rail Project												✓			✓							
213913	Individual - Unique	Individual	Objects	Berrima Rail Project	✓							✓				✓				✓	✓	✓				✓
213936	Individual - Unique	Individual	Objects	Berrima Rail Project	✓									✓		✓					✓				✓	✓
214113	Individual - Unique	Individual	Objects	Berrima Rail Project									✓			✓					✓					✓
214175	Individual - Unique	Individual	Objects	Berrima Rail Project	✓		✓	✓					✓	✓			✓		✓	✓	✓					✓
214183	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
214343	Individual - Unique	Individual	Objects	Berrima Rail Project	✓											✓										✓
214428	Individual - Unique	Individual	Objects	Berrima Rail Project									✓			✓										✓
214490	Individual - Unique	Individual	Objects	Berrima Rail Project								✓														✓
214834	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										✓
214836	Individual - Unique	Individual	Objects	Berrima Rail Project									✓			✓	✓			✓						
214838	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓												
214856	Individual - Unique	Individual	Objects	Berrima Rail Project	✓								✓	✓		✓			✓	✓						✓
214866	Individual - Unique	Individual	Objects	Berrima Rail Project																						✓
215095	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
215451	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓	✓		✓	✓	✓				✓	✓
215461	Individual - Unique	Individual	Objects	Berrima Rail Project															✓	✓		✓				✓
215500	Individual - Unique	Individual	Supports	Berrima Rail Project																						
215531	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓	✓									✓
215535	Individual - Unique	Individual	Objects	Berrima Rail Project									✓			✓										
215537	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
215539	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										✓
215541	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
215543	Individual - Unique	Individual	Objects	Berrima Rail Project										✓		✓										
215549	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										

DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
216207	Individual - Unique	Individual	Objects	Berrima Rail Project			✓						✓	✓		✓	✓		✓							
216249	Individual - Unique	Individual	Objects	Berrima Rail Project				✓					✓	✓					✓							✓
216251	Individual - Unique	Individual	Objects	Berrima Rail Project				✓					✓	✓	✓		✓		✓	✓		✓			✓	✓
218805	Individual - Unique	Individual	Objects	Berrima Rail Project	✓									✓	✓		✓		✓					✓	✓	✓
198161	Individual - Unique	Individual	Supports	Berrima Rail Project												✓			✓							
211039	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
211332	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										
211785	Individual - Unique	Individual	Supports	Berrima Rail Project				✓											✓	✓						✓
212151	Individual - Unique	Individual	Objects	Berrima Rail Project							✓					✓										
212423	Individual - Unique	Individual	Objects	Berrima Rail Project												✓				✓	✓					✓
212434	Individual - Unique	Individual	Objects	Berrima Rail Project	✓									✓		✓										✓
213272	Individual - Unique	Individual	Supports	Berrima Rail Project												✓										✓
213310	Individual - Unique	Individual	Supports	Berrima Rail Project																						
213583	Individual - Unique	Individual	Objects	Berrima Rail Project	✓											✓	✓				✓					
213621	Individual - Unique	Individual	Objects	Berrima Rail Project			✓				✓		✓			✓					✓	✓				✓
213637	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										✓
213919	Individual - Unique	Individual	Objects	Berrima Rail Project																						✓
214155	Individual - Unique	Individual	Objects	Berrima Rail Project												✓										
214384	Individual - Unique	Individual	Objects	Berrima Rail Project									✓	✓		✓										
214466	Individual - Unique	Individual	Objects	Berrima Rail Project	✓															✓		✓				✓
214666	Individual - Unique	Individual	Objects	Berrima Rail Project	✓			✓					✓	✓						✓	✓				✓	✓
214676	Individual - Unique	Individual	Objects	Berrima Rail Project																	✓					✓
214716	Individual - Unique	Individual	Objects	Berrima Rail Project	✓								✓	✓		✓					✓					✓
201120	Individual - Unique	Individual	Supports	Berrima Rail Project												✓			✓							
201485	Individual - Unique	Individual	Supports	Berrima Rail Project												✓			✓							
213302	Individual - Unique	Individual	Supports	Berrima Rail Project											✓				✓							
213483	Individual - Unique	Individual	Supports	Berrima Rail Project																						
214603	Individual - Unique	Individual	Supports	Berrima Rail Project	✓										✓				✓	✓						
214778	Individual - Unique	Individual	Supports	Berrima Rail Project															✓	✓						
214882	Individual - Unique	Individual	Objects	Berrima Rail Project															✓	✓					✓	
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DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
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DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
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DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
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DPE Identification Number	Type	Submitter	Objects/Supports	Hume Coal Project or Berrima Coal Project	Legislation, planning instruments and policies	Stakeholder engagement and community outreach	Surface water	Groundwater	Rejects management	Water licensing	Agriculture, land and soil resources	Biodiversity	Noise and vibration	Air quality	Mine design and geology	Traffic and transport	Visual amenity	Closure and rehabilitation	Economic assessment	Social assessment	Health	Tourism	Aboriginal heritage	European heritage	Greenhouse gas	Other matters
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Appendix 2

Hume Coal Project
Revised Water Assessment
– Main report
– Appendices A to C

Hume Coal Project

Response to Submissions | Appendix 2|
Revised Water Impact Assessment Report
Prepared for Hume Coal Pty Limited | 27 June 2018

Hume Coal Project

Response to Submissions | Appendix 2|

Revised Water Impact Assessment Report

Prepared for Hume Coal Pty Limited | 27 June 2018

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Hume Coal Project

Final

Report J14136RP2 | Prepared for Hume Coal Pty Limited |27 June 2018

Prepared by	**Nicola Fry**	Approved by	**Liz Webb**
Position	Associate Hydrogeologist	Position	Associate Director
Signature		Signature	
Date	27 June 2018	Date	27 June 2018

Document Control

Version	Date	Prepared by	Reviewed by
1	27/6/2018	Nicola Fry	Liz Webb

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Executive Summary

ES1 Assessment overview

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate an underground coal mine and associated mine infrastructure (the 'project’) in the Southern Coalfield of New South Wales (NSW). This water assessment report forms part of the *Hume Coal Project Response to Submissions* (EMM 2018), and replaces the Water Assessment prepared for the Hume Coal Project EIS (EMM 2017a). The revised water assessment is required as it addresses rework associated as a result of submissions on the original EIS. Hume Coal Project under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The report documents the groundwater and surface water assessment methods and results, the initiatives built into the project design to avoid and minimise water associated impacts, and the additional mitigation and management measures proposed to address residual effects unable to be avoided. The assessment also considered in great detail the uncertainty associated with the water resources of the greater area, and natural climatic variability. The assessment has been made in accordance with relevant NSW and Commonwealth guidelines and the Environmental Assessment Requirements (SEARs) issued by the Secretary of the NSW Department of Planning and Environment (DPE) for the Hume Coal Project (the project) and supplementary SEARs both issued on 20 August 2015.

The water assessment was undertaken by a team of leading specialists and a number of technical reports that have been appended for reference to this document, namely:

- the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) (Appendix D), which contains:
  - the revised water balance and the EIS *Hume Coal Project Water Balance* report (WSP PB 2016a) as Appendix A;
  - the revised flow assessment and the EIS H*ume Coal Project Surface Water Flow and Geomorphology Assessment* report (WSP PB 2016c) as Appendix B;
  - the revised surface water quality assessment and the EIS *Hume Coal Project Surface Water Quality Assessment* report (WSP PB 2016b) as Appendix C;
  - the EIS *Hume Coal Project Flooding Assessment* report (WSP PB 2016d) as Appendix D; and
  - the *Berrima Rail Project EIS Surface Water Assessment* (WSP PB 2016f) as Appendix E.
- the *Hume Coal Project Revised Groundwater Modelling* report (HydroSimulations 2018) (Appendix F), which contains:
  - the *Hume Coal Project Groundwater Assessment Volume 1: Data Analysis* (Coffey 2016a) within Appendix E; and
  - the *Hume Coal Project Groundwater Assessment Volume 2: Numerical Modelling and Impact Assessment* report (Coffey 2016b) as Appendix F.
- the EIS *Hume Coal Project Hydrogeochemical Assessment* report (Geosyntec 2016) (Appendix I).

- the *Hume Coal Project Hydrogeochemical Modelling Assessment* report (RGS 2018) (Appendix J).

The proposed project life is 23 years, with active mining occurring over 19 years. Hume Coal has adopted a number of leading practices in mine design such that it will minimise impacts to water assets. Extensive technical investigations have taken place over several years to develop and refine the project, and arrive at the proposed design. The key leading practices adopted to minimise impacts to water resources and related assets are:

- innovative and tailored non-caving mine design (resulting in imperceptible levels of subsidence or damage to the overlying Hawkesbury Sandstone);

- underground emplacement of reject (which removes the need for permanent surface stockpiles); and

- sealing mined panels, and filling with water (which allows groundwater to recover more rapidly).

The project area is in a semi-rural setting, with the wider region characterised by grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns, industrial activities such as the Berrima Cement Works and Inghams Berrima Feed Mill, some extractive industry and major transport infrastructure such as the Hume Highway.

There is a long history of mining in the Southern Coalfield, including mining for coal, iron ore, bauxite, gold, diamonds, shale, sand, clay and kerosene shale. There is also a history of hard rock quarrying in the area, including basalt quarries at Exeter and Mount Gingenbullen as well as the heritage-listed dimension stone quarry at Mount Gibraltar. Mining still occurs at various locations within Wingecarribee Shire local government area (LGA), including the Dendrobium longwall coal mine in the shire's north-east. Deposits of potentially commercial bauxite are known to occur in the south of the shire.

The project is within the Southern Coalfield of the sedimentary Permo-Triassic Sydney Basin. The Triassic Ashfield Shale outcrops over much of the eastern part of the project area while the Triassic Hawkesbury Sandstone outcrops over much of the western part (Moffit 1999). Mining is proposed in the Wongawilli Coal Seam of the Permian Illawarra Coal Measures which directly and unconformably underlie the Hawkesbury Sandstone in the project area.

ES2 Water resources

The surface water and groundwater sources near the project area are within water sharing plans and therefore most aspects of project water management come under the *Water Management Act 2000*. However, licensing monitoring bores is regulated under the *Water Act 1912*.

The project area and A349 are mostly within the Wingecarribee River catchment of the Upper Nepean and Upstream Warragamba Water Source, which is managed under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. A small portion of the south-east corner of A349 is within the Bundanoon Creek catchment, a sub-catchment of the Shoalhaven River catchment (WSP PB 2016c), and this is still managed under the same water sharing plan.

The groundwater resources of the project area are within Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source, which is managed under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

The project area is traversed by several drainage lines all of which ultimately discharge to the Wingecarribee River, at least 5 km downstream of the project area. The Wingecarribee River's catchment forms part of the broader Warragamba Dam and Hawkesbury-Nepean River catchments, which supply water to Sydney. Most local drainage lines are classified as 'confined valley setting with occasional floodplain', under the River Styles Framework.

The groundwater units within the project area are defined as:

- localised low permeability groundwater systems associated with the Robertson Basalt and Wianamatta Group shales;
- regional porous fractured rock groundwater system located in the Hawkesbury Sandstone; and
- localised water bearing zones associated with the Illawarra Coal Measures and the Shoalhaven Group.

The Hawkesbury Sandstone is the main groundwater bearing unit used for water resources in the project area. Groundwater within the Hawkesbury Sandstone is generally fresh with varying bore yields (the median bore yield of registered bores in the area is 2 L/sec).

Streams in the area are mostly 'gaining' streams with groundwater providing stream baseflows. Recharge to the groundwater system is via rainfall infiltration. Lateral groundwater flow dominates with regional flow influenced by the regional topography (ie incised streams to the north-west) and the general dip of the strata to the east. Faults and igneous intrusions can operate as both barriers and conduits to flow on a local scale; however, they do not appear to influence groundwater flow on a regional scale.

Water quality is mostly good in both groundwater and surface water systems. Surface water is generally fresh, but has elevated salinity when associated with the shale geology. Elevated nutrients are associated with agricultural practices and town effluent discharges, and elevated metals are associated with the geology, which is naturally high in some metals such as iron and manganese. Medway Dam is prone to algal blooms as a result of the high nutrient loads. Groundwater is relatively fresh in the Hawkesbury Sandstone and Illawarra Coal Measures and mostly comparable to surface water. The shale geology hosts brackish groundwater remnant from the marine depositional setting.

ES3 Mining methods and water management

A non-caving mining layout will be adopted, with mining occurring sequentially in panels that are separated from each other by solid barriers of unmined coal. The proposed method is low impact with negligible surface and subsurface subsidence impacts, and minimal overburden fracturing. Once mined, the open voids will be used for the emplacement of reject materials left over from washing raw coal.

After mining is complete, each panel will be sealed with an impermeable bulkhead and water will be allowed to flow into the sealed panels, resulting in a decreased volume of groundwater inflow to the workings and faster recovery post-mining. Once mining ceases (end of year 19) groundwater inflow to the void is expected to continue for two to five years (ie until all panels are full at the end of year 24) (HydroSimulations 2018). Water in the void will be part of the greater groundwater source and will be available for others to use.

The water management objectives are to minimise disturbance to water resources; runoff will be diverted from undisturbed areas, collected and reused, and releases minimised. This will be achieved via a series of mine water dams and stormwater basins. Water supply for the project will be fully self-contained by using:

- rainfall-runoff stored in the mine water dams;
- groundwater collected in the underground mine sump (where groundwater inflow to underground workings will be captured); and
- when required, groundwater will be extracted from behind the sealed mine void bulkheads.

The volume of water required to be licensed for the project is defined within the Aquifer Interference Policy (NOW 2012) as the groundwater inflow to the sump that is physically extracted, plus the groundwater inflow to the void, even though the majority of the groundwater in the void remains physically within the groundwater source, and the resulting flux of water from adjacent water sources.

Based on the numerical groundwater model (HydroSimulations 2018) and the water balance model (WSP 2018) results, the maximum volume required for licensing is 2,093 ML. Hume Coal has already secured in 93% of the total licence requirement for the project, and has a clear pathway for how the remaining licence volume will be secured so that all water taken is adequately licensed.

ES4 Monitoring network

A comprehensive water monitoring network has been designed and implemented to establish comprehensive baseline data for the project. The surface water monitoring network measures hydrologic conditions in the project area, providing over six years of baseline data (2012–2018, inclusive) across 11 streamflow gauging locations and 24 water quality monitoring locations.

Over five years of baseline hydrogeological data have been collected at 54 groundwater monitoring bores at 22 locations, 11 vibrating wire piezometer sensors at three locations, and three landholder bores. The network was developed in consultation with the NSW Department of Primary Industries (DPI) Water (formerly NSW Office of Water) and documented in the Hume Coal Project Groundwater Monitoring and Modelling Plan (EMM 2017b).

A diverse range of hydraulic tests have been made to provide site-specific information on the hydraulic properties of the groundwater systems, including rising and falling head tests (slug tests), packer tests, laboratory core permeability tests and constant rate pumping tests (WSP PB 2016e).

There are no identified high-priority groundwater dependent ecosystems (GDEs) within or proximate to the project area. Stygofauna sampling assessed 19 groundwater monitoring bores (eight within the project area and 11 outside of the project area) in 2013 and 2014 (EMM 2017c), and no rare or significant stygofauna was found. Stygofauna are fauna that live in underground water. They are mainly crustaceans but include worms, snails, insects, other invertebrate groups, and, in Australia, two species of blind fish. Most species spend their entire lives in groundwater and are found nowhere else.

ES5 Assessment and findings

Numerical modelling and analytical techniques have been used in this assessment to develop the site water balance, investigate potential changes in the extent of flooding, and predict quantity and quality changes in groundwater and surface water resources.

Assessment of the project considers the NSW Aquifer Interference Policy, the Commonwealth Department of Environment *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE 2013) and the *Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (*IESC 2015). In addition the principles of Neutral or Beneficial (NorBE) impact on water quality have been adopted.

The possible predicted effects and assessed significance are:

- flow and yield changes for users and the environment – **insignificant**;
- stream bank erosion and geomorphology changes –**insignificant**;
- surface water quality changes – **insignificant**;
- flooding – **insignificant**;
- **no impacts** predicted for GDEs;
- effects on ecosystems that potentially use groundwater – **insignificant**;
- reductions to baseflow – **insignificant**;
- water quality changes due to coal dust deposition – **insignificant**;
- water quality changes for private landholder bores – **insignificant**; and
- drawdown on private landholder bores – **significant**.

ES6 Mitigation, avoidance, management and monitoring

The primary mitigation strategy to protect water resources has been the mine design (non-caving) and operation of the mine (progressively sealing panels and pumping in water following mining). Other mitigation strategies include efficient and optimised water management practices, underground reject emplacement, and use of limestone.

Two overarching and adaptive Water Management Plans (WMPs) will be prepared for the project in consultation with NSW Government agencies: one for the construction phase (CWMP) and one for the operational phase (OWMP).

A range of make good provisions for landholder bores that could experience a drawdown greater than 2 m have been proposed. The actual provisions that will be applied will be identified following case-by-case assessments and will depend on the existing infrastructure, the degree of drawdown at each site and the outcome of consultation with the relevant landholder. Strategies could include compensation for increased pumping costs, repositioning pumps to unaffected strata, or relocating bores.

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1 Introduction

This chapter describes the context of the project and outlines the purpose, scope and outcomes of this revised water assessment.

1.1 Overview

Hume Coal Pty Limited (Hume Coal) proposes to develop and operate an underground coal mine and associated mine infrastructure (the 'Hume Coal Project' or 'the project') in the Southern Coalfield of New South Wales (NSW) (Figure 1.3). Hume Coal holds exploration Authorisation 349 (A349) to the west of Moss Vale, in the Wingecarribee local government area (LGA). The project area boundary is illustrated in Figure 1.4. The underground mine will be developed within A349 and associated surface infrastructure facilities will be developed within and to the north of A349.

Approval for the project is being sought under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An environmental impact statement (EIS) is a requirement of the approval processes. This water assessment report forms part of the *Hume Coal Project Environmental Impact Statement* (EMM 2017a). It documents the groundwater and surface water assessment methods and results, the initiatives built into the project design to avoid and minimise water associated impacts, and the additional mitigation and management measures proposed to address residual impacts unable to be avoided. Specialist technical studies are included in this document's appendices.

Hume Coal is also seeking approval in a separate development application for the construction and operation of a new rail spur and loop, known as the Berrima Rail Project. Coal produced by the Hume Coal Project will be transported to port for export or to domestic markets by rail via this new rail spur and loop.

Hume Coal is a wholly-owned subsidiary of POSCO Australia (POSA), the Australian subsidiary of POSCO. POSCO is a leading multinational steel manufacturer and one of the largest buyers of Australian coal and iron ore. The Hume Coal and Berrima Rail Projects have evolved progressively since Hume Coal began exploration drilling in the project area in May 2011 and following detailed geological, engineering, environmental, financial and other technical investigations to define the mineable resource, and to address identified environmental and technical constraints. The two projects have been designed to extract coal efficiently and transport the coal to market within these identified constraints, while minimising adverse environmental impacts.

Since this time the project has been developed following detailed geological, engineering, environmental, financial and other technical investigations to define the reserve and resource and to identify and address environmental and other constraints. Numerous alternative designs have been prepared and evaluated, as discussed in detail in Chapter 6 of the EIS. This process has allowed a well-considered, practical and economic project to be designed that will efficiently recover resources, while minimising environmental impacts and potential land use conflicts, and delivering socio-economic benefits to the local and broader communities.

1.2 Purpose of this report

This Revised Water Assessment report is a replacement and updated version of the impact assessment for the Hume Coal Project. It has been updated to address matters raised in submissions received for both the Hume Coal Project EIS (EMM 2017a) and Berrima Rail Project EIS (EMM 2017d).

This report only contains updates for the water quality assessment for the Berrima Rail project. The remainder of the water assessment for the Berrima Rail project remains valid, and is assessed in the original EIS.

This revised Water Assessment forms part of the Response to Submissions Report, which will be submitted to the DPE who will distribute it to relevant government agencies and the Planning Assessment Commission (PAC) for consideration in the proposal's assessment and determination. The report describes the further technical studies undertaken since exhibition of the Hume Coal Project and includes only those aspects of the Berrima Rail Project EIS (EMM 2017d) that were questioned or changed as a result of the RTS (ie the water quality modelling only).

1.3 Key terms

A glossary of terms is included at the back of this report. Commonly used terms are defined in Table 1.1 for ease of reference.

Table 1.1 Key terms

Term	Definition and description
Active mining area	The part of the underground mine where mining and reject emplacement taking place as well as other parts of the mine that are used for personnel and materials access, conveying coal, and ventilation. These areas will not be sealed off by bulkheads or seals.
Bulkhead	Following mining and co-disposal of coal rejects into each active panel, a permanent seal (bulkhead) will be installed near the entrance of the panel in each roadway. Each bulkhead will be designed to sustain anticipated groundwater pressures at an appropriate level of safety (nominally larger by a factor of four). The area behind the bulkheads then becomes an inactive part of the mine.
Cumulative impacts	Impacts from existing and future projects that may have an impact in combination with the predicted impacts from the project. These projects may already exist, be under construction, are confirmed, or are at various stages of the development application process.
Drawdown	The change in the groundwater head (level) as measured in a bore. The groundwater level in a bore reflects the pressure of the natural groundwater in the aquifer at the depth where the bore is open/screened. Drawdown refers to the change (lowering) in the groundwater level over time. Note that adjacent monitoring bores with different screen depths would be subject to different drawdown (see Figure 1.1).
Mine water dam	Structures designed to store and manage water at the surface during mining operations.
Model domain or groundwater model domain	The area that has been included in the groundwater model. This extends beyond the project area and is defined by hydrogeological or other boundaries.
Panel	A distinct part of the underground mine where coal is actively mined and removed. Each panel has its own separate ventilation circuit. The project consists of about 50 panels, which will be mined sequentially. The panels are generally separated from one another by solid coal barrier pillars 50 m wide.

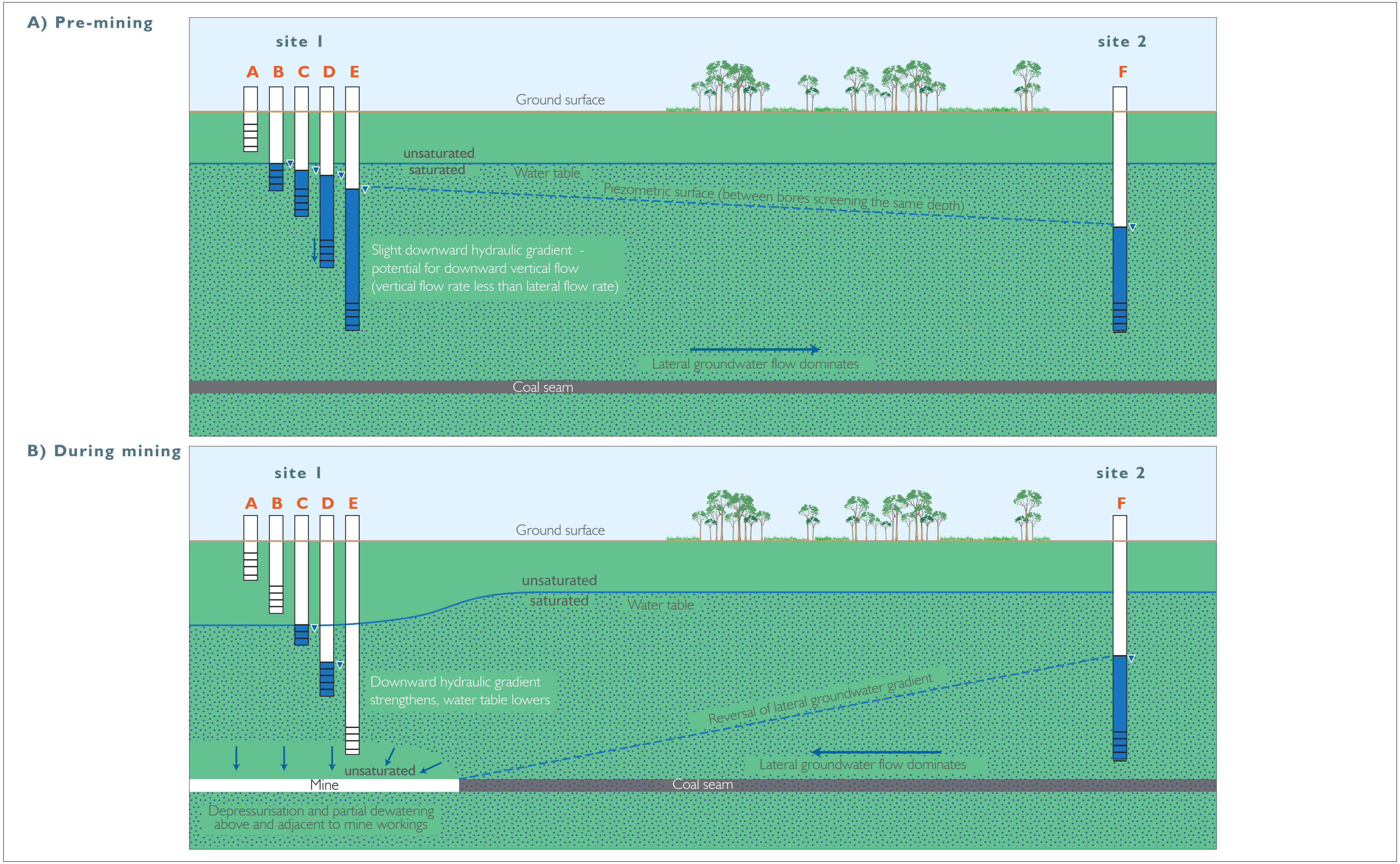
Table 1.1 Key terms

Term	Definition and description
Potentiometric surface/ level	An imaginary surface representing the static head of groundwater and defined by the level to which water will rise in a bore. In an unconfined groundwater system, this will generally be the same as the water table. If a bore is installed and screened below the water table, the groundwater level in the bore will rise up to the height of the potentiometric surface at the depth of the bore screens.
Reject co-disposal emplacement	The mixture of crushed rock and fines that have been separated from the coal during processing, along with limestone and water that will be emplaced underground into the void spaces in the mining panels prior to them being sealed with a bulkhead.
Reject co-disposal make-up water	The water that is mixed with the crushed rock rejects and limestone and which will be co-disposed in completed mining panels.
Sediment dam	Temporary structures that are constructed and used during construction of the surface infrastructure area to prevent sediment-laden runoff entering the local catchment. Water from dams will be released to the local catchment (as they are designed to do) once sediment is settled and separated. Once construction of the infrastructure area is finished, sediment dams will generally be decommissioned and will not remain part of the operations phase water management system.
Stormwater basin	Structures designed to collect and temporarily store water that falls within the mine surface infrastructure area during large rainfall events. These basins will contain mainly clean run-off water in high rainfall events, and water that enters them will have limited, if any, direct contact with coal.
Sump	An underground water storage where water is pumped to/from, or collects. For the project, the sump is where water from various parts of the mine is collected. This water is then either pumped to the surface for use in mine operations or is pumped into the void.
Void	The open volume remaining following coal extraction.
Volume of licensable water	The volume of water required to be licensed for the project is defined as the groundwater inflow to the sump that is physically taken, plus the groundwater inflow to the void, even though the majority of the groundwater in the void remains physically within the groundwater source
Water flow to void	Water that flows in to the sealed void remains within the groundwater system. It will not flow into the active mining area or the sump. Water in the void is natural inflow to the void and/or pumped excess water from the sump or mine water dams. Water in the void may be extracted for use in the mine operations during times of deficit; the volumes extracted will be licensed.
Water table	The depth, or level, below which the ground is fully saturated with groundwater.

To provide context for the key terms in the above table, two figures are presented to illustrate the conceptual changes in the groundwater resource from pre-mining to mining.

Figure 1.1 shows a conceptualisation of groundwater systems and hydraulic head in bores during pre-mining (A) and during mining (B) conditions. Two bore sites are shown: one situated in groundwater systems above a mine (site 1) and the other at distance from a mine (site 2). The response to depressurisation from mining in each bore depends on the depth and location of the bore.

Figure 1.2 shows a schematic representation of progression of mining in adjacent panels from active mining (panel G), co-disposal reject emplacement, bulkhead installation, pumping of excess mine water, and groundwater inflows. Panel A was mined first, followed by Panel B, and so on.



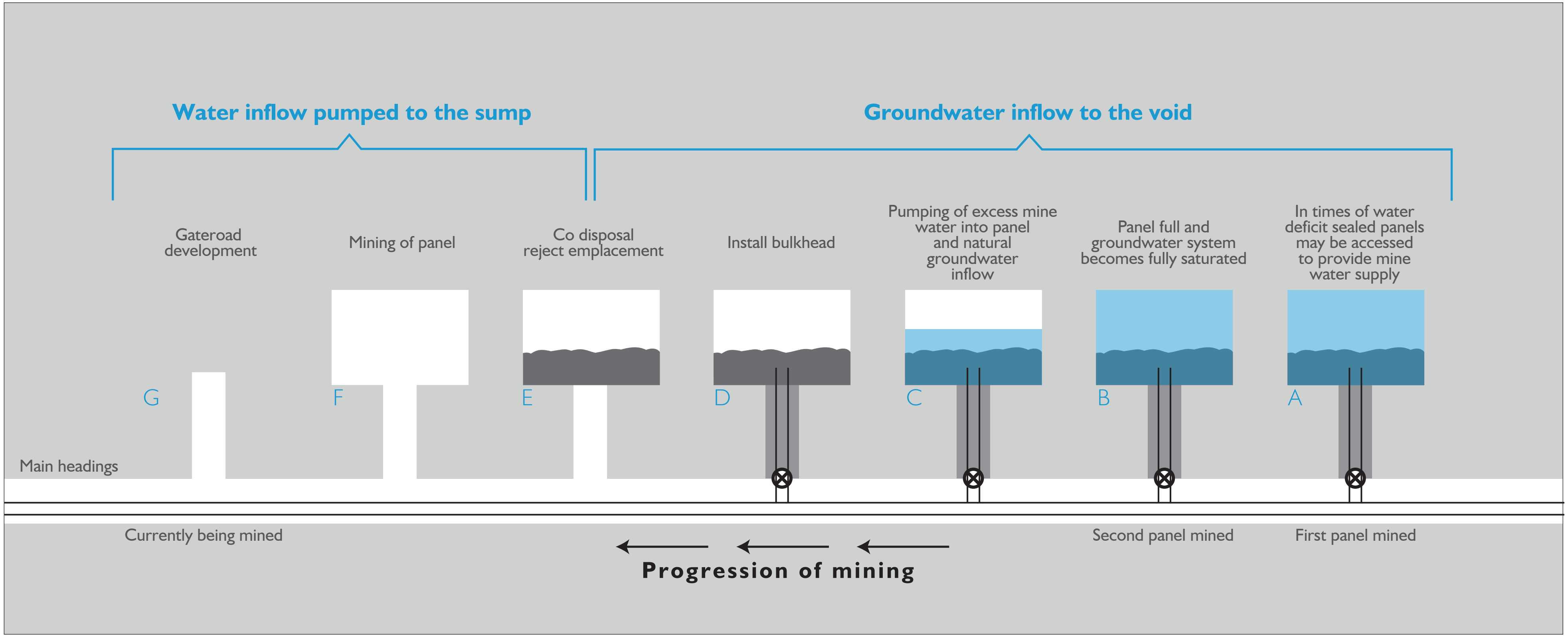
EMM HUMECOAL PROJECT

Hydraulic head in bores schematic — pre-mining and mining

Hume Coal Project

Revised Water Assessment

Figure 1.1



Panel A was mined first, then panel B and so on.
Panel G is in the first stages of mining.

Water inflows into sequential panels during mining
Hume Coal Project
Revised Water Assessment
Figure 1.2

1.4 Project description

The proponent will develop and operate an underground coal mine and associated infrastructure over a total estimated project life of 23 years. Indicative mine and surface infrastructure plans are provided in Figure 1.5 and Figure 1.6.

The key components of the Hume Coal Project are:

- Ongoing resource definition activities, along with geotechnical and engineering testing and other fieldwork to facilitate detailed design.
- Establishment of temporary construction offices and a temporary construction accommodation village.
- Development and operation of an underground coal mine, comprising of approximately two years of construction and 19 years of mining, followed by a closure and rehabilitation phase of up to two years, leading to a total project life of 23 years. Coal extraction will commence during the second year of construction following excavation of the drifts, and hence there will be some overlap between the construction and operational phases.
- Extraction of approximately 50 Mt of ROM coal from the Wongawilli Seam, at a rate of up to 3.5 Mtpa. Low impact mining methods will be used, which will have negligible subsidence impacts.
- Following processing of ROM coal in the coal preparation plant (CPP), production of up to 3 Mtpa of metallurgical and thermal coal for sale to international and domestic markets.
- Construction and operation of associated mine infrastructure, mostly on cleared land, including:
  - one personnel and materials drift access and one conveyor drift access from the surface to the coal seam;
  - ventilation shafts, comprising one upcast ventilation shaft and fans, and up to two downcast shafts installed over the life of the mine, depending on ventilation requirements as the mine progresses;
  - a surface infrastructure area, including administration, bathhouse, washdown and workshop facilities, fuel and lubrication storage, warehouses, laydown areas, and other facilities. The surface infrastructure area will also comprise the CPP and ROM coal, product coal and temporary emergency reject stockpiles;
  - surface and groundwater management and treatment facilities, including storages, pipelines, pumps and associated infrastructure;
  - overland conveyors;
  - rail load-out facilities;
  - a small explosives magazine;
  - ancillary facilities, including fences, access roads, car parking areas, helipad and communications infrastructure; and

  - environmental management and monitoring equipment.

- Establishment of site access from Mereworth Road, and construction or upgrade of minor internal roads.
- Relocation of some existing utilities.
- Coal reject emplacement underground, in the mined-out voids.
- Peak workforces of approximately 414 full-time equivalent employees during construction and approximately 300 full-time equivalent employees during operations.
- Decommissioning of mine infrastructure and rehabilitating the area once mining is complete, so that it can support land uses similar to current land uses.

The project area, shown in Figure 1.4, occupies some 5,051 hectares (ha). Surface disturbance will mainly be restricted to the surface infrastructure areas shown indicatively on Figure 1.6, though will include some other areas above the underground mine, such as drill pads and access tracks. The project area generally comprises direct surface disturbance areas of up to about 117 ha, and an underground mining area of about 3,474 ha, where negligible subsidence within the associated geological units is anticipated.

A construction buffer zone will be provided around the direct disturbance areas. The buffer zone will provide an area for construction vehicle and equipment movements, minor stockpiling and equipment laydown, as well as allowing for minor realignments of surface infrastructure. Ground disturbance will generally be minor and associated with temporary vehicle tracks and sediment controls as well as minor works such as backfilled trenches associated with realigning existing services. Despite this, environmental features identified in the relevant technical assessments will be marked as avoidance zones so that activities in these areas will not have an environmental effect.

Product coal will be transported by rail to Port Kembla for shipment to export markets and/or by rail to domestic customers. Rail works and rail use are covered by a separate development application for the Berrima Rail Project.

1.5 Assessment requirements

This revised water assessment (and the original EIS water assessment (EMM 2017g)) are prepared following the appropriate guidelines, policies and industry requirements, and in consultation with relevant government agencies. The revisions in this water assessment (ie the changes since the original EIS water assessment (EMM 2017g)), incorporate feedback from the RTS process and incorporate suggestions and comments received by the NSW Regulator, the IESC, interest groups, local businesses and the general community.

The main guidelines, legislation and policies relevant to the project are discussed in Chapter 3. Of particular note for the groundwater assessment are the requirements of the NSW Government Aquifer Interference Policy (AIP) (NOW 2012a).

This assessment has been prepared in accordance with requirements of the Commonwealth Department of the Environment (DoE) (now the Department of Environment and Energy (DoEE)) and NSW Department of Planning and Environment (DPE). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project and supplementary SEARs both issued on 20 August 2015. The SEARs identify matters that must be addressed in the EIS and essentially form its terms of reference. The complete SEARs are included in the *Hume Coal Project EIS* as Appendix B (EMM 2017a), while Table 1.2 lists individual requirements relevant to this water assessment and where they are addressed in this report.

Table 1.2 Water-related SEARs

Requirement	Chapter where addressed in this document
An assessment of the likely effects of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the EPA's[1], DPI's[2] and Water NSW requirements and recommendations.	10, 11
An assessment of the likely effects of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users.	10, 11
An assessment of the potential flooding effects of the development.	10.3
A water management strategy, having regard to the EPA's, DPI's and WaterNSW's requirements.	13

Notes: 1. EPA = Environment Protection Authority.
2. DPI = Department of Primary Industries.

To inform the preparation of the SEARs, the DPE invited other government agencies to recommend matters to be addressed in the *Hume Coal Project EIS* (EMM 2017a). These matters were taken into account by the Secretary for the DP&E when preparing the SEARs. Copies of the government agencies' advice to DP&E were attached to the SEARs.

A number of agencies, including the Department of Primary Industries, Water (DPI Water), WaterNSW, Environment Protection Authority (EPA), Office of Environment and Heritage (OEH), and the DoEE raised matters relevant to the water assessment. These were mainly their standard requirements for projects of this nature, though included some project-specific requirements relating to groundwater and surface water quality and flow. The agency recommendations (AR), and where they are addressed in this document, are listed in Appendix A, Table 15.1 along with the SEARs, and have been taken into account in preparing this assessment. Each SEAR and AR has been allocated a unique identification number (water assessment ID) for the purpose of reference within this document. Blue boxes identifying each relevant SEAR and/or AR precede the sections of the report where they have been addressed. Some SEARs and/or ARs contain multiple aspects that are addressed in a number of different sections of the report. In these cases, the full text of the SEAR and/or AR has been included in the blue box in each of the report section, even when only part of it is addressed in that section.

In addition, the *Information Guidelines for Independent Expert Scientific Committee (IESC) advice on coal seam gas and large coal mining development proposals checklist of specific information needs* (IESC 2015) has been included in Appendix B and cross-referenced with relevant sections of this document where the information has been provided.

The submissions received on the original EIS Water Assessment (EMM 2017g) have guided the revision of the water assessment and details of these submissions are contained in the RTS document. This report summarises the methods and results of the assessments undertaken.

1.6 Purpose of the water assessment

The key objectives of the water assessment are to:

- outline the proposed site water management arrangements for the project;
- assess the existing hydrological and hydrogeological and related environments and baseline conditions within the project and surrounding area;
- assess the regulatory environment within which the project will operate;
- quantify the requirements of the project for water access licences to satisfy project demands, and specify arrangements for acquiring them;
- identify and quantify the potential effects of the project on the current surface water and groundwater resources, and on water users both environmental and extractive (including cumulative effects);
- specify mitigation and management measures, and monitoring requirements for surface water and groundwater;
- satisfy the SEARs relevant to groundwater and surface water effects; and
- inform the wider community about the project and its potential effects on the local and regional water environments.

This assessment covers all issues relating to site water management, groundwater and surface water and their related environmental and other uses. For surface water, this includes issues relating to river waters, geomorphology, and flooding. Ecological effects are referred to in this report but are given more detailed treatment in the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c) and Chapter 13 of the *Hume Coal Project Response to Submissions Report* (EMM 2018).

A number of consultants were commissioned for various water-related technical studies to inform the project. The water assessment was prepared using a number of technical assessments that have been appended to this document, namely:

- the *Hume Coal Project Revised Surface Water Assessment* (WSP 2018) (Appendix D), which contains:
  - the revised water balance and the EIS *Hume Coal Project Water Balance* report (WSP PB 2016a) as Appendix A;
  - the revised flow assessment and the EIS H*ume Coal Project Surface Water Flow and Geomorphology Assessment* report (WSP PB 2016c) as Appendix B;
  - the revised surface water quality assessment and the EIS *Hume Coal Project Surface Water Quality Assessment* report (WSP PB 2016b) as Appendix C;
  - the EIS *Hume Coal Project Flooding Assessment* report (WSP PB 2016d) as Appendix D; and
  - the *Berrima Rail Project EIS Surface Water Assessment* (WSP 2016f) as Appendix E.

- the *Hume Coal Project Revised Groundwater Modelling* report (HydroSimulations 2018) (Appendix F), which contains:
  - the *Hume Coal Project Groundwater Assessment Volume 1: Data Analysis* (Coffey 2016a) within Appendix E; and
  - the *Hume Coal Project Groundwater Assessment Volume 2: Numerical Modelling and Impact Assessment* report (Coffey 2016b) as Appendix F.
- the EIS *Hume Coal Project Hydrogeochemical Assessment* report (Geosyntec 2016) (Appendix I).
- the *Hume Coal Project Hydrogeochemical Modelling Assessment* report (RGS 2018) (Appendix J).

The technical studies have been carried out in accordance with the SEARs and ARs and with reference to leading practice guidelines, legislation and policies. Consideration to submissions received on the original EIS water assessment was also incorporated.

1.7 Project area and study area

The project area boundary is illustrated in Figure 1.4.

Each technical assessment (as discussed in Section 1.6) focused on a particular study area that was relevant to the subject matter. For example, the groundwater assessment's study area is larger than that examined in the water balance. The study area for each technical assessment is shown in Table 1.3.

Table 1.3 Defined study areas for each technical assessment

Technical assessment	Study area
Water balance	The surface infrastructure area (Figure 1.6) and the underground mine (Figure 1.5)
Surface water quality	The streams with potential to be affected by the project within the groundwater model domain (Figure 8.5)
Surface water flow and geomorphology	Streams adjacent to and downstream of the surface infrastructure areas within the Medway Rivulet and Oldbury Creek catchments; and streams affected by loss of baseflow due to aquifer depressurisation
Flooding	The surface infrastructure area (Figure 1.6) and the surrounding Medway Rivulet and Oldbury Creek catchments
Groundwater numerical model	The groundwater model domain (Figure 8.4)
Hydrogeochemical	The underground mine and portions of the groundwater systems down hydraulic gradient from the underground workings

1.8 Scope of the water assessment

The scope of the water assessment was to:

- assess the existing hydrological and hydrogeological environments and baseline conditions within the project and surrounding area;
- identify and quantify the potential effects of the project on the current surface water and groundwater resources, and on water users both environmental and extractive (including cumulative effects);

- specify mitigation and management measures, and monitoring requirements for surface water and groundwater; and

- discuss water licensing requirements in accordance with the relevant legislation.

1.9 Adoption of leading practices

Hume Coal has adopted a number of leading practices to produce a mine design that avoids and minimises impacts to water assets. The key leading practices adopted to minimise impacts to water related assets are:

- innovative and tailored non-caving mine design (ie imperceptible levels of subsidence or damage to the overlying Hawkesbury Sandstone);

- underground emplacement of coal rejects (ie removes the need for permanent surface stockpiles); and

- sealing of mined panels (ie allows groundwater to recover more rapidly).

Extensive technical investigations have taken place over several years to develop and refine the project, and arrive at the proposed design.

1.10 Actions taken since EIS exhibition

1.10.1 Overview

The Hume Coal Project is accurately defined and remains consistent with that described in the EA, although there have been some modifications to how the impacts were assessed following receipt of submissions and consultation with NSW Government. The assessment modifications have been incorporated to provide a greater level of confidence in the model results and with consideration of ongoing Government consultation and expert independent peer review.

The NSW Department of Planning and Environment (DPE) appointed Hugh Middlemis as the independent expert peer reviewer for the groundwater model (Hydrogeologic 2017). As part of the expert review process an 'issues log' was prepared by the NSW Government independent expert peer reviewer, and this formed the basis for consultation between the regulator, the peer reviewer and the Hume Coal Project team, and subsequent audits and updates to the groundwater model.

As a result of submissions and the revised groundwater model, the site water balance and surface water quality models and assessments were also revised. These revisions were undertaken following additional consultation with Water NSW. Also as a result of submissions, additional geochemical modelling was undertaken.

1.10.2 Consultation

Consultation on water related aspects following submission of the EIS are shown in Table 1.4.

Table 1.4 Water related consultation

Date	Objective	Attendees	Outcome
4 July 2017	Make good concept discussion	**DPE:** (David Kitto, Clay Preshaw and Paul Freeman) **DPI:** Mitchell Isaacs Hume: Greig Duncan, Ben Anderson, **EMM:** Liz Webb	Hume and EMM confirmed water would remain available for the licensed purpose of the relevant water supply work.
25 August 2017	DPI Water submission discussion	**DPI Water:** Mitchell Isaacs, Tim Baker, Greg Russell, Graeme White Fabienne d'Hautefeuille, Andrew Drusneski, **Hume:** Greig Duncan, Ben Anderson, Luke Edminson, **EMM:** Liz Webb Noel Merrick, Frans Kalf **Posco**:Patrick Yeou	Open discussion and clarification of issues raised by DPI Water in their submission. Hume committed to undertaking a model audit and rework as per discussion and agreement at this meeting.
9 October 2017	Consultation and discussion on model details	Hugh Middlemis and Noel Merrick	Revised model subsequently tailored to ensure Middlemis' outstanding concerns could be addressed.
24 October 2017	Water NSW submission discussion	**Hume**: Greig Duncan, Luke Edminson, Ben Anderson, Alex Pauza, Rob Leslie, Leigh Doeleman, **EMM**: Liz Webb, Nicola Fry, **WaterNSW:** Girja Sharma, Neil Cowley, Malcolm Hughes, Maria Dubikova, Peter Dupen, Hemantha DeSilva	Focused on surface water quality and water management in dams (including the first flush).

1.10.3 Summarised changes

The specific steps taken in response to the submissions and consultation as outlined above are summarised:

- water risk assessment;
- additional presentation of baseline data;
- detailed audit of the numerical groundwater model;
- upgrade of numerical groundwater model software and coding package to provide more elaborate mathematical solutions;
- consideration and alterations made to the groundwater model based on relevant concerns raised by the NSW Government independent peer reviewer and the NSW Government;
- more detailed sensitivity analysis;
- detailed *Monte Carlo* uncertainty analysis (as per IESC guidelines);

- updated 'make good' landholder bore assessment (using revised groundwater model results);
- updated site water balance (using revised groundwater model results);
- updated surface water flow assessment (using revised groundwater model results and revised site water balance);
- updated surface water quality assessment (using revised groundwater model results and revised site water balance); and
- additional geochemical modelling on potential groundwater quality impacts and pathways.

Although revisions have been made, the overall results of the assessment essentially remain similar to what was presented in the EIS.

1.10.4 Groundwater modelling – detailed audit, upgrade and alterations

The alternations to the groundwater model are described in detail in Chapter 8.6.

Following submission of the EIS, from the NSW Government, interest groups and the business and local community, additional groundwater modelling work was commissioned. The additional modelling work was undertaken by Noel Merrick of HydroSimulations, and involved:

- a detailed model audit/verification;
- a model revision using a later version of MODFLOW-SURFACT with better solver settings;
- conversion to MODFLOW-USG (ie upgraded software and solvers, allowing use of time varying materials and pseudo-soil functions));
- additional sensitivity analysis (including wet and dry climate sensitivity); and
- detailed uncertainty analysis.

These model revisions and upgrades provided for a more realistic simulation of inflow to the mine and recovery of water levels following the completion of the Hume Coal Project

Additional sensitivity analysis was conducted on;

- specific storages and specific yield;
- adoption of pseudo-soil function;
- drain conductance (1 order of magnitude); and
- vertical basalt barrier -effect of its presence/absence.

While defensible, the EIS model predictions were based on average climate into the future. This is a standard and proper approach for predictive modelling to ascertain mining effects exclusive of potential climate effects. However, groundwater model climate sensitivity analysis was undertaken, with climate sequences aligned to the surface water assessment. Model runs were also completed that used the 'wettest' and 'driest' climate scenarios, based on maximum and minimum average daily rainfall.

With the recent release of the draft IESC Explanatory Note for Uncertainty Analysis in Groundwater Modelling (Middlemis & Peeters 2018), an extensive and detailed uncertainty analysis as conducted. This was undertaken as *Monte Carlo* simulations for different realisations of model properties.

1.10.5 Make Good assessment

The predicted impacts to landholder bores and the make good assessment were key subjects of interest raised during the submissions process, by both the NSW Government and the community. The focus of the concerns was the question on the ability for a project to be approved that resulted in 'more than minimal impact' (as defined in the NSW Aquifer Interference Policy 2012 (the AIP) (NOW 2012). The logistics of being able to physically 'make good' on water supply changes was a key community concern.

The NSW Government is relying on 'make good' as a tool for ensuring a development predicted to have more than 'minimal impact' on existing water users can be managed. This is required under the *NSW Water Management Act 2000* (WMA 2000) and the AIP) (NOW 2012). However, currently the concept of 'make good' has not been clearly defined, and there is no set guidelines that outline the details on the nature or extent of make good provisions to which the AIP refers, such as:

- the potential mechanisms to 'make good' supply that would be acceptable to NSW Government in the context of a development that results in more than 'minimal impact';
- administrative arrangements and processes to enable contracts or agreements to be entered into that will satisfy the NSW Government;
- conflict resolution process or enforcement mechanisms; and
- limits to liability of the proponent given the variability of existing infrastructure.

The updated make good assessment (Appendix M) is based on the results of the revised groundwater model, which has lead to minimal changes (from 93 to 94) in the total number of landholder bores predicted to experience drawdown by more than 2 m.

The revised make good assessment is more comprehensive than the original EIS *Hume Coal Project Water Assessment* report (EMM 2017g). It provides a staged approach to make good and the level of detail required for stage 1 is heightened. However, all bores predicted to experience drawdown great than 2 m, are assessed individually in detail. Make good options specific to each individual bore is discussed, including timeframes for implementation of each stage. Individual negotiations are now required to fine tune suitable and agreed make good arrangements, timeframes and other details as required for each of the individual properties identified.

a. Historical context for make good

Due to the lack of clarity surrounding the requirements to implement make good arrangements and the lack of policy or regulatory guidance, Hume Coal considers both legal precedent and historical context. The historical context of the concept of make good is discussed to explore the evolution of make good and the nationally agreed principles around water reform and Australia's competition policy.

In response to an undertaking of the Council of Australian Governments (COAG) Water Reform Framework Agreement of 1994 (CoAG 1995) to further investigate and report on groundwater, in 1995 the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ 1997) prepared a paper establishing inter-governmental agreement or guidance on some implementation issues relating to groundwater within the formal commitments of the *Water Reform Framework Agreement* and the Competition Policy, 1995.

The paper, *Allocation and Use of Groundwater: A National Framework for Improved Groundwater Management in Australia - Policy Position Paper for Advice to States and Territories* (Task Force on COAG Water Reform Sustainable Land Water Resource Management Committee, Occasional Paper Number 2 December 1996, Commonwealth of Australia 1997), set key principles for managing interference between groundwater uses. In particular, Recommendation 4 in the report stated:

> In preparing groundwater management plans, policies and strategies, States should ensure that the efficient utilisation of groundwater resources is not compromised by protection of existing users with inefficiently designed or constructed wells. This particularly applies to domestic and stock wells.

ARMCANZ provided the following explanation for this position:

> There are many cases throughout Australia where relatively shallow wells tap the top of an aquifer. This especially applies to domestic and stock wells. As a consequence, new and frequently deeper wells readily dewater existing wells and their owners seek redress in varying forms. **As a policy position, these frequently old and inefficiently designed wells should not be used as a basis for "tying up" the resource. To limit new development on the basis of the shallowest well is considered to be economically inefficient and poor management as new users frequently cannot gain access to a largely under-utilised resource.** [bold added for emphasis]

The ARMCANZ paper did not go as far as to recommend who should pay to in effect 'untie' the resources, and the NSW Government grappled with this issue in the ensuing years, and to some degree explains the lack of clarity around the concept of 'make good' in the AIP.

b. Revised make good assessment

The revised make good assessment therefore considers:

- historical context for make good;
- the policy guidance for assessment (ie the 2m drawdown);
- revised groundwater model results from the 67th percentile uncertainty analysis;
- legal precedent; and
- NSW Government recommendations for additional detail at each individual bore, as outlined during consultation with DPE.

Individual and practical 'make good' arrangements are available and viable for all bores experiencing drawdown of greater than 2 m, and include one of a combination of the following; subsidised increased pumping costs (or other compensatory measures); bore refurbishment, lowering pump intake depth; relocating bore; and additional bores to augment supply.. Refer to Appendix M for further details.

The revised groundwater model has lead to a revision in the number of bores that experience drawdown in excess of 2 m. The 'make good' assessment has therefore been reworked using the same principles, but the revised model results.

1.10.6 Revised site water balance

The water balance modelling undertaken for the EIS has been updated to include the revised groundwater inflow estimates from post-EIS numerical groundwater modelling undertaken by HydroSimulations (2018). The groundwater inflows predicted by the revised numerical groundwater modelling are key inputs to the water balance. No other changes were made to the water balance model developed for the Hume Coal Project EIS (EMM 2017a). The water balance model base case adopts groundwater inflow estimates from groundwater model 67th percentile uncertainty analysis results.

Additional sensitivity analysis was also assessed relating to predictions of groundwater inflows based on average, wet and dry climate scenarios output from the groundwater model. This sensitivity analysis was undertaken to address matters raised in submissions from government agencies to understand how sensitive the water balance model is with respect to changing climate.

Details regarding the revisions of the site water balance model and the outputs are presented in Section 8.2 and Appendix D.

1.10.7 Revised surface water flow assessment

The surface water flow assessment undertaken for the EIS has been updated to address matters raised in the submissions from government agencies and other stakeholders. The surface water flow assessment has also been updated to reflect post-EIS numerical groundwater modelling undertaken by HydroSimulations (2018).

The 'reduction in baseflow' estimates, predicted by the revised numerical groundwater modelling, are key inputs to the surface water flow assessment. In addition, a revised output of the revised water balance model of predictions of releases from SB03 and SB04 to Oldbury Creek, following first flush, have been included in the surface water flow assessment.

Additional sensitivity analysis was also assessed relating to predictions of baseflow reduction based on average, wet and dry climate scenarios output from the groundwater model. This sensitivity analysis was undertaken to address matters raised in submissions from government agencies to understand how sensitive the water balance model is with respect to changing climate.

Details regarding the revisions of the surface water flow assessment and the outputs are presented in Section 8.3 and 10.1, and Appendix D.

1.10.8 Revised surface water quality assessment

Work undertaken to update the water quality assessment is based on the result of the amended groundwater model and subsequent water balance and flow impact assessment changes, as well as modifications to the MUSIC modelling following suggestions raised during the submissions process for assessment of the project against the neutral or beneficial effect (NorBE) principles.

The following revisions have been made to the MUSIC modelling for the NorBE assessment of releases from stormwater basins to Oldbury Creek and also of mine access roads:

- altered time-series releases from SB03 and SB04 to Oldbury Creek to reflect the revised water balance model results;
- existing flows modelled as a combination of baseflow and storm flow;
- MUSIC model timestep changed from daily to 6-minutes; and
- alterations of MUSIC model parameters and proposed water quality treatment measures for the mine access roads assessment.

An additional GoldSim mass balance analysis has been undertaken to allow for quantitative assessment of potential water quality changes associated with baseflow reduction, building on the baseflow reduction water quality assessment presented in the EIS.

Additional management measures of vegetation protection zones are included to offset potential water quality impacts associated with baseflow reduction.

An additional analysis has also been undertaken to assess potential water quality changes associated with coal dust deposition in surface water catchments.

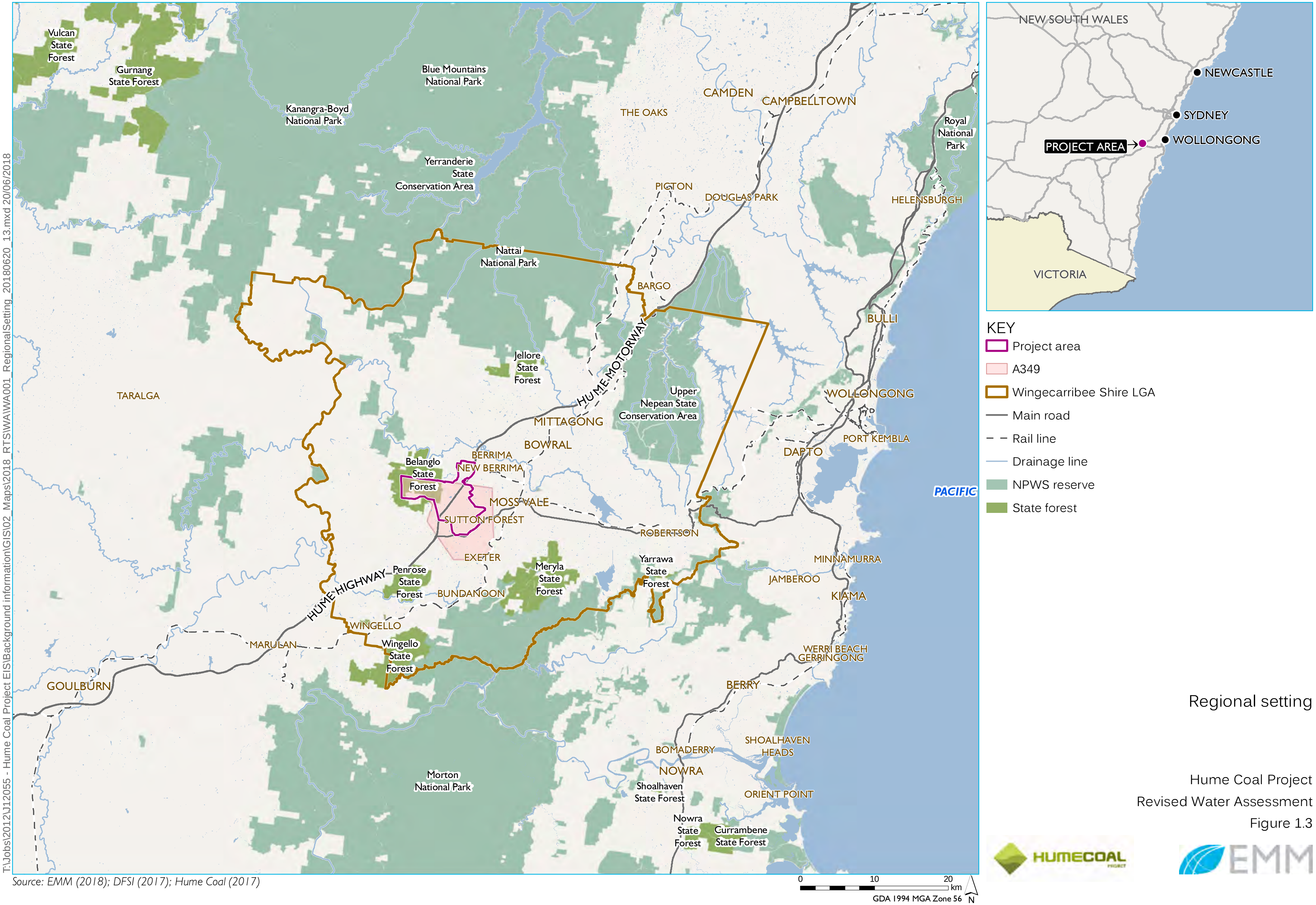
Details regarding the revisions of the surface water quality assessment and the outputs are presented in Section 8.4 and 10.1.5, and Appendix D.

1.10.9 Groundwater quality impacts and pathways

Additional geochemical modelling has been undertaken to address two issues raised in several submissions regarding predicting water quality evolution in the primary water dam (PWD) and the groundwater response to underground placement of rejects.

Several hydrogeochemical models were constructed in Geochemist's Workbench and PHREEQC to ultimately estimate the range of water qualities likely to exist in the PWD over the life of the mine and to determine the likely water qualities resulting from the placement of co-disposed reject (reject porewater and PWD water) into mined-out voids (panels) and the effect on groundwater systems.

Details regarding the additional geochemical modelling and the outputs are presented in Section 8.7 and Appendix J.



Source: *EMM (2018); DFSI (2017); Hume Coal (2017)*

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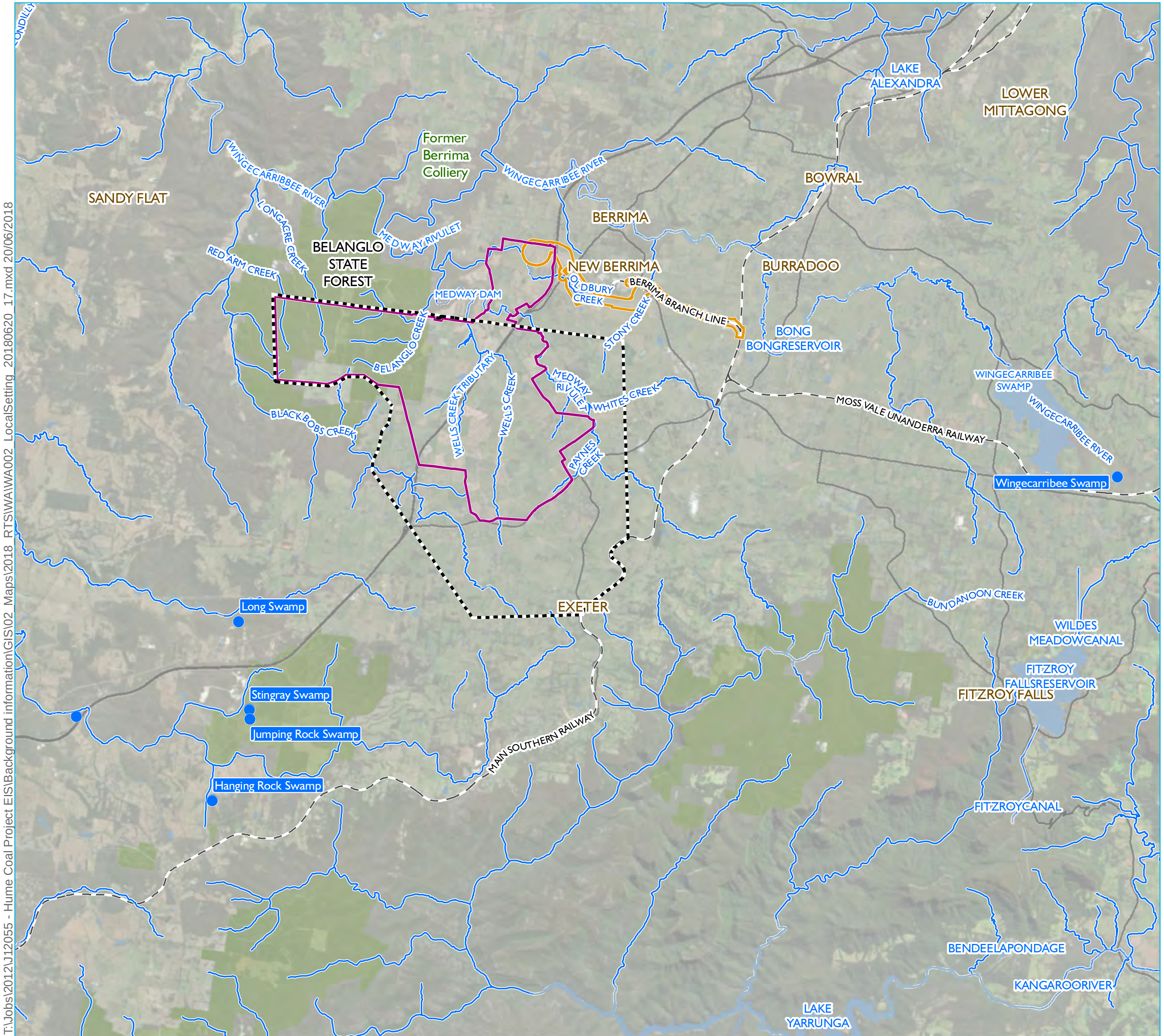
Regional setting

Hume Coal Project
Revised Water Assessment
Figure 1.3



Source: EMM (2018); DFSI (2017); Hume Coal (2017)

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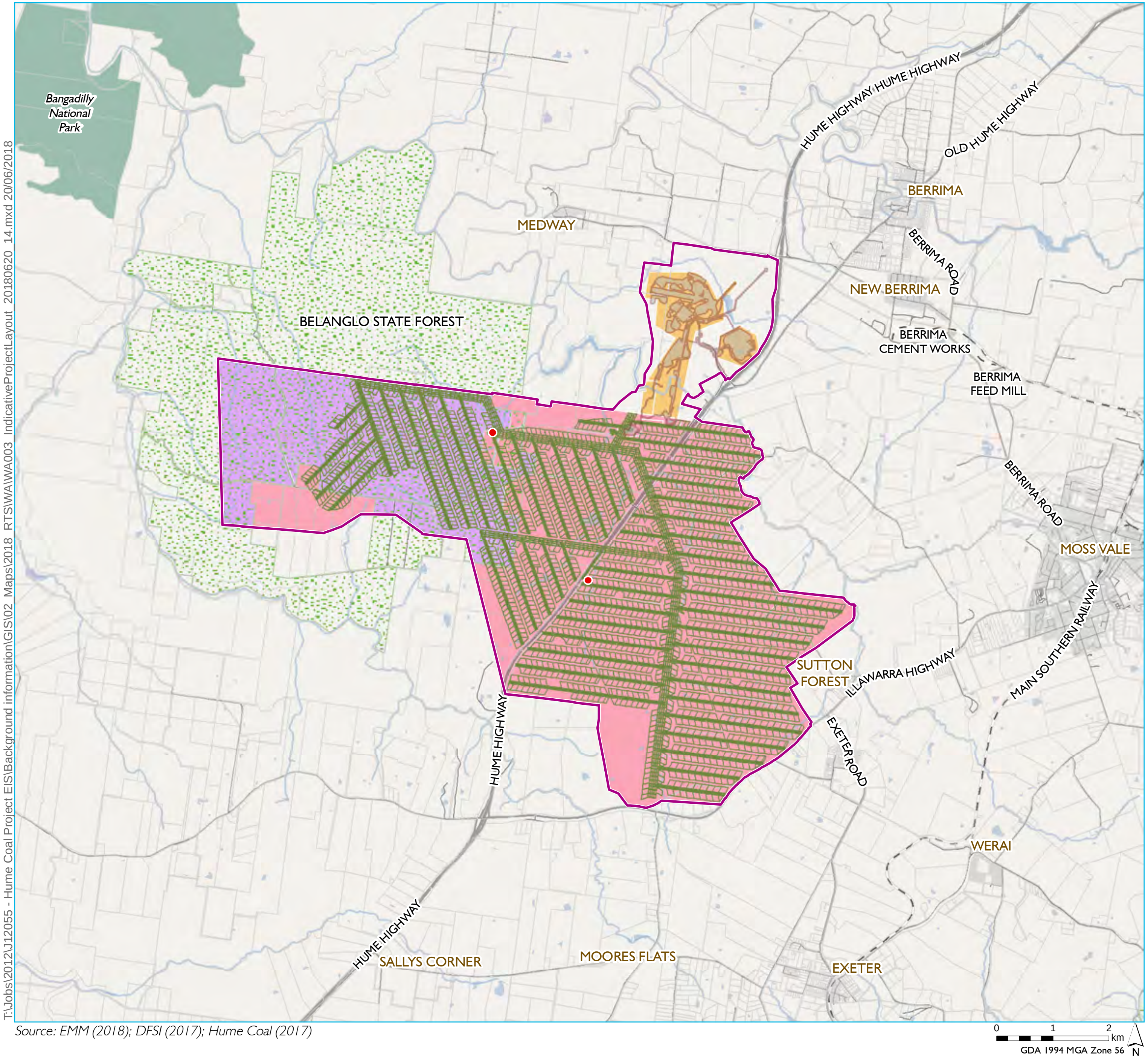
KEY
- Project area
- Berrima Rail Project area
- A349
- Southern Highlands Peat Swamp on Sandstone
- Drainage line
- Main road
- Rail line
- Waterbody
- State forest

Note: Hume Coal Project area, Berrima Rail Project area and A349 boundary have been offset for clarity

Local setting

Hume Coal Project
Revised Water Assessment
Figure 1.4



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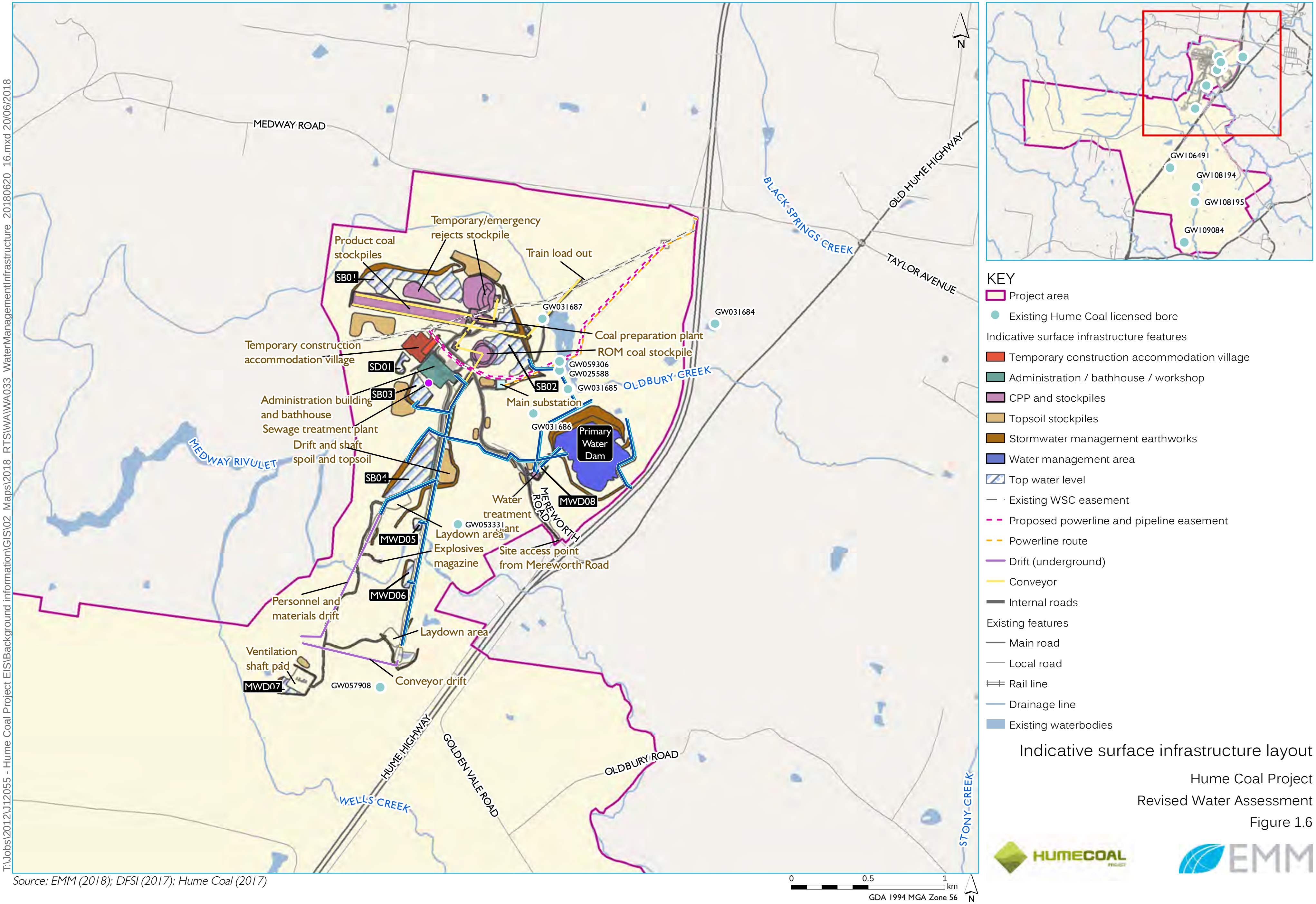
Source: EMM (2018); DFSI (2017); Hume Coal (2017)

Mine and surface infrastructure layout

Hume Coal Project
Revised Water Assessment
Figure 1.5



Indicative surface infrastructure layout

Hume Coal Project

Revised Water Assessment

Figure 1.6

HUMECOAL EMM

Source: EMM (2018); DFSI (2017); Hume Coal (2017)

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2 Project setting

This chapter describes the project setting, topography, rainfall, and water resources, and gives details of the mining method and site water management.

AR 79: A full description of the development including those aspects which have the potential to impact on the quality and quantity of surface and groundwaters at and adjacent to the site, including:
- *the mining proposal and mine layout*
- *the location, mapping and geomorphology of all creeks and water resources overlying and adjacent to the proposed mining area*
- *the hydrogeological fluxes between surface and groundwaters, including the filling of pine feather voids*
- *the location, management and storage of all hazardous materials- the disposal of wastes from the treatment of mine waters in the mine water treatment plant*
- *the management of dirty water from the washing and preparation of coal for transport*
- *the location, sizing and description of all water quality management measures*
- *the location and description of all water monitoring points (surface and ground waters)*
- *on-site domestic (sewage) wastewater management*

2.1 General site description

The project area is about 100 km south-west of Sydney and 4.5 km west of Moss Vale town centre in the Wingecarribee LGA (refer to Figure 1.3 and Figure 1.4). The nearest area of surface disturbance will be in the surface infrastructure area, which will be 7.2 km north-west of Moss Vale town centre. It is in the Southern Highlands region of NSW and the Sydney Basin Biogeographic Region.

The project area is in a semi-rural setting, with the wider region characterised by grazing properties, small-scale farm businesses, natural areas, forestry, scattered rural residences, villages and towns. In addition, industrial activities such as the Berrima Cement Works and Inghams Feed Mill, some extractive industry and major transport infrastructure such as the Hume Highway are present.

Surface infrastructure is proposed to be developed on largely cleared land owned by Hume Coal or affiliated entities, or for which there are appropriate access agreements in place with the landowner. Over half of the remainder of the project area (principally land above the underground mining area) comprises cleared land that is, and will continue to be, used for livestock grazing and small-scale farm businesses. Belanglo State Forest covers the north-western portion of the project area and contains pine forest plantations, areas of native vegetation and several creeks that flow through deep sandstone gorges. Native vegetation within the project area is largely restricted to parts of Belanglo State Forest and riparian corridors along some watercourses.

The project area is traversed by several drainage lines including Oldbury Creek, Medway Rivulet, Wells Creek, Wells Creek tributary, Belanglo Creek and Longacre Creek, all of which ultimately discharge to the Wingecarribee River, at least 5 km downstream of the project area (Figure 1.4). The Wingecarribee River's catchment forms part of the broader Warragamba Dam and Hawkesbury-Nepean River catchments. Medway Dam is also next to the northern portion of the project area (Figure 1.4).

Most of the central and eastern parts of the project area have very low rolling hills with occasional elevated ridge lines. However, there are steeper slopes and deep gorges in the west in Belanglo State Forest.

Existing built features across the project area include scattered rural residences and farm improvements such as outbuildings, dams, access tracks, fences, yards and gardens, as well as infrastructure and utilities, including roads, electricity lines, communications cables and water and gas pipelines. Key roads that traverse or border the project area are the Hume Highway, Golden Vale Road, and the Illawarra Highway.

Industrial and manufacturing facilities near the project area include the Berrima Cement Works and Berrima Feed Mill on the fringe of New Berrima. Berrima Colliery's mining lease (CCL 748) also adjoins the project area's northern boundary. Production ended at Berrima Colliery in 2013 after almost 100 years of operation. The mine is being closed.

2.1.1 Historical mining activity

There is a long history of mining in the Southern Coalfield within the Wingecarribee Shire including mining for coal, iron ore, bauxite, gold, diamonds, shale, sand, clay, and kerosene shale. There is also a history of hard rock quarrying in the area including basalt quarries at Exeter and at Mount Gingenbullen as well as the heritage-listed dimension stone quarry at Mount Gibraltar. Mining still takes place at various locations within Wingecarribee Shire, including the Dendrobium longwall coal mine in the shire's north-east. Deposits of potentially commercial bauxite are known to occur in the south of the shire.

Chapter 5 of the *Hume Coal Project EIS* discusses historical mining activity in the Southern Coalfield in more detail. In summary, historical mines within and near the project area include:

- Berrima Colliery – to the north of Wingecarribee River. Berrima Colliery's mining lease (CCL 748) adjoins the project area's northern boundary; it is being closed having ceased operations in 2013. The workings are the most extensive of any mine in the area and comprise first workings and pillar extraction in the Wongawilli Seam. Mining operations began in 1926, with mechanisation starting in 1968.

- The Loch Catherine Mine (abandoned) – underneath the former Berrima Colliery stockpile pad bounded by Medway Rivulet and the Wingecarribee River. The mine worked the Wongawilli Seam. Operations ceased at Loch Catherine Mine in the 1960s. The adits are still open, and iron staining is evident in the water pooled at the mine entries.

- Southern Colliery (abandoned) – on Foxgrove Road, about 5 km south-west of the project area. Mining appears to have occurred in the Tongarra Seam. This was a small-scale mine that ceased operations many years ago.

- Numerous adits exist at coal seam outcrops along escarpments and are examples of pre-mechanisation (manual) abandoned workings. Typical examples of these adits are Black Bobs, Belanglo (abandoned in the 1950s), Belanglo Extended, and Flying Fox collieries to the west and north of the project area, Erith Colliery near Bundanoon, and two adits of unknown length along Longacre Creek, in the far north-east of the project area. Most are not sealed and drain into local watercourses.

2.1.2 Topography

The project area is situated on the elevated but relatively flat Nattai Plateau. Elevations typically range from around 550 to 735 metres above Australian Height Datum (AHD) (Figure 2.1). Most of the central and eastern parts of the project area have very low rolling hills with occasional elevated ridge lines. Steeper slopes and deep gorges are located to the immediate west, north-west, and south of the project area and are products of incision from watercourse flow.

The Southern Highlands has some peaks of igneous origin. These include Mount Gingenbullen (800 mAHD) to the north-east of the project and Mount Gibraltar (860 mAHD) further north-east near Bowral (Figure 2.1). Broad basalt peaks are also observed to the south.

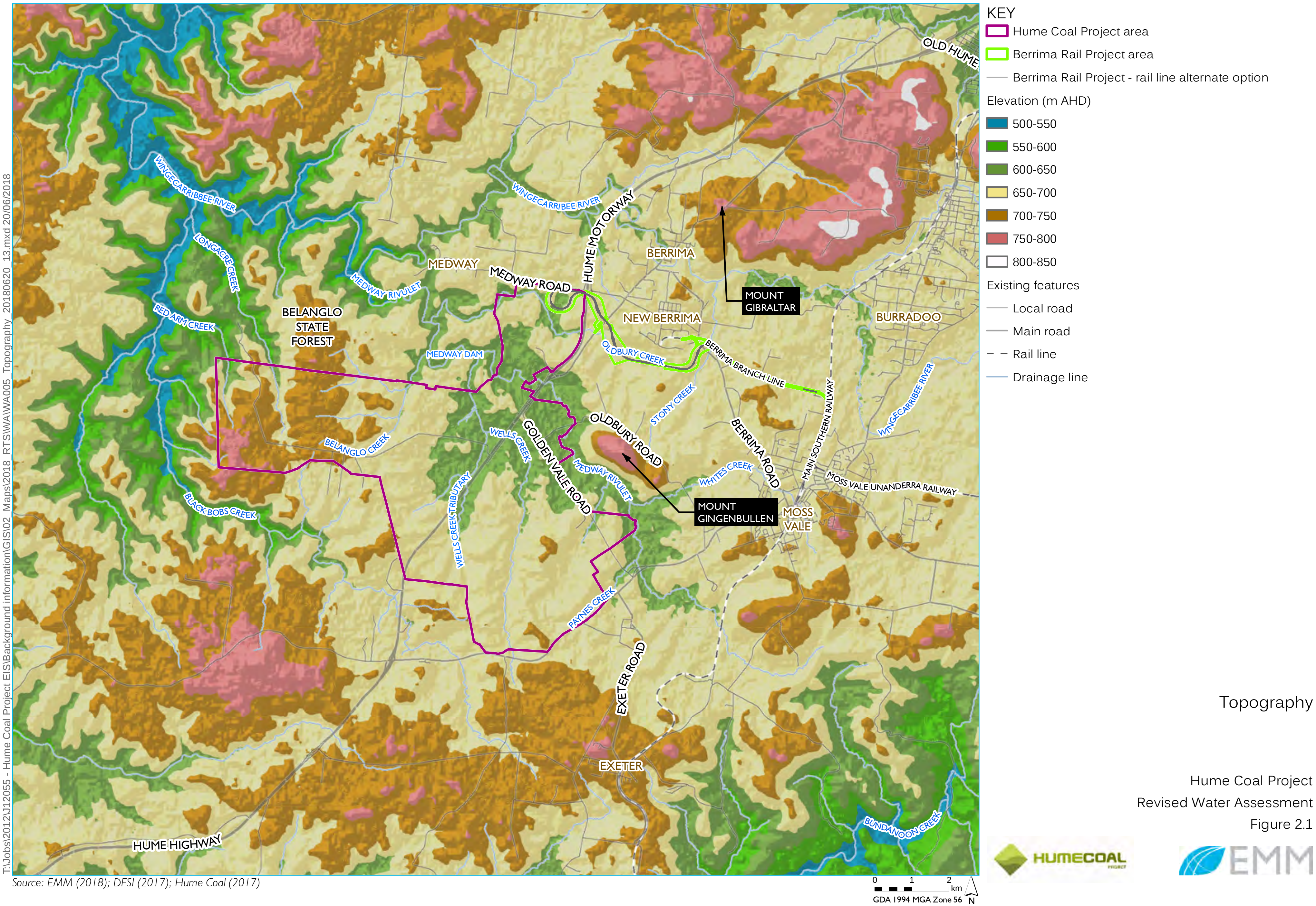
2.1.3 Meteorology

The project area's climate is cool temperate, characterised by warm summers and cool winters. September is typically the driest month. Table 2.1 summarises average climate data for the project area, mainly using data from the Bureau of Meteorology (BoM) station at Moss Vale, Hoskins St (station 068045), which began recording in 1871, and mean pan evaporation measurements have been referenced from the BoM Goulburn TAFE station (site number 070263), which began recording in 1971. The data in Table 2.1 shows that temperatures range from an average maximum of 25.8°C in January to an average minimum of 1.3°C in July.

Table 2.1 Local climate data

Parameter		Measurement	Month
Mean temperature at Moss Vale BoM station 068045			
Maximum	Annual	21.2°C	-
	Highest monthly	25.8°C	January
	Lowest monthly	11.8°C	July
Minimum	Annual	6.9°C	-
	Highest monthly	12.6°C	February
	Lowest monthly	1.3°C	July
Mean rainfall at Moss Vale BoM station 068045			
Annual		963 mm	-
Highest monthly		102 mm	June
Lowest monthly		60 mm	September
Mean pan evaporation at Goulburn TAFE BoM station 070263			
Annual		1,264 mm	-
Highest monthly		195 mm	January
Lowest monthly		33 mm	June

Figure 2.2 compares mean monthly evaporation and rainfall from the Goulburn and Moss Vale stations, respectively. Rainfall is relatively consistent throughout the year, although rainfall slightly decreases in the months of August and September. A soil moisture deficit is likely from September to March when evaporation typically exceeds rainfall. The long-term regional average annual rainfall for the project area is about 957 mm and is slightly lower than that observed at the Moss Vale station; this approximation is based on area-weighting of 20 nearby BoM climate stations (Coffey 2016b).



Source: EMM (2018); DFSI (2017); Hume Coal (2017)

Topography

Hume Coal Project
Revised Water Assessment
Figure 2.1

Evaporative losses from Medway Dam are about 100 ML per year. This is a conservatively low estimate of the losses based on the lake evaporation data used in the assessment and the water surface area of the Medway Dam waterbody. Further details are included in Appendix D (WSP PB 2016c).

In each technical study included in Appendices D - J, the source of the climatic data used has been selected based on its appropriateness in data completeness or spatial coverage. For example, the water balance assessment (WSP 2018) used the SILO Data Drill data, which are interpolated estimates of climatic data at point locations derived from BoM stations (DSITIA 2015). This dataset is considered more appropriate for water balance modelling than individual BoM station data as it provides a long-term climate sequence. The flood assessment (WSP PB 2016d) required climate data specific to the flood assessment study area (the surface infrastructure area and the surrounding Medway Rivulet and Oldbury Creek catchments), and thus, the closest BoM stations and a Hume Coal weather station were used as data sources. Conversely, the numerical groundwater model used area-weighted data from 20 BoM climate stations (as mentioned above) covering a much broader area to better represent the climate of the numerical groundwater model's larger study area (Coffey 2016b). As a result, climatic statistics, including averages, referenced in each technical report vary slightly.

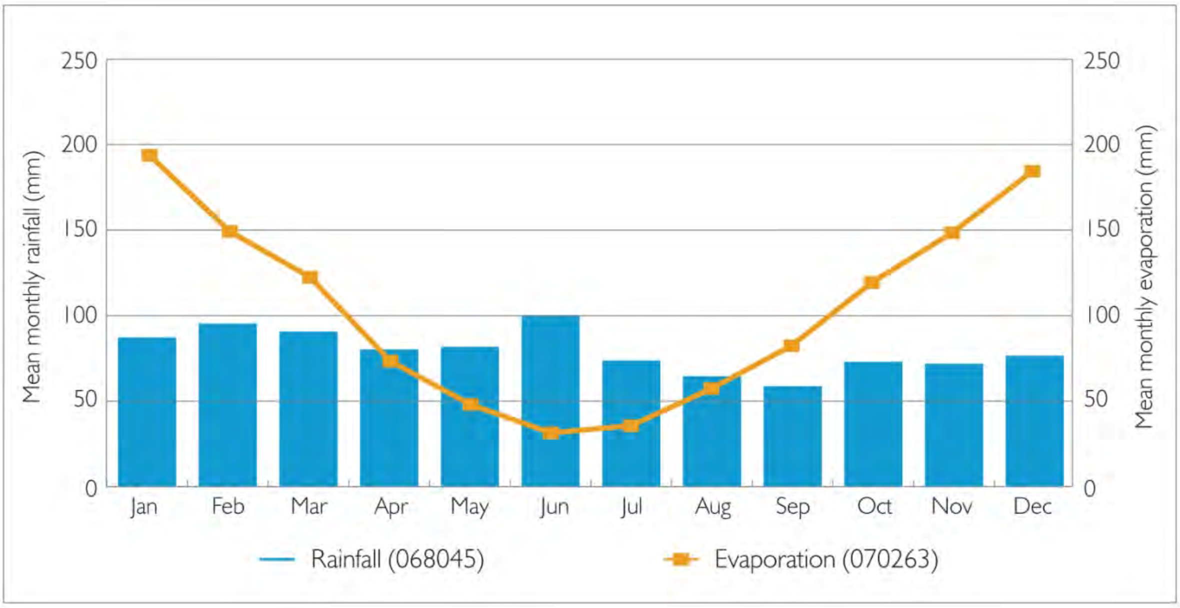


Figure 2.2 Mean monthly rainfall and evaporation

i Cumulative deviation rainfall

The long-term annual cumulative deviation from the mean (CDFM) of rainfall at Moss Vale (from 1900 to 2014) is plotted in Figure 2.3.

The CDFM plot is made by subtracting the mean annual rainfall (calculated from the whole dataset) from the actual annual rainfall observed in each particular year. Periods of below average rainfall plot as a downward trend while periods of above average rainfall plot as an upward trend. These deficits and excess in rainfall can also correspond to falling and rising groundwater levels respectively.

The CDFM plot for Moss Vale shows that for the 43 years from 1948–1991 rainfall was mainly above average, with the exception of two short-term below average periods. Rainfall from 1991 to 2011 was below the long-term average. Rainfall has been above average since 2011.

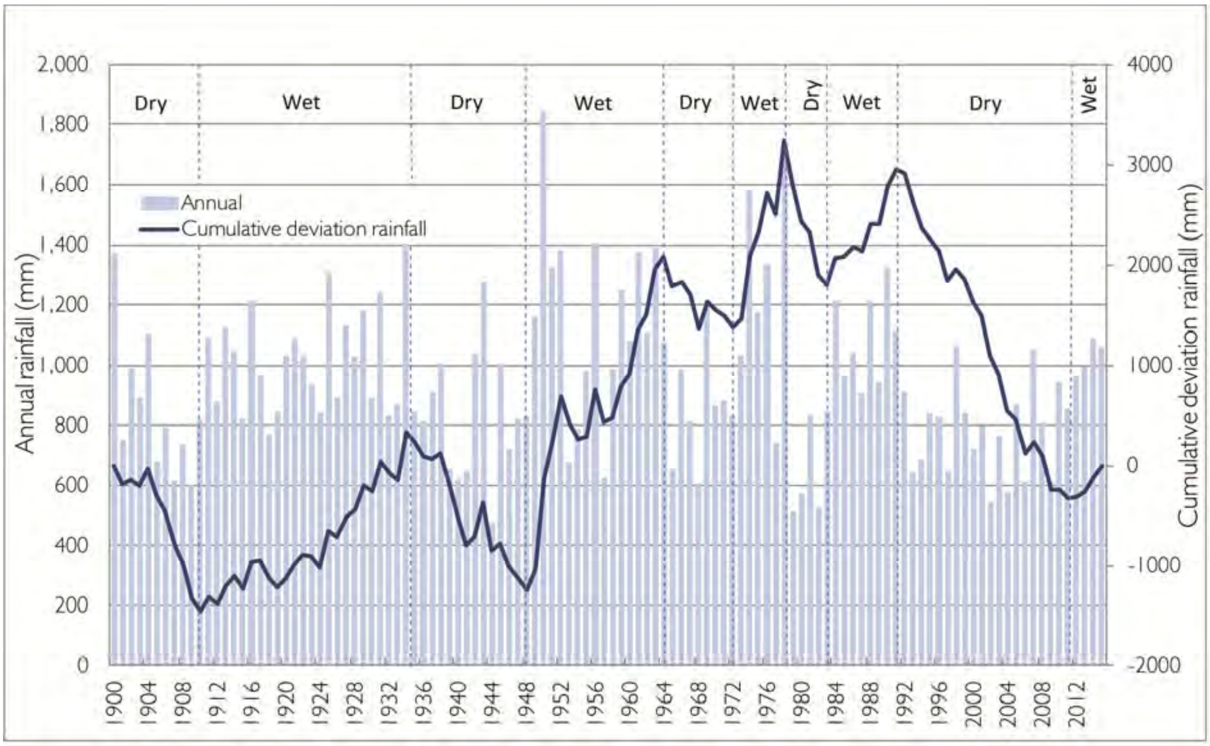


Figure 2.3 Annual cumulative deviation from the mean of rainfall (1900 – 2014)

2.1.4 Water resources

The project area and most of A349 are within the Wingecarribee River catchment, a sub-catchment of the Hawkesbury-Nepean River catchment. A small portion of the south-eastern corner of A349 is within the Bundanoon Creek catchment, a sub-catchment of the Shoalhaven River catchment (WSP PB 2016c). The surface water resources of both these sub-catchments are managed under the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. The Wingecarribee River catchment is part of the Upper Nepean and Upstream Warragamba Water source in this water sharing plan.

The groundwater resources of the project are entirely within the Sydney geological basin, and are managed under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. This water sharing plan divides the Sydney geological basin, and the project area is situated within the Nepean Management Zone 1 of the Sydney Basin Nepean Groundwater Source.

A detailed description of the water resources is provided in Chapters 5 and 6. A summary of the surface water and groundwater resources is provided below.

i Surface water resources

The Wingecarribee River catchment is a southern (upstream) sub-catchment of the larger Hawkesbury-Nepean River catchment, and is some 225 km^2 in area. It forms part of the 9,051 km^2 Warragamba Dam catchment, which supplies water to Sydney. The Hawkesbury-Nepean River catchment has an area of about 21,400 km^2.

The Warragamba Drinking Water catchment is managed by WaterNSW. Around one quarter of Warragamba Dam's catchment comprises 'special areas' where public access and land use are carefully regulated to protect water quality. The project area is not within a special area, nor is the nearby Medway Dam (refer to Figure 2.4).

The surface facilities will be within the Medway Rivulet and Oldbury Creek catchment areas, which form part of the Medway Rivulet Management Zone, flowing into the Wingecarribee River (Figure 2.4) within the Upstream Warragamba and Upper Nepean Unregulated River Water Source. The project area is traversed by several drainage lines (including creeks) generally flowing north to north-westerly, all of which discharge to the Wingecarribee River, at least 5 km downstream (north-west) of the project area boundary. Surface water features in and surrounding the project area are shown in Figure 1.4, and include the following local sub-catchments of the Wingecarribee River catchment:

- Medway Rivulet catchment, incorporating Medway Rivulet sub-catchment and Oldbury Creek sub-catchment (shown in Figure 2.4), where most of the project area and the surface infrastructure is located; and

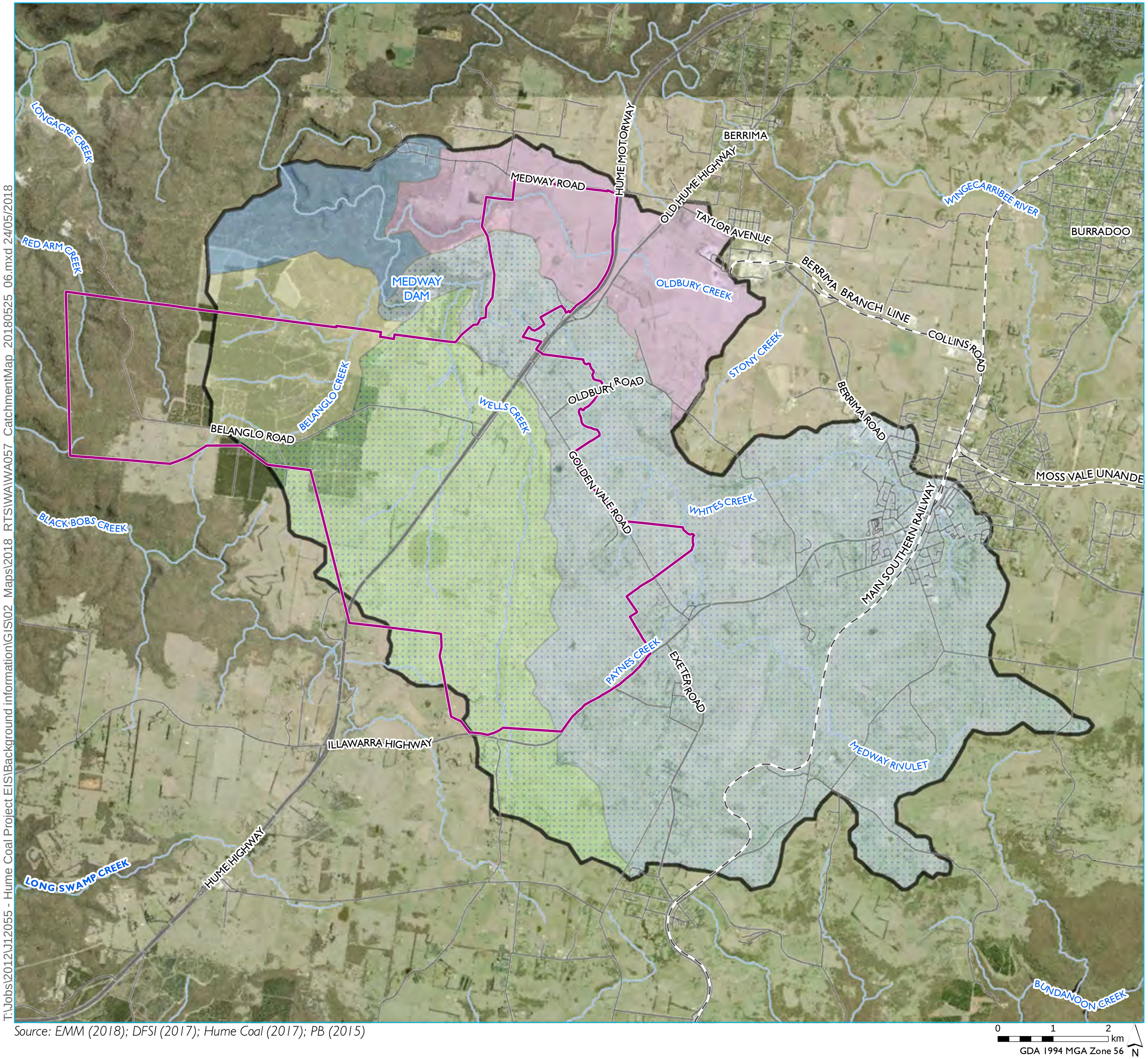
- Black Bobs Creek catchment, incorporating Red Arm Creek and Longacre Creek catchments.

The Wingecarribee River flows east to west, north of the project area. The median flow in Medway Rivulet and Oldbury Creek are 5 ML/day and 0.014 ML/day respectively, compared with a median flow in the Wingecarribee River, into which they eventually flow, of 30.1 ML/day (WSP PB 2016c).

Medway Rivulet is the main drainage line in the project area. Its primary tributaries include Oldbury Creek, Paynes Creek, Wells Creek, Wells Creek tributary and Whites Creek. The headwaters of Medway Rivulet start near Moss Vale. Surface water flow is influenced by several in-stream storages that impede continuous flow within the upper catchment. Near the project surface infrastructure area, Medway Rivulet is confined by steep gullies (WSP PB 2016c). Downstream of the project area, Medway Rivulet has been dammed to create Medway Dam, a relatively small (1,350 ML) reservoir that is part of Wingecarribee Shire Council's water supply system. Treated sewage from the Moss Vale sewage treatment plant discharges into Whites Creek, which is a tributary of Medway Rivulet upstream of Medway Dam.

Medway Dam, shown in Figure 2.4, is a prescribed dam under Schedule 1 of the *Dams Safety Act 1978*. This dam is outside the project area and no mining will occur beneath it or its Notification Zone. It supplies an 8 ML/day capacity water treatment plant that can provide water to Berrima and back-up supply to parts of Bowral and Mittagong and the Wingecarribee LGA system, but has not been operational since June 2013. The main water supply for these communities and the locality more broadly is from Wingecarribee Reservoir, around 14 km east of the proposed underground mining area, which has a 40 ML/day capacity water treatment plant. Additional back-up or supplementary supply is from Bundanoon Creek Dam.

Oldbury Creek begins near New Berrima and joins Medway Rivulet 1.5 km downstream from Medway Dam. Similarly to Medway Rivulet, the creek is characterised by several in-stream storages that impede continuous flow within the upper catchment. A large agricultural in-stream storage dam is near the northern part the surface infrastructure area. The treated sewage from the Berrima sewage treatment plant discharges directly into Oldbury Creek.



Source: EMM (2018); DFSI (2017); Hume Coal (2017); PB (2015)

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Subcatchments of the Medway Rivulet Management Zone

Hume Coal Project
Revised Water Assessment
Figure 2.4

HUMECOAL PROJECT

EMM

ii Groundwater resources

The groundwater units within the project area are defined as:

- localised low permeability groundwater systems associated with the Robertson Basalt and Wianamatta Group shales;
- regional porous fractured rock groundwater system located in the Hawkesbury Sandstone; and
- localised water bearing zones associated with the Illawarra Coal Measures and the Shoalhaven Group.

In addition, localised groundwater systems can be associated with unconsolidated Quaternary alluvium in major streams and river valleys within the region (ie the upper reaches of the Wingecarribee River), although not within the project area.

The Hawkesbury Sandstone is the main groundwater bearing unit used in the project area, although a small number of bores are situated in the overlying shale, adjacent basalts and the underlying coal seam.

Groundwater within the Hawkesbury Sandstone is generally fresh with varying bore yields depending on final bore depth, diameter and interception of fractures. The overlying Wianamatta Group Shale has low permeability and regionally retards (an aquitard) downward groundwater flow (Ross 2014). Groundwater within the shale is generally brackish to saline with very low bore yields. Reported yields from registered bores within 9km of the centre of the project area have a median yield value of 2.0 L/s based on NSW Government records; most of these bores extract groundwater from the Hawkesbury Sandstone (DPI Water 2015b).

2.2 Mining methods overview

A non-caving mining layout and method are planned. Mining will occur sequentially in panels (not longwall panels) that are separated from each other by solid barriers of unmined coal. The proposed method is low impact and will have negligible surface and subsurface subsidence, and minimal overburden fracturing. Mining will begin in the north of the extraction area and move west then to the south. Indicative underground mine progression is shown in Figure 2.5.

Individual mining panels will be separated by wide, solid (unmined) barrier pillars to prevent direct hydraulic connection between panels. The approximately 50 m wide barrier pillars will also aid geotechnical stability.

Once mined, the panels will contain open voids that will be used for the emplacement of coal reject materials. Mine voids will be backfilled with co-disposal reject (comprised of crushed rock rejects and water from the coal processing plant mixed with up to 1% limestone), to buffer any potential oxidation reaction of sulfur in the coal. It is estimated that reject and other rock wastes will fill some 36% of the total mined volume (Coffey 2016a) and temporal process for reject emplacement is outlined.

- For approximately the first 18 months of operation, while underground void space is being created, coal rejects will be mixed with 2% limestone (to buffer pH) and stored in a temporary stockpile at surface, which will be progressively re-shaped, top-dressed and re-vegetated and then remain in place until mining finishes.

  Once all mining is complete, rejects in the temporary stockpile will be emplaced underground in the remaining mined panels.

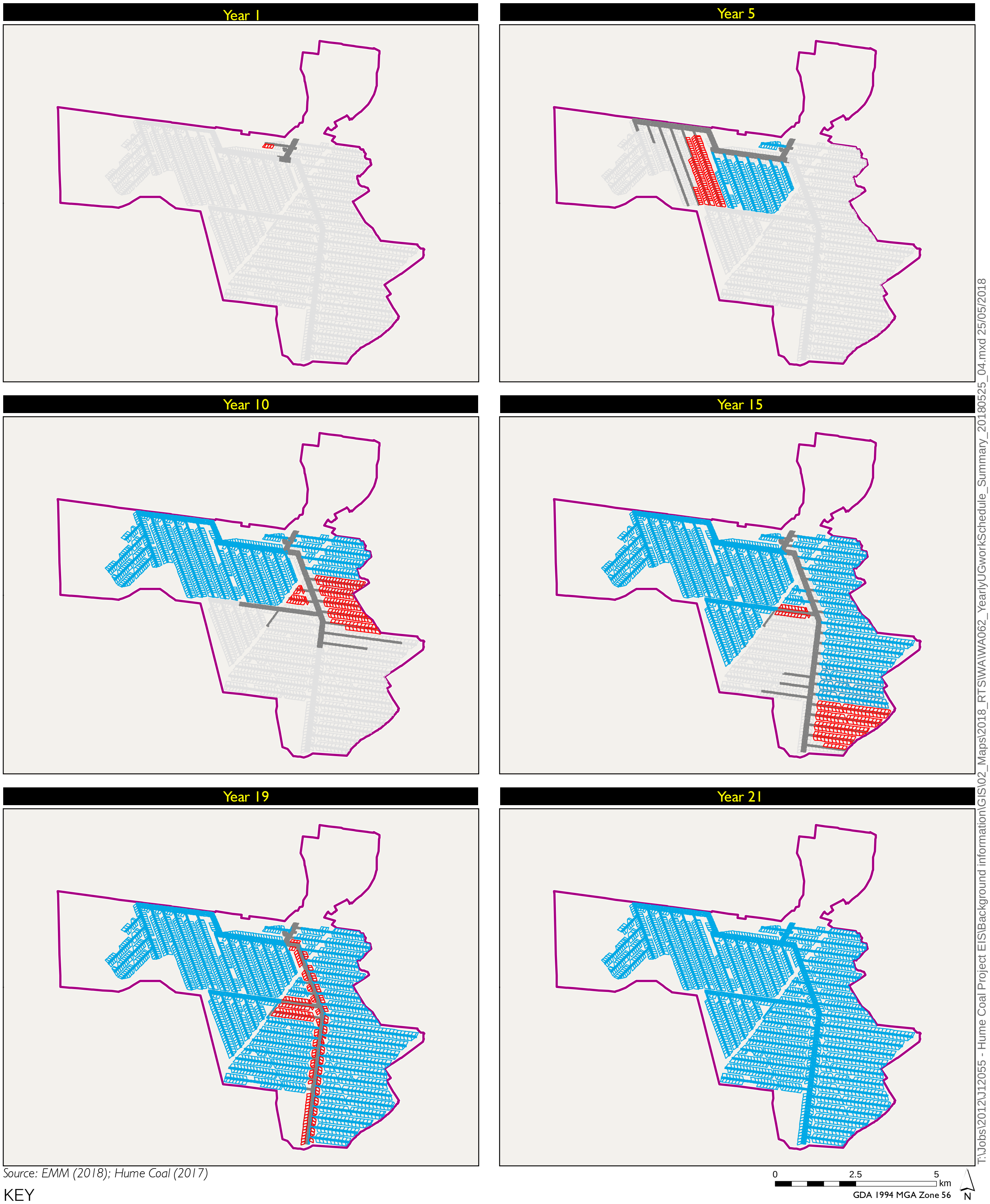
- After approximately 18 months of operation, coal rejects from processing will be mixed with water from the coal preparation plant (CPP) and 1% limestone (to buffer pH) and emplaced, essentially immediately, underground to partially back-fill mined-out voids. They will not be stockpiled at surface.

After mining and backfilling operations are complete, individual panels will be sealed at the entrance with permanent seals (bulkheads) designed to sustain anticipated groundwater pressures, at an appropriate factor of safety (nominally a factor of four). The bulkhead seals will vary in thickness depending on the anticipated groundwater pressure. Water may be added to the sealed void before total filling or abstracted thereafter through valves constructed in the bulkheads.

Active pumping of water behind the bulkheads will occur from year three (ie once the first bulkhead is sealed) through to year 19 of mining, resulting in a decreased volume of groundwater inflow to the workings and faster recovery post -mining. Once mining ceases (end of year 19) groundwater inflow to the void is expected to continue for three years (ie until all panels are full) (Coffey 2016b and HydroSimulations 2018).

Once panels are sealed and flooded, the void will become part of the greater groundwater source. Relocating mine sump water into the underground sealed voids averts the need for management and or release of that water at the surface. Facilitating groundwater storage behind the bulkheads naturally and via pumping will also greatly decrease groundwater depressurisation, and speed up the groundwater recovery time.

Minimal overburden deformation is expected to occur. Most will be small amounts of elastic deformation of the rock mass, while non-elastic deformation will be restricted to the immediate roof over the openings. The height of deformation was estimated to be 2 m into the roof above the panel (Coffey 2016b) with sensitivity analysis demonstrating that groundwater inflows would not be sensitive to doubling this height of deformation. Within the deformation (dilated) zone, existing cleats or defects may become enlarged and minor cracking may occur, which could increase hydraulic conductivity. The deformation zone is likely to become desaturated during mining activities. Above this zone, deformation will be negligible and groundwater saturation of the strata would be maintained (Coffey 2016b and HydroSimulations 2018).



Source: EMM (2018); Hume Coal (2017)

KEY

- Project area
- Active underground workings
- Underground roadway
- Sealed underground workings
- Future underground workings

Indicative underground mine progression

Hume Coal Project
Revised Water Assessment
Figure 2.5

2.3 Site water management overview

AR 1: Surface and groundwater usage and management

AR 17: Proposed management and disposal of produced or incidental water

AR 26: Provide a description of any site water use (amount of water to be taken from each water source) and management including all sediment dams, clear water diversion structures with detail on the location, design specifications and storage capacities for all the existing and proposed water management structures

AR 42: Description of all works and surface infrastructure that will intercept, store, convey, or otherwise interact with surface water resources

AR 45: Works likely to intercept, connect with or infiltrate the groundwater sources

AR 46: Any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes

AR 57: Proposed methods of the disposal of waste water and approval from the relevant authority

AR 79: A full description of the development including those aspects which have the potential to impact on the quality and quantity of surface and groundwaters at and adjacent to the site, including:

- *the mining proposal and mine layout*
- *the location, mapping and geomorphology of all creeks and water resources overlying and adjacent to the proposed mining area*
- *the hydrogeological fluxes between surface and groundwaters, including the filling of pine feather voids*
- *the location, management and storage of all hazardous materials- the disposal of wastes from the treatment of mine waters in the mine water treatment plant*
- *the management of dirty water from the washing and preparation of coal for transport*
- *the location, sizing and description of all water quality management measures*
- *the location and description of all water monitoring points (surface and ground waters)*
- *on-site domestic (sewage) wastewater management*

AR 80: A detailed assessment of the development on water resources which considers the design, construction, operational and decommissioning phases and have regard for operation during periods of wet weather and include:

- *details of measured and predicted coal mine, preparation area and stockpile area performance with respect to water quality management*
- *details of measures proposed to be adopted to offset impacts associated with construction activities eg earthworks, vegetation clearing and track construction*
- *impacts on overlying and adjacent creeks and water resources within risk management zone associated with subsidence*
- *impact of the proposed on-site domestic (sewage) wasterwater management and associated effluent disposal area*
- *pre-development and post development run off volumes and pollutant loads from the site*
- *details of the measures to manage site water associated with processing coal and coal reject, general stormwater runoff and any human activities likely to affect water quality at the site, and how neutral or beneficial effect on water quality (NorBE) principles will be assessed and applied*
- *assessment of the impacts of the development on receiving water quality and volume, both surface and groundwater including from the filling of pine feather voids and associated impact on interaction and baseflows of surface waters*
- *details of the structural stability, integrity, ongoing maintenance and monitoring of all site water management measures including dams over the life of the project*
- *details of proposed monitoring of groundwater levels, surface water flows, groundwater and surface water quality, along with information as to how the proposed monitoring will be used to monitor, and, if necessary, mitigate impacts on surface water and groundwater resources*
- *the principles outlined in the 'Managing Urban Stormwater - Soils and Construction - Mines and Quarries' Manual prepared by the Department of Environment and Climate Change (2008)*

2.3.1 Water demand and supply

During construction, the project's water needs will be sourced via licensed groundwater bores, located on land owned by Hume Coal. Potable water will also be sourced from water supply bores and/or trucked to site and stored in tanks, both at construction sites and the accommodation village.

During operation the project will require water for a range of uses including:

- coal preparation plant (CPP) process water;
- co-disposed reject make-up water;
- product coal handling water;
- ROM stockpile water;
- underground operations water;
- administration and workshop area water; and
- accommodation village consumption and cleaning.

The water volumes for the various demands over the mine's 19-year life are presented in Figure 2.6. These volumes were inputs to the water balance model, which is discussed further in Section 8.2.

Potable water will continue to be sourced from bores and/or trucked to site and stored in tanks during mine operation. Water for use in amenities (non-potable) will be sourced from bores. This volume is negligible and, so is not included in the water balance model or shown in Figure 2.6.

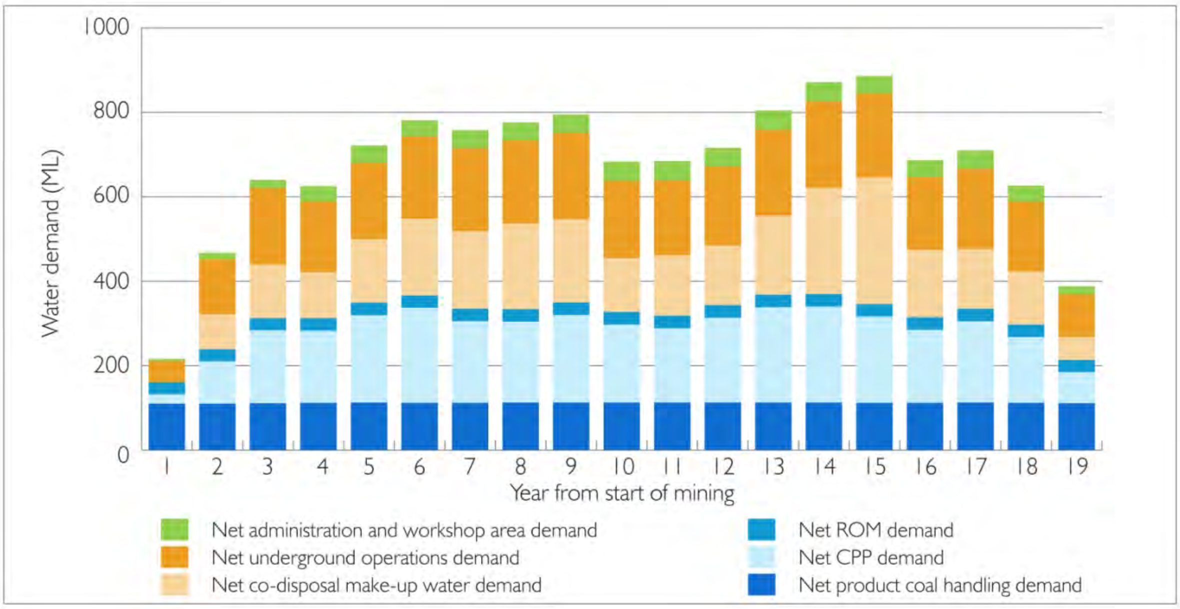


Figure 2.6 Project water demands

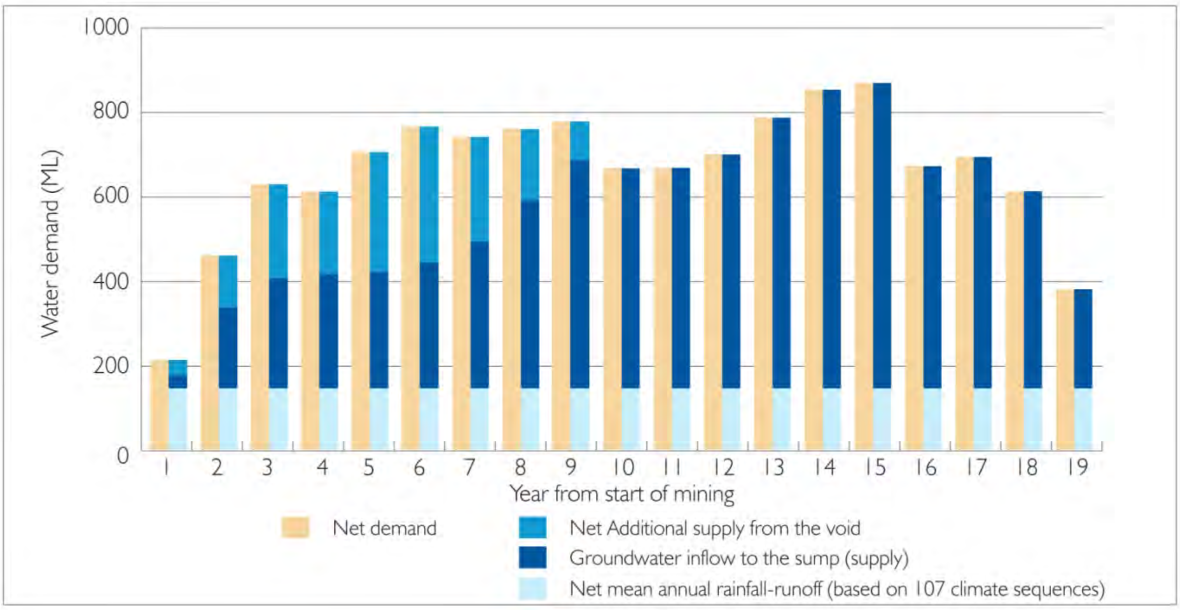
As discussed in Section 8.2, the water balance model (WSP 2018) was run for 107 sets of climatic sequences for the duration of 19 years of mining. The water balance model estimates surpluses and deficits in meeting total annual project demands from available water supplies and it shows that project demands will be fully met by using:

- rainfall-runoff from the mine water dams;
- groundwater collected in the underground mine sump (where groundwater inflow to underground workings will be captured); and
- additional groundwater abstracted from behind the sealed mine void bulkheads as required.

Figure 2.7 show the relationship between project water demand and water supply sources used to meet these demands. The primary water supply sources will be captured rainfall-runoff, and groundwater inflow to the sump. In some years additional demands will be met by abstracting water from sealed mine voids.

Excess supply of water will be managed by pumping to the void behind the bulkheads. If the void space is full and cannot take excess water, and the primary water dam (PWD) volume is also above the adopted capacity then the excess water will be treated in a water treatment plant (WTP) for release into Oldbury Creek, if required. The WTP is included in the project infrastructure as a provisional item only. In all climate sequences modelled, the water balance model indicates that the PWD has adequate capacity to store excess supply and that treatment and release will not be required.

Rainfall-runoff from two areas on the surface infrastructure not in direct contact with coal will be released directly into Oldbury Creek following confirmation that first-flush and water quality parameters have been met (refer to Section 2.3.2iii).



(based on mean annual climate sequence from 107 climate sequences)

Figure 2.7 Project water demands and supply volumes

2.3.2 Mine infrastructure and water management

AR 33: Information on the purpose, location, construction and expected annual extraction volumes including details on all existing and proposed water supply works which take surface water, (pumps, dams, diversions, etc)

AR 34: Details on all bores and excavations for the purpose of investigation, extraction, dewatering, testing and monitoring. All predicted groundwater take must be accounted for through adequate licensing

AR 35: Details on existing dams/storages (including the date of construction, location, purpose, size and capacity) and any proposal to change the purpose of existing dams/storages

AR 36: Details on the location, purpose, size and capacity of any new proposed dams/storages

The mine infrastructure will consist of the following:

- mine access, ventilation systems, and shaft(s);
- the administration and workshop area, including: administration, bathhouse, wash-down, workshop, fuel depot and lubricant storage facilities, warehouses, laydown areas, an explosives magazine, and other facilities;
- surface and groundwater management and treatment facilities including: dams, drains, sumps, pipelines, pumps and associated infrastructure;
- coal preparation plant and stockpiles including: coal product stockpile areas, conveyors, transfer points, a tertiary sizing station, enclosed screening station, coal washing facilities and a reject co-disposal reject plant;
- overland conveyors;
- train load-out facilities;
- ancillary facilities including: fences, access roads, car parking areas, a helipad, and communications and electricity reticulation infrastructure; and
- environmental management and monitoring equipment.

The surface facilities will be within the Medway Rivulet and Oldbury Creek catchment areas, which form part of the Medway Rivulet Management Zone within the Upstream Warragamba and Upper Nepean Regulated River Water Source. Rainfall within the infrastructure area will enter the mine water management system via a series of stormwater basins (SBs) or mine water dams (MWDs). Surface water and rainfall outside of the mine infrastructure area will be diverted back into the natural catchment areas.

The surface infrastructure area and underground mine workings are within Zone 1 of the Sydney Basin, Nepean Groundwater Source. Water intercepted in active mining areas will be pumped into the mine sump and enter the mine water management system. Water that flows or is pumped into the sealed mine void will remain an accessible part of the water source available for access from the surface by other users. Some of the void water may be harvested to supplement water supplies during times of deficit.

The water management infrastructure is shown in Figure 1.6.

i Water management system

The water management system for the project is detailed in the Hume Coal Project Water Balance Assessment Report (WSP PB 2016a). The water management system is based on the infrastructure layout plan and flowchart by prepared Arkhill Engineers (WSP PB 2016a). The water management system will be implemented during operation to prevent contamination of local waterways, and will aim to use mine water as a priority to meet all demands (with the exception of potable water) over imported water. If the water demand cannot be fully met from the harvested rainfall-runoff and the groundwater collected from the mine sump, the water supply will be supplemented by harvested water from the sealed voids. Surface water runoff from areas of the site in direct contact with coal will be fully contained within the mine water management system to prevent discharge to local waterways. The water management objectives are to reuse water on site and minimise the release to more sensitive environmental areas.

The site water management involves:

- Runoff from undisturbed areas being diverted around or away from the infrastructure into natural watercourses via clean water diversion drains.

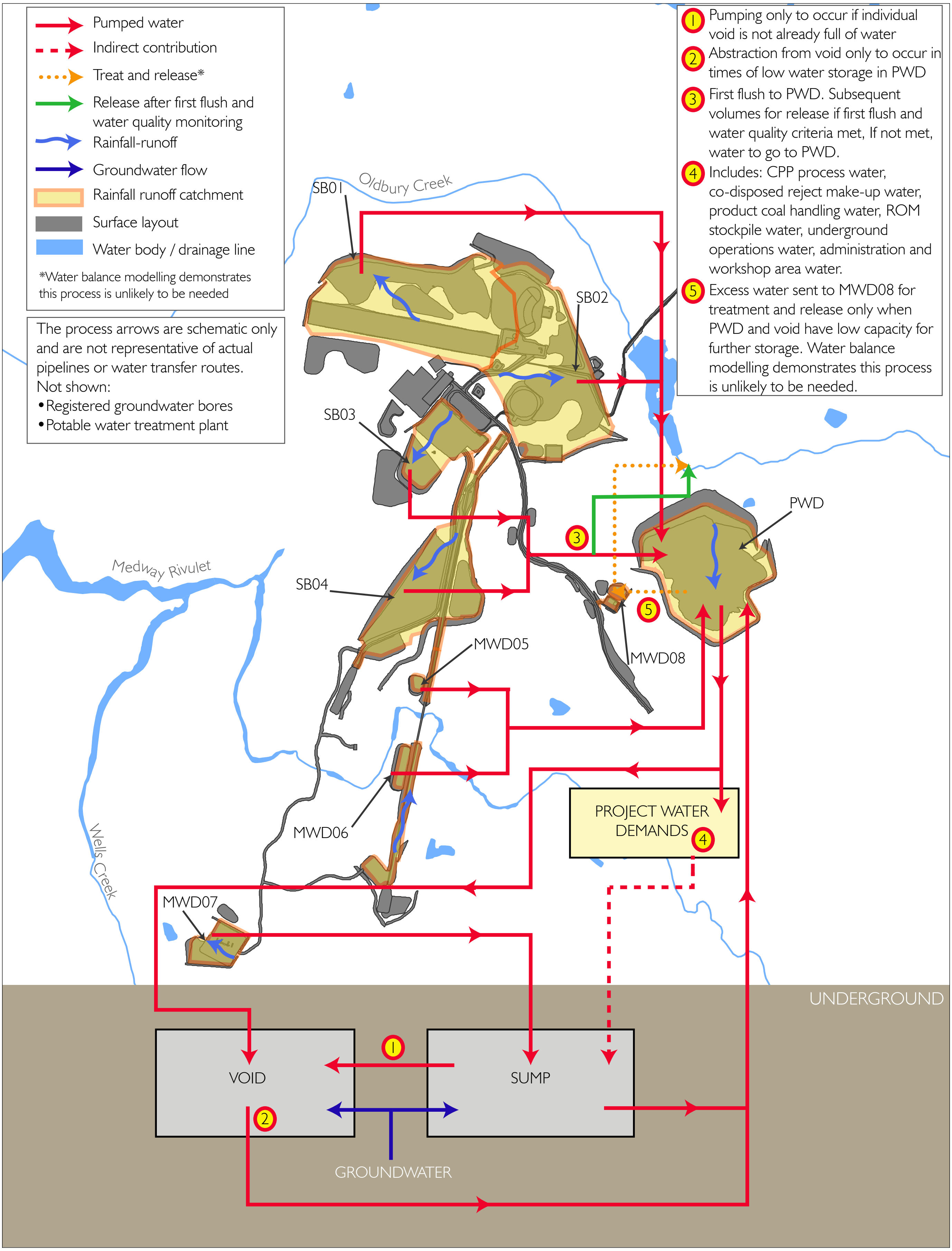
- Runoff from disturbed areas within the mine infrastructure footprint being directed to the SBs, MWDs and the PWD for storage and reuse.

- Runoff from areas where there is a low risk of coal contact (ie runoff from areas that do not contain coal stockpiles or the processing plant but that could contain small amounts of coal due to mine vehicle traffic) may be released to local creeks after collection of the first flush has been diverted into storage and reuse dams, and monitoring shows that post-first flush runoff is of an acceptable quality to release.

- Runoff from areas where there is a low risk of coal contact and that does not meet the adopted first flush criteria being transferred to the PWD for storage.

- Sewage from the administration and workshop area being treated and reused on site during operation. Grey water will be subject to primary treatment and reused. Black water will be subject to tertiary treatment and reused in the CPP.

Site water management is summarised schematically in Figure 2.8 and discussed in detail in the following sections.



Water management schematic
Hume Coal Project
Revised Water Assessment
Figure 2.8

ii Dam and basin functions and water storage controls

There are no existing dams outside of the surface disturbance area that will be used as part of the project. There are about four minor agricultural dams within the surface disturbance area that will need to be removed and filled or otherwise incorporated in the earthworks design. A road that traverses an instream storage within Oldbury Creek will be widened to accommodate surface infrastructure; however, the instream storage's purpose or capacity will not be modified. Proposed water storage infrastructure for the project is discussed below.

The PWD will contain the runoff from coal contact areas, such as the CPP, ROM and product stockpiles. This dam will be maintained at adequate volume to provide enough storage for runoff collected at the MWDs during and after rainfall events. The dam will also supply water for all project water demands other than potable water, which will be sourced externally from licensed groundwater bores.

SB01 will collect runoff from the product stockpile and the temporary reject areas. Water collected in this basin will be transferred to the PWD for storage and reuse.

SB02 will collect runoff from the ROM stockpile and return water from the coal handling plant. Water collected in this basin will be transferred to the PWD for storage and reuse.

SB03 will collect runoff from the administration and workshop area. Water collected in this basin will not come into direct contact with coal or reject stockpiles. Water will be transferred to the PWD if the corresponding rainfall does not meet the first flush criteria. When the rainfall meets the first flush rainfall and water quality criteria, then water may be released to Oldbury Creek. This will minimise any reduction in flows that occurs due to runoff harvesting for the project water management.

SB04 will collect runoff from the mine road and conveyor corridor area north of Medway Rivulet. Water will be transferred to the PWD if the corresponding rainfall does not meet the first flush criteria. When the rainfall meets the first flush rainfall and water quality criteria, then water may be released to Oldbury Creek. This will minimise any reduction in flows that may occur due to runoff harvesting for the project water management.

MWD05 will collect runoff from the overland conveyor number 1 corridor, which will then be transferred to the PWD for storage and reuse. Technically, water from this dam could be handled in the same manner as water from SB03 and SB04; however, the catchment area is small and it is simpler to transfer it directly to the PWD.

MWD06 will collect runoff from the area in between the conveyor portal and the overland conveyor number 1 corridor, which will then be transferred to the PWD for storage and reuse. Technically water from this dam could be handled in the same manner as water from SB03 and SB04; however, the catchment area is small and it will be simpler to transfer it directly to the PWD.

MWD07 will collect runoff from the ventilation shaft pad area, which is then transferred to the underground mine sump via a borehole or pipe in the ventilation shaft for reuse or pumping into the void. This avoids the need for an overland pipeline from this location.

MWD08 is designed to operate with a water treatment plant (WTP), if required, near the PWD before water is released to Oldbury Creek. This dam, along with the WTP, is included as provisional infrastructure in the unlikely event that excess water stored in the PWD may need to be treated and released to Oldbury Creek. The water balance modelling indicates that this is not required for all climate sequences tested. This dam is not included in the water balance model as it is part of the provisional WTP and independent of the mine water balance, which covers transfer of water between the SBs, other MWDs, the underground mine, and the PWD. The capacity of this dam and the WTP would be determined during the detailed design stage of the project, if required.

The underground mine sump (sump) is the primary collection point for excess water in the underground mine. The sump will receive most inflows of groundwater originating from Zone 1 of the Sydney Basin Nepean Water Source. The sump will also receive water transferred from MWD07 and excess water from underground mining equipment operations, such as sprays.

Once a panel has been mined and the bulkhead is installed, the sealed void will receive excess water from the sump and the PWD. Water stored within a void behind a bulkhead will then begin receiving groundwater, allowing the system to recover more rapidly than it otherwise would. It will also provide a source of water that can be accessed to supply to the PWD if needed during particularly dry years.

Sediment dams will be constructed during the construction phase of the project. They will release water to the local catchment once the sediments are settled. When mining starts, these dams will not be part of the water management system and so have not been included in the water balance modelling.

Above-ground tanks will be used to store smaller volumes of water around the surface infrastructure area.

iii First flush criteria for SB03 and SB04

As discussed in Section 3.5.19, the following first flush criteria were developed for the project based on the applicable EPA guideline (NSW EPA 2013):

- The first flush is assumed to have occurred once the rainfall exceeds 20 mm in any 24-hour period. On such days, runoff could be released from SB03 and SB04 to Oldbury Creek, if water quality criteria are also met.

- Testing for total dissolved solids (TDS) and pH will be used to determine whether water quality is acceptable to be released. Results will be compared to trigger thresholds developed from baseline monitoring data.

- The first flush collected in SB03 and SB04 will be pumped to the PWD and contained within the mine water management system to prevent pollution of local streams. Only once the first flush collected in SB03 and SB04 has been pumped to the PWD will water from these two catchments be released to Oldbury Creek provided water quality criteria are met.

- From the day of occurrence of the first flush, subsequent daily rainfall amounts less than 20 mm for the next four days are assumed to produce clean runoff and releases will be allowed to continue to Oldbury Creek.

- If daily rainfall remains less than 10 mm after the fifth day, no runoff will be released to Oldbury Creek until the next first flush event. If daily rainfall depth is above 10 mm, releases will continue until rainfall drops below 10 mm per day.

In the event that water quality in SB03 or SB04 does not meet the water quality criteria, water will not be released to Oldbury Creek and will be contained within the water management system. The water balance model (refer to Section 8.2) has demonstrated that the PWD has the capacity to store all runoff from SB03 and SB04 for all climate sequences, if required.

iv Dam and basin capacities

All SBs, MWDs and the PWD will have the capacity to accommodate at least the 200 year Annual Recurrence Interval (ARI) 72 hour storm runoff volume, with the exception of MWD07 which will have the capacity to store between the 100 and 200 year ARI 72-hour storm runoff volumes. Proposed capacities and catchment areas are listed in Table 2.2.

The capacities of these dams were based on physical constraints and the requirement that no dam overflows would occur when the dams are operated as part of the overall site water management system under historical climate conditions, including wet and dry sequences.

The capacity of the PWD has been sized to hold all water on site without the need to dispose of excess water in local waterways. The adopted dam capacity of 730 ML is significantly larger than the volume required to meet a 500 year ARI event and was assessed by the water balance modelling under historical climate conditions as able to prevent discharges for all 107 climate sequences (refer to Section 8.2).

The stage-storage-area relationships for the proposed basins and dams are based on the three-dimensional dam/basin designs (WSP PB 2016a).

The water balance modelling confirmed that the basins or dams will not spill with the adopted capacities for any of the wettest periods in the climate sequences.

Sediment dams for use during construction will be managed to achieve a neutral or beneficial effect (NorBE) on the receiving environment (WSP PB 2016b), and constructed according to the recommended criteria in the *Managing Urban Stormwater – Soils and Construction – Volume 2E Mines and Quarries* guidelines (DECC 2008) as a minimum. The sediment dams will include a 'settling zone' for temporary treatment storage and a 'sediment zone' to store sediment. The guidelines recommend that the 'settling zone' be sized to capture the 95th percentile 5-day duration storm event, and the 'sediment zone' be sized at 50% of the 'settling zone' volume. This sizing is based on a sensitive receiving environment and site disturbance duration of more than three years and would result in an average sediment dam overflow frequency of one to two overflows per year.

Table 2.2 Proposed basin and dam capacity summary

ID	Description	Catchment area (ha)	Proposed capacity (ML)
SB01	Proposed stormwater basin capturing runoff from product stockpile area	26.36	106.4
SB02	Proposed stormwater basin capturing runoff from CPP and ROM areas	22.64	91.1
SB03	Proposed stormwater basin capturing runoff from administration and workshop area	5.91	19.4
SB04	Proposed stormwater basin capturing runoff from mine road and conveyor embankment	14.73	140.2
MWD05	Proposed mine water dam capturing runoff from north of Medway Rivulet – overland conveyor no. 1	0.64	5.9
MWD06	Proposed mine water dam capturing runoff from south of Medway Rivulet – conveyor portal	2.69	14.8
MWD07	Proposed mine water dam capturing runoff from ventilation shaft pad dam	2.60	5.7
MWD08	Proposed mine water dam capturing runoff from water treatment area, if required	0.27	4.1
PWD	Proposed primary water dam storing mine water pumped from stormwater basins, mine water dams and underground mine sump dewatering	18.28	730.0

v Water pipelines

Water will be moved around the project area via pipelines, and possibly by water trucks most likely during construction. Exact locations of pipelines and construction details will be determined during detailed project design.

vi Water treatment

The water management system will include the following treatment systems:

- potable water treatment plant – to treat water from onsite groundwater bores;
- commercial sewage management facility, equipped with wet weather storage and commercial spray irrigation system;
- an oil and water separator to remove hydrocarbons from water from workshop and wash down bay areas; and
- provisional water treatment plant at MWD08 if required – for treating excess water that may be released to Oldbury Creek, unlikely to be required based on water balance model results.

2.3.3 Wastewater management and release

The water management system has been designed to efficiently manage water and minimise impacts. Water management is staged, with different options being used depending on the volume of water required to be managed.

Most water will be used on site for coal processing and infrastructure requirements. Any excess of water will then be pumped underground and into the sealed mine panels that have not been completely filled. This is an important mitigation strategy that will decrease the volume of groundwater inflow to mined workings and help recover groundwater levels generally.

The operational water management and balance during mining involves minor recycling and reuse of water on site. The concentration/accumulation of contaminants within the project water supply in the PWD as a result of this will be negligible due to the very low volume re-entering the system and dilution from rainfall and groundwater inflow (both of which are fresh).

SB03 and SB04 will collect runoff not in direct contact with coal. During and immediately following high rainfall events, these basins will release water into Oldbury Creek, following the direction of the first flush into the PWD and provided that water quality criteria are met (discussed in 2.3.2iii). Runoff from catchments in direct contact with coal and/or coal reject will not be released to creeks but will be pumped to the PWD for eventual reuse or storage.

A concept on-site wastewater management assessment for the project is included in Appendix E (Harris Environmental 2018). In summary, the following features will be included as part of the wastewater management for the project:

- early in the construction phase of the construction accommodation village, installation of a commercial sewage management facility with capacity to treat up to 33,470 L per day to a secondary standard to accommodate up to 395 workers, depending on the eventual numbers of non-local construction workers;
- installation of up to 200,000 L (equivalent to seven days) of wet weather storage tanks, or potentially use a modified existing farm dam (modified to a lined, turkey's nest dam), for wet weather storage;
- commercial spray irrigation system, for treated wastewater application, to cover up to 17,470 m^2, fenced and restricted from public access;
- stormwater diversion measures to divert clean water away from the proposed irrigation area;
- cropping of fescue pasture for hay production; and
- monitoring of wastewater quality, soils and groundwater within the vicinity of the wastewater management infrastructure.

Once the project has been given Development Consent, approval to install and operate the nominated sewage management system will be sought from the Wingecarribee Shire Council in accordance with the Section 68 of the *NSW Local Government Act 1993*. The commercial facility will be installed and maintained in accordance with Section 5 of the Use of Effluent by Irrigation Guidelines (DEC 2004).

Four potential areas for commercial wastewater disposal and one potential area for domestic wastewater disposal have been identified as suitable and compliant with the relevant guidelines (SCA 2012a; DEC 2004), including application of the viral die-off method to incorporate appropriate setback distances accounting for possible subsurface wastewater movement (Cromer et al 2001). The treated wastewater will be applied using spray irrigation and will not be re-used for any other purpose.

The commercial sewage management facility will be prioritised to be installed as early as practicable during construction. Prior to its installation, temporary facilities will be utilised and sewage will be trucked offsite during this initial stage. If there is insufficient capacity at STPs within the shire at the time early construction works commence, Hume Coal will employ an appropriately licensed waste contractor to cart and dispose of the waste at the nearest STP with capacity.

Reject from the preparation plant will be placed underground in the void space. This method of reject storage is consistent with the method used by other coal mines that backfill voids with tailings. Additional details regarding groundwater quality associated with reject emplacement are provided in Section 11.2.2.

Section 6.5 of the *Hume Coal Project EIS* (EMM 2017a) discusses alternative options considered for water management. Alternative options for water management that were considered are:

- managed aquifer recharge (MAR) into specifically designed bores to recharge directly into the Hawkesbury Sandstone; and
- water treatment and use (for example, for irrigation).

Chapter 13 of this report discusses the respective merits of the alternative options.

3 Regulatory and policy context and assessment

This chapter summarises relevant Commonwealth and NSW water legislation and supporting policies and guidelines.

AR 19: Consideration of relevant policies and guidelines

AR 23: The EIS should take into account the objects and regulatory requirements of the Water Act 1912 (WA 1912) and Water Management Act 2000 (WMA 2000), and associated regulations and instruments, as applicable

AR 25: Demonstrate how the proposal is consistent with the relevant rules of the Water Sharing Plan including rules for access licences, distance restrictions for water supply works and rules for the management of local impacts in respect of surface water and groundwater sources, ecosystem protection (including groundwater dependent ecosystems), water quality and surface-groundwater connectivity

AR 27: Provide an analysis of the proposed water supply arrangements against the rules for access licences and other applicable requirements of any relevant WSP, including:

- *Sufficient market depth to acquire the necessary entitlements for each water source*
- *Ability to carry out a "dealing" to transfer the water to relevant location under the rules of the WSP*
- *Daily and long-term access rules*
- *Account management and carryover provisions*

AR 29: The EIS should take into account the following policies (as applicable):
· NSW Guidelines for Controlled Activities on Waterfront Land (NOW, 2012)
· NSW Aquifer Interference Policy (NOW, 2012)
· Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012)
· Australian Groundwater Modelling Guidelines (NWC, 2012)
· Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC, 2014)
· Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources (Australian Govt. 2014)
· NSW State Rivers and Estuary Policy (1993)
· NSW Wetlands Policy (2010)
· NSW State Groundwater Policy Framework Document (1997)
· NSW State Groundwater Quality Protection Policy (1998)
· NSW State Groundwater Dependent Ecosystems Policy (2002)
· NSW Water Extraction Monitoring Policy (2007)
· Groundwater Monitoring and Modelling Plans - Information for prospective mining and petroleum exploration activities (NOW, 2014)
· NSW Code of Practice for Coal Seam Gas Well Integrity (DTIRIS 2012)
· NSW Code of Practice for Coal Seam Gas Fracture Stimulation (DTIRIS 2012)

The primary water related statutes that apply to the project are the *NSW Water Management Act 2000* (WMA 2000), *Water Act 1912 (*WA 1912*), Protection of the Environment Operations Act 1997* (POEO Act), and the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (*EPBC Act), and their attendant regulations (including water sharing plans under the WMA 2000).

The requirements of the applicable legislation and policies and a summary of assessments of the project against key policy requirements are given in the following sections. Most critical is the NSW Aquifer Interference Policy (NOW 2012a). As such, discussion of this is included below in the context of the WMA 2000. Note also that a checklist of compliance against the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals (IESC 2014) is given in Appendix B.

3.1 Water Act 1912

The WA 1912 is gradually being repealed and replaced by the WMA 2000 as water sharing plans (WSPs) are developed for water sources across NSW, and as new regulations are made. However, some aspects of the WA 1912 are still operational across all of NSW, such as licences for monitoring bores. Monitoring bores will continue to be licensed under the WA 1912 until the aquifer interference regulation commences and provides a mechanism to approve of these activities.

3.2 Water Management Act 2000

The WMA 2000 is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WMA 2000 recognises that water management decisions must consider: economic, environmental, social, cultural and heritage factors. In addition, the WMA 2000 recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW.

The WMA 2000 provides for water sharing between different water users, including environmental, basic rights or existing water access licence (WAL) holders and provides security for licence holders.

The licensing provisions of the WMA 2000 apply to those areas where a WSP has commenced; it has progressively been enacted across NSW since July 2004. The licensing provisions of the WMA 2000 become effective for any water source once a WSP for that water source commences.

One of the key components of the WMA 2000 is the separation of the water licence from the land; this facilitates opportunities for licence holders to trade water. The WMA 2000 outlines the requirements for taking and trading water through water access licences (WALs), water supply works, and water use approvals.

The WMA 2000 is the primary legislation governing water management and licensing within the project area. The licensing requirements for mining are similar to other licensing requirements, but there are some additional policies and clauses related to mining that need consideration, in particular the NSW Aquifer Interference Policy (AIP) (NOW 2012a), and Section 60I of the WMA 2000.

3.2.1 Water sharing plans

AR 24: Describe the ground and surface water sharing plans, water sources, and management zones that apply to the project. Multiple water sharing plans may apply and these must all be described

AR 40: Identification of all surface water sources as described by the relevant water sharing plan

WSPs are statutory documents that apply to one or more water source areas. They contain the rules for sharing and managing the water resources within water source areas. The WSPs also set the water management vision and objectives, management rules for WALs, what water is available within the various water sources, and procedures for dealing in licences and water allocations, water supply works approvals and the extraction of water. WSPs are designed to establish sustainable use and management of water resources. Each WSP is in place for 10 years.

WSPs describe the basis for water sharing, and document the water available and how it is shared between environmental, extractive, and other uses. The WSPs then outline the water available for extractive uses within different categories, such as: local water utilities, domestic and stock, basic rights, and access licences.

Two WSPs are applicable for the project area and surrounds. These WSPs cover numerous water sources, which are then subdivided into management zones, as described below.

Surface water

Water Sharing Plan for the Greater Metropolitan Region, Unregulated River Water Sources 2011 (Metropolitan surface water WSP):

- Upper Nepean and Upstream Warragamba Water Source:
  - Medway Rivulet Management Zone.
  - Lower Wollondilly River Management Zone.
  - Upper Wingecarribee River Management Zone.
  - Lower Wingecarribee River Management Zone.
  - Nattai River Management Zone.
- Shoalhaven River Water Source:
  - Bundanoon Creek Management Zone.

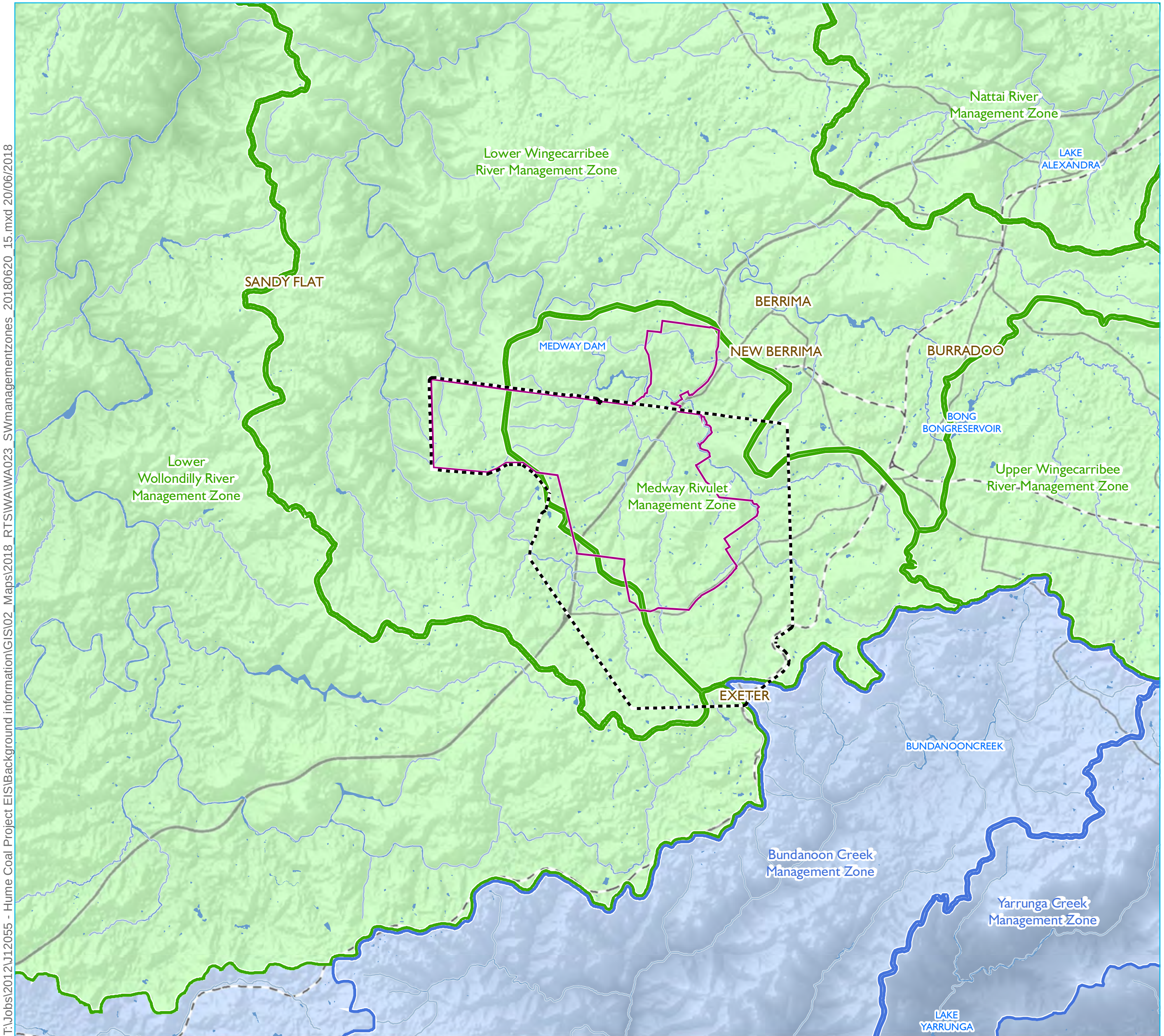
Groundwater

Water Sharing Plan for the Greater Metropolitan Region, Groundwater Sources 2011 (Metropolitan groundwater WSP):

- Sydney Basin Nepean Groundwater Source:
  - Nepean Management Zone 1.
  - Nepean Management Zone 2.
- Sydney Basin South Groundwater Source.

The WSP, water source, and management zone boundaries are shown in Figure 3.1 and Figure 3.2.

The project area is physically within and overlying the Upstream Nepean and Upstream Warragamba Water Source – Medway Rivulet and Lower Wingecarribee River Management Zones, and the Sydney Basin Nepean Zone 1 Groundwater Source. The project's effects regarding water sharing and licensing requirements are discussed in Chapter 12.



Source: EMM (2018); DFSI (2017); Hume Coal (2017); DPI (2013)

KEY

- Project area
- A349

Greater Metropolitan Water Sharing Plan, Unregulated Rivers

- Shoalhaven River Water Source
- Management zone within the Shoalhaven River Water Source
- Upper Nepean and Upstream Warragamba Water Source
- Management zone within the Upper Nepean and Upstream Warragamba Water Source

Existing features

- Main road
- Rail line
- Watercourse

Surface water management zones

Hume Coal Project
Revised Water Assessment
Figure 3.1

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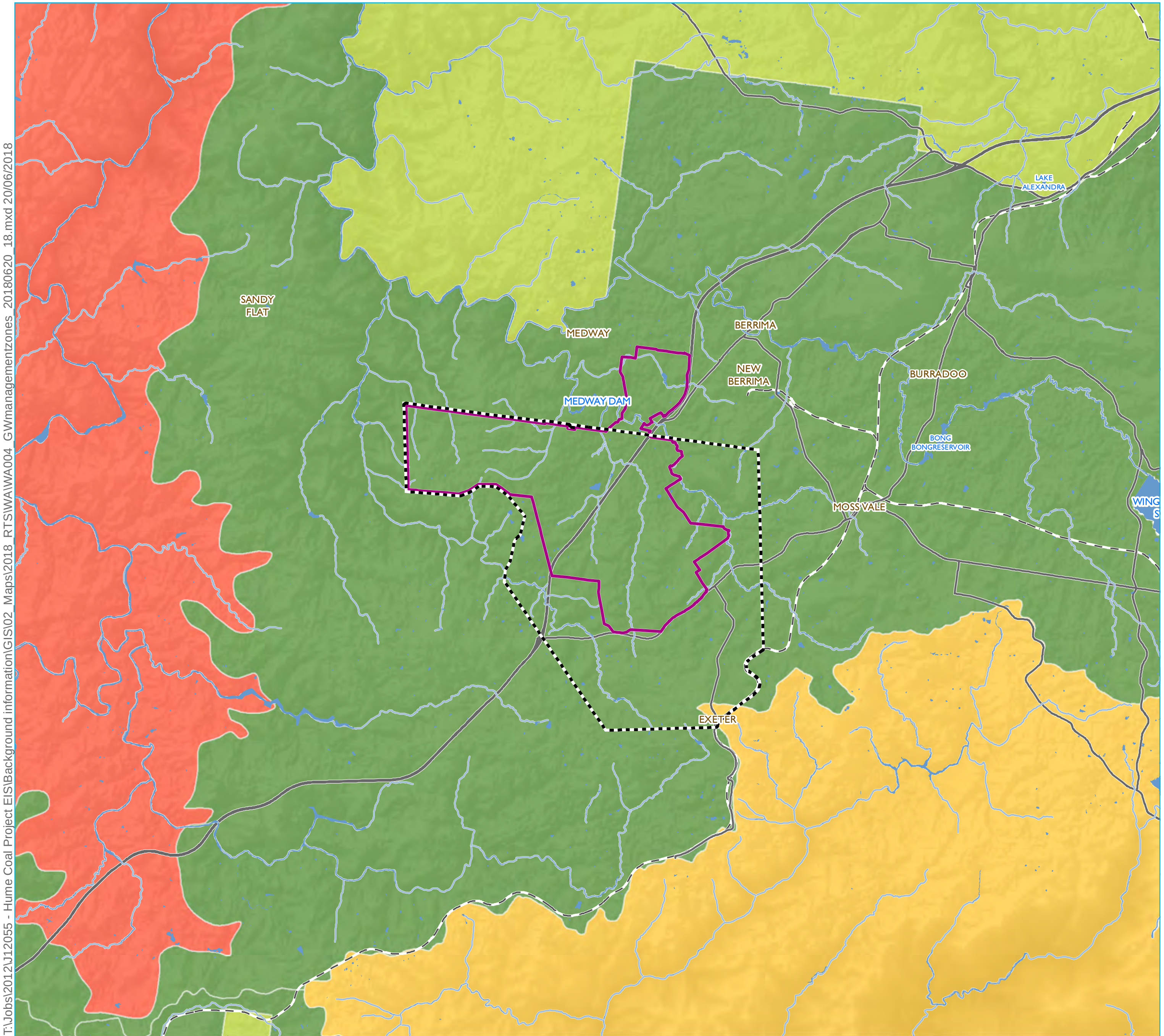


KEY

- Project area
- A349

Water Sharing Plan for the Greater Metropolitan Region Groundwater Source (2014)

- Sydney Basin Nepean Groundwater Source (Nepean Zone 2)
- Sydney Basin Nepean Groundwater Source (Nepean Zone 1)
- Sydney Basin South Groundwater Source
- Goulburn Fractured Rock Groundwater Source

Existing features

- Main road
- Rail line
- Drainage line
- Waterbody

Source: EMM (2018); DFSI (2017); Hume Coal (2017)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

T:\Jobs\2012\J12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2018_RTS\WA\WA004_GWmanagementzones_20180620_18.mxd 20/06/2018

Groundwater management zones

Hume Coal Project
Revised Water Assessment
Figure 3.2

i Environmental water

Planned environmental water is water prescribed under the rules of a water sharing plan to protect the aquifer and GDEs (for groundwater) or the river and streams systems and associated ecosystems (surface water).

For groundwater, environmental water typically is defined as 100% of the storage volume within the aquifers as well as a proportion of the annual recharge volume. The environmental water volume set aside in the Metropolitan groundwater WSP for the Sydney Basin Nepean Groundwater Source is estimated to be 63,224,915 ML/yr; which is 100% of the storage (estimated at 63,100,000 ML) and approximately 56% (124,915 ML/yr) of the annual recharge (224,483 ML/yr). The volume that is able to be made available for extraction is called the long term average annual extraction limit (LTAAEL) and is equal to 99,568 ML/yr, or 0.16% of the total volume of water in that system (ie storage and annual recharge). The maximum annual volume of water that the project proposes to intercept from the Sydney Basin Nepean Source is 2,067 ML/yr, which is 2% of the LTAAEL and 0.003% of the total volume in the system. Figure 3.3 represents the environmental water, recharge, and LTAAEL components for the Sydney Basin Nepean Groundwater Source.

The environmental water provisions in the Metropolitan surface water WSP have complex environmental flow rules and daily release volume stipulations from various dams.

ii Water availability and licences

The groundwater presence, availability and licences for the Sydney Basin Nepean Groundwater Source and for the Sydney Basin South Groundwater Source are shown in Figure 3.3 and Figure 3.4, respectively. The information used to create these diagrams was sourced from the Metropolitan groundwater WSP, the background document to the WSP (NOW 2011c), and from a recent search of the NSW Water Register (DPI Water 2016a).

The surface water available for extractive uses within water sources and management zones of relevance to the project is shown in Table 3.1 and Figure 3.5 respectively. The dominant users of water in the Metropolitan surface water WSP are major water utilities and local water utilities, such as WaterNSW. For the Upper Nepean and Upstream Warragamba water source, the total volume of water utility licence is 653,539 ML/yr, which compares to a total of 15,540 ML/yr of the tradeable unregulated river licences available. Similarly, in the Shoalhaven River Water Source, the total volume of water utility licence is 27,275 ML/yr, which compares to a total of 6,143 ML/yr of the tradeable unregulated river licences available.

iii Other plan rules

The WSPs also establish the rules for granting licences, managing of water allocations and accounting for water, trading entitlements and water allocations, and in the case of groundwater, rules for managing the effects of water extraction between users, and between users and dependent environmental assets. In short:

- No new licences are currently being granted in the surface water sources or in the Sydney Basin Nepean Zone 1 Groundwater Source. Licences for groundwater can be granted by the NSW Government and are granted by way of controlled allocation orders (under section 65 of the WMA 2000) in the adjacent groundwater sources of Sydney Basin South Groundwater Source, and Sydney Basin Nepean Zone 2 Groundwater Source (see Section 3.2.1.iv below).

- Trading entitlements and allocations between water sources and between management zones within water sources is either prohibited or limited in both groundwater and surface water WSP's.

- Significant carryover of unused allocation between water years is available for surface water licences. In the groundwater sources, carryover is limited to 10% of entitlement volume.

- Part 9 of the Metro Groundwater WSP outlines rules that apply to the location of water supply works (bores) and are predominantly distance conditions that apply to the location of bores in relation to property boundaries, other users, GDEs and streams.

The project will comply with the rules in both WSP's (details in Chapter 12). The project has secured 93% of the required licence volume from within the appropriate groundwater and surface water sources, and there is a clear pathway to secure remaining licence volume.

Dealings (trades) of groundwater licence volumes will be undertaken in accordance with the rules and principles in the WSP. In addition, the project would seek to participate in future controlled allocation orders as facilitated by DI Water for 3ML in Nepean Management Zone 2 of the Sydney Basin Nepean Groundwater Source.

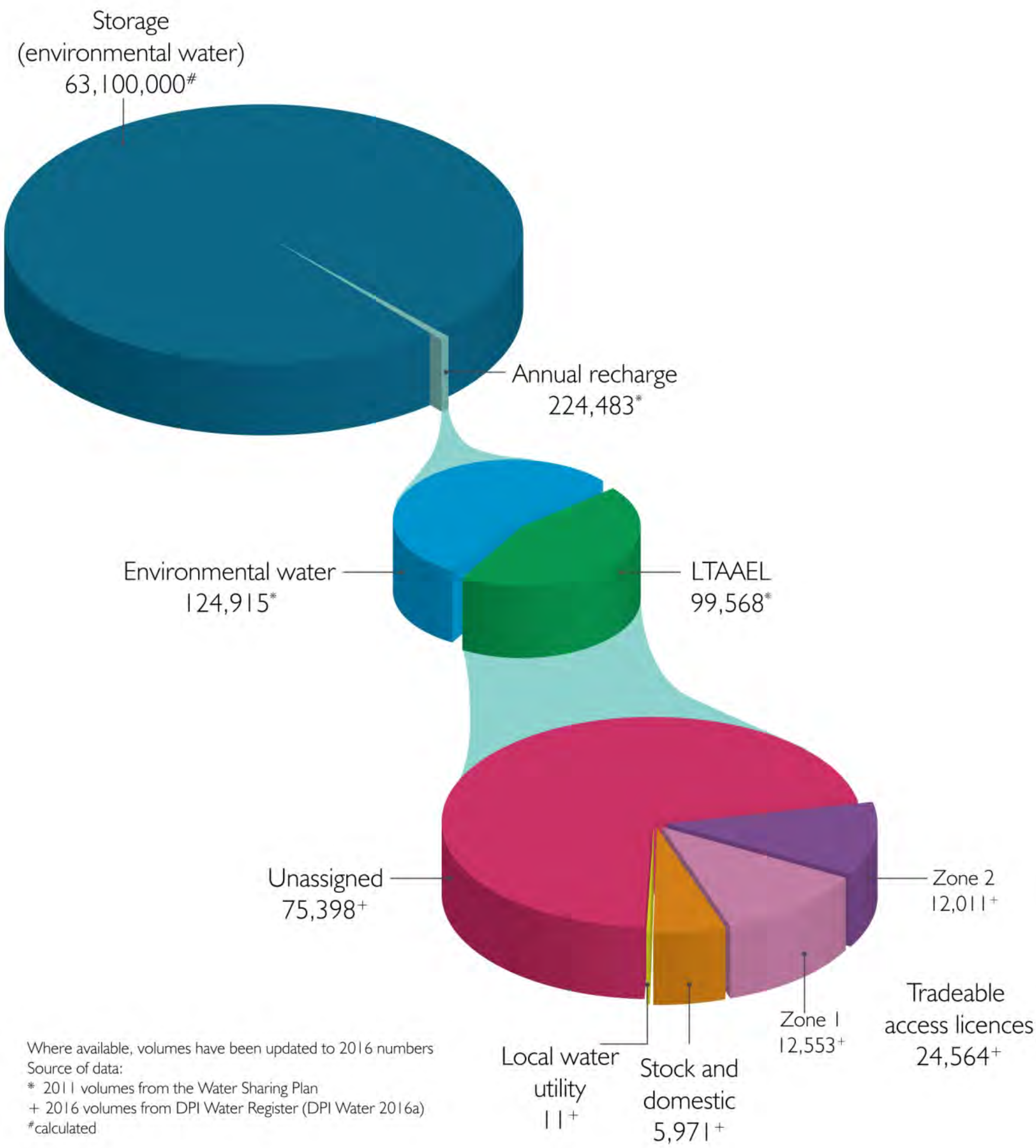
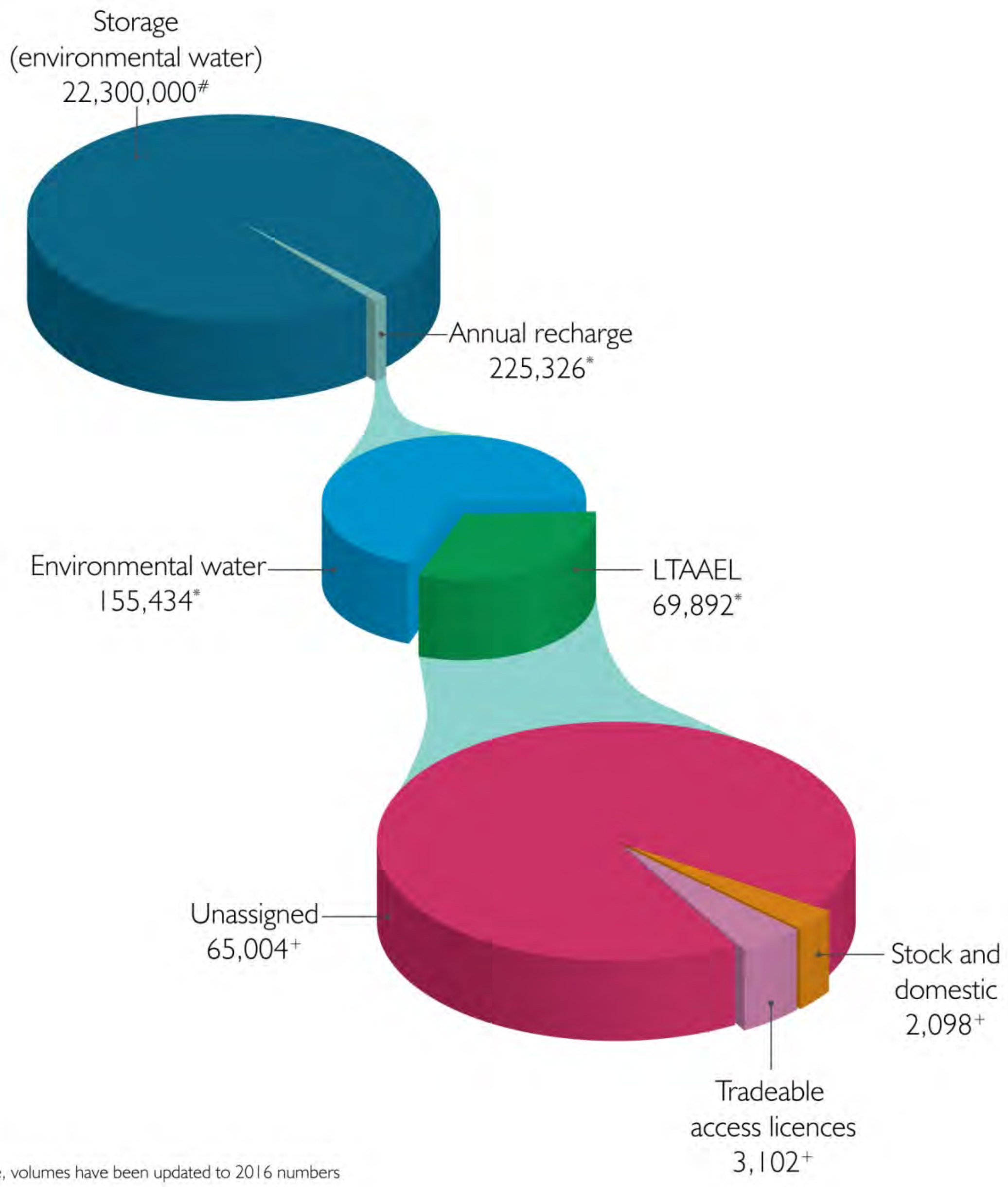


Figure 3.3 Sydney Basin Nepean Groundwater Source provisions (ML/yr)



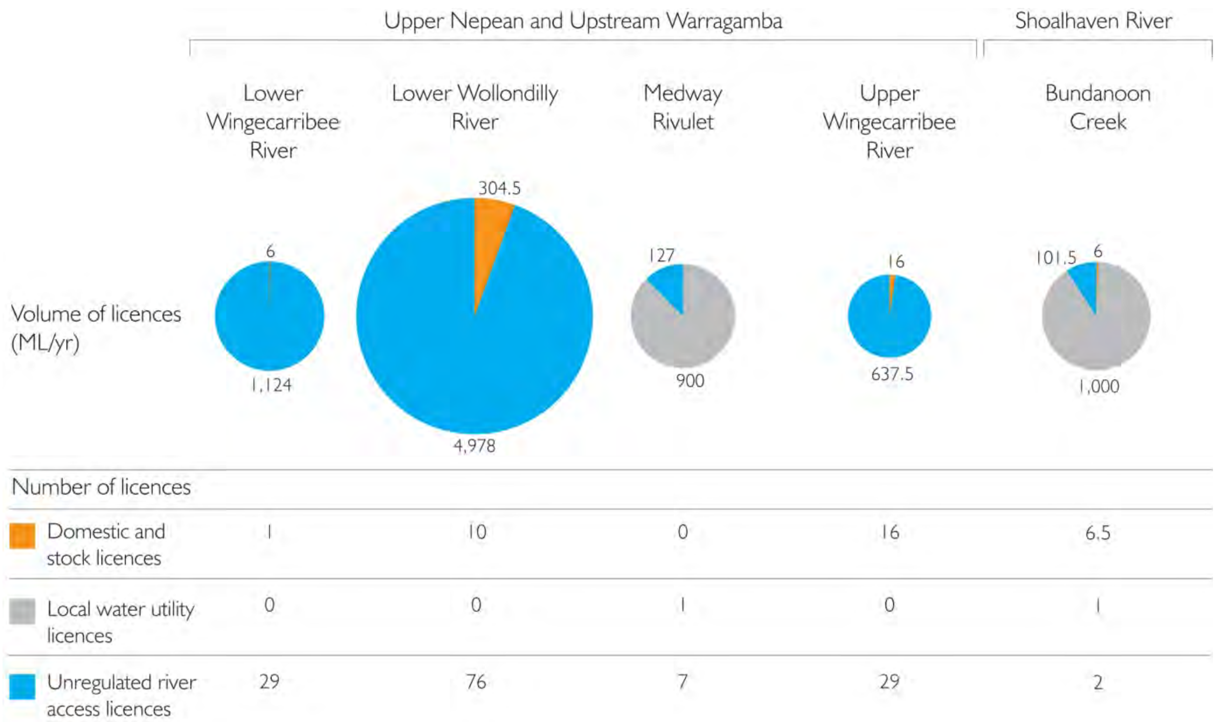
Where available, volumes have been updated to 2016 numbers
Source of data:
* 2011 volumes from the Water Sharing Plan
\+ 2016 volumes from DPI Water Register (DPI Water 2016a)
#calculated

Figure 3.4 Sydney Basin South Groundwater Source provisions (ML/yr)

Table 3.1 Water rights in the WSP for the Greater Metropolitan Unregulated River Water Sources 2011 – Upper Nepean and Upstream Warragamba and Shoalhaven River

Surface water source	Unit	Upper Nepean and Upstream Warragamba	Shoalhaven River Source
Basic landholder rights			
Domestic and stock	ML/day	21	13.6
Native title	ML/yr	0	26.6 (ML/yr) in Kangaroo River
Harvestable rights		nd	nd
Water access licences			
Domestic and stock licences	ML/yr	440.7	243.4
Local water utility licences	ML/yr	8,539	27,031
Major utilities	ML/yr	645,000	329,000
Unregulated river access licences (tradeable)	Unit shares	15,540.20	10,976.80

Notes: nd - volume not defined based on an entire water source.



Based on a search of DPI Water's Water Licence Register (DPI 2016a)

Figure 3.5 Number and volume of water access licences in relevant management zones

iv Controlled allocation

An access licence can be granted by the NSW Government where the right to apply for the licence has been acquired in accordance with a controlled allocation order made under Section 65 of the WMA 2000. Section 65 (1) provides that:

> The Minister may, by order published in the Gazette, declare that the right to apply for an access licence for a specified water management area or water source is to be acquired by auction, tender or other means specified in the order.

There have been three controlled allocation releases made within the groundwater sources surrounding the project area; details are provided in Table 3.2. The outcomes of the most recent release (5 May 2017) have not yet been made available.

Table 3.2 Controlled allocation release

Controlled allocation order	Water source	Units made available	Quantity of shares issued	Price paid per unit share ($)	Total price paid ($)
31 May 2013	Sydney Basin Nepean (Zone 2)	3,865	0	-	-
	Sydney Basin South	3,245	0	-	-
4 September 2014	Sydney Basin Nepean (Zone 2)	3,767	25	800	20,000
			6	900	5,400
			10	900	9,000
			10	910	9,100
	Sydney Basin South	3,061	15	820	12,300
			2,500	850	2,125,000
			300	850	255,000
5 May 2017	Sydney Basin Nepean (Zone 2)	14,935	NA	NA	NA
	Sydney Basin South	10,484	NA	NA	NA

3.2.2 NSW Aquifer Interference Policy

The dictionary to the WMA 2000 (under Section 91) defines an 'aquifer interference activity' as an activity involving any of the following:

- penetration of an aquifer;
- interference with water in an aquifer;
- obstruction of the flow of water in an aquifer;
- taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations; or
- disposal of water taken from an aquifer in the course of carrying our mining or any other activity prescribed in the regulations.

Section 91 (3) of the WMA 2000 relates to aquifer interference approvals. The requirement to obtain an aquifer interference approval under Section 91 is triggered only when a proclamation has been made under Section 88A that the particular type of approval is required. To date, no proclamation has been made specifying that an aquifer interference approval is required in any part of NSW.

Nevertheless, the NSW Aquifer Interference Policy 2012 (the AIP) must be taken into account in accordance with clause 12AB(7) of the SEPP (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP), which sets the non-discretionary standards, and as per the requirements of the SEARs. sets the policy with respect to aquifer interference. The policy explains the role and requirements of the Minister in determining applications for aquifer interference activities. There is a series of seven fact sheets relating to the AIP. Six of these factsheets are relevant to this assessment and have been considered with the policy itself. DPI Water's assessment framework for aquifer interference is included (and completed) in Appendix C. The AIP:

- clarifies the requirements for licensing water intercepted during aquifer interference activities (such as mining, quarrying, dewatering for construction); and
- defines and establishes 'minimal impacts' for water related assets (such as existing bores and groundwater dependent ecosystems.

The AIP specifically refers to 'take' that is 'required to allow for the effective and safe operation of an activity, for example dewatering to allow mining' (p.3), regardless of whether the take is required to be used. For mining projects in NSW, the take, use, and incidental interception of groundwater requires a licence. The AIP states that, unless specifically exempt, a WAL is required under the WMA 2000 where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source;
- the movement of water from one part of an aquifer to another part of an aquifer; and
- the movement of water from one water source to another water source, such as:
    - from an aquifer to an adjacent aquifer; or
    - from an aquifer to a river/lake; or
    - from a river/lake to an aquifer.

The AIP defines water sources as being either 'highly productive' or 'less productive' based on levels of salinity and average yields from bores; the mapped distribution of the highly productive and less productive groundwater sources in NSW are included in NOW (2012b). The AIP then further defines water sources by their lithological character, being one of: alluvium, coastal sand, porous rock, or fractured rock.

For each category of water source the AIP identifies thresholds for minimal impact considerations. These thresholds relate to impacts on the water table, water pressure and water quality, and are ranked as being either 'Level 1: minimal impact' or 'Level 2: exceeding minimal impact'. The definition of 'minimal impact' is outlined in a series of tables which demonstrate how the criteria are applied for different types of water sources and for different sensitive receptors (ie other users, and ecosystems). The aspects applicable for the project have been reproduced in Table 3.3.

If the impact of an activity is assessed as being Level 1: minimal impact then the project is considered to have impacts that are acceptable. Where the predicted impacts exceed the Level 1 thresholds by no more than the accuracy of the model, then this is considered as having impacts within the range of acceptability and extra monitoring or mitigation or remediation will be required during operations.

Where the predicted impacts an activity is assessed as being 'Level 2' or 'greater than minimal impact', additional studies are required to fully understand the predicted impacts. If the assessment shows that the predicted impacts, although greater than 'minimal', do not prevent the long-term viability of the relevant water-dependent asset, then the impacts will be considered to be acceptable.

Where impacts are predicted to be 'greater than minimal impact' and the long-term viability of the water-dependent asset is compromised the impact is subject to make good provisions.

It is important to note that neither the AIP nor clause 12(7) of the Mining SEPP prohibits a project where impacts are predicted to be 'greater than minimal'. However, if greater than minimal impact is predicted, the AIP requires that additional studies, additional monitoring and management plans are undertaken and that 'make good' provisions apply to ensure that water supply to 'impacted' users are maintained.

AIP Fact Sheet 4 (NOW 2013b) outlines how a minimal impact is to be considered. It describes how the minimal impact criteria are applied to both a water supply work and a groundwater dependent ecosystem (GDE) defined in a water sharing plan (Figure 3.6). This fact sheet also defines the term 'make good provisions' as the requirement to ensure that third parties have access to an equivalent supply of water through enhanced infrastructure or other means, for example deepening an existing bore, compensation for extra pumping costs or constructing a new pipeline or bore.

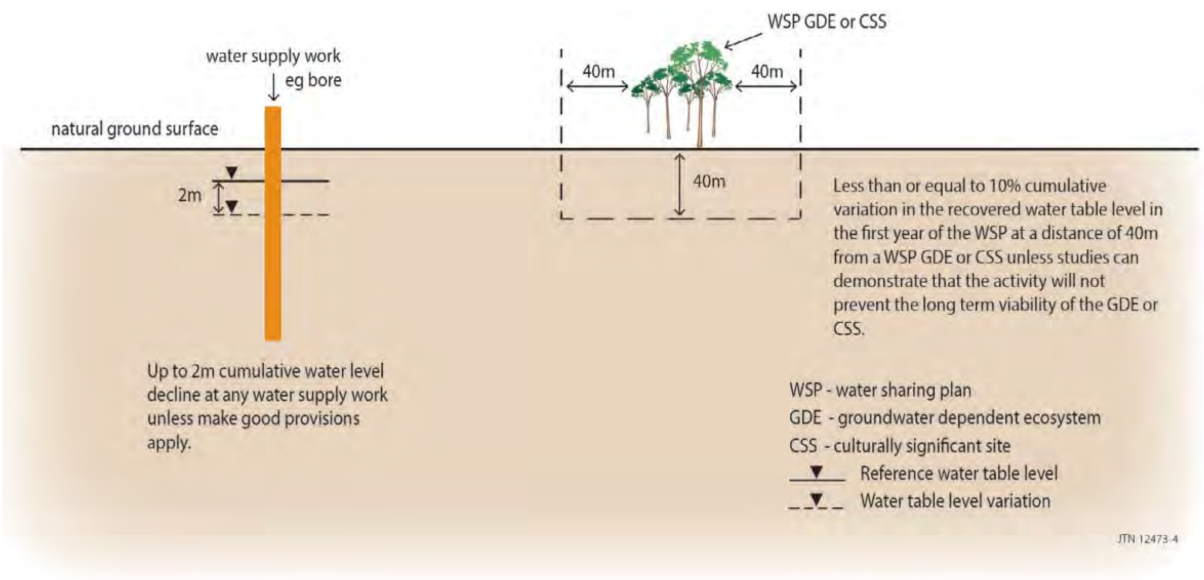


Figure 3.6 Porous or fractured rock groundwater source – minimal impact consideration

Table 3.3 Minimal impact criteria for 'highly productive' porous rock water source

Impact level	Water table	Water pressure	Water quality
Level 1 impact (ie less than minimal)	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work.	1. A cumulative pressure head decline of not more than a 2 m decline, at any water supply work.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.
Level 2 impact (ie greater than minimal)	2. If more than 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies (including the hydrogeology, ecological condition and cultural function) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2 m decline cumulatively at any water supply work then make good provisions should apply.	2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

The AIP requires that two years of baseline groundwater data be collected and incorporated into an impact assessment before lodging a development application for an activity. The project has a monitoring network, developed in consultation with DPI Water (and former departments), that includes 54 conventional groundwater monitoring bores at 22 nested locations, 11 vibrating wire piezometer (VWP) sensors at three locations, three private landholder bores, 11 stream gauges, and 24 water quality monitoring sites. Groundwater monitoring began in 2011 and surface water monitoring began in 2012. Baseline data has been collected continuously since that time and there is up to 8 years of monitoring at many locations within and surrounding the project area. The baseline monitoring program is discussed in Chapter 4.

An assessment of the project against the AIP can be found in Chapter 13 and Appendix C.

3.3 NSW Protection of the Environment Operations Act

The *Protection of the Environment Operations Act 1997* (PoEO Act) is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA). The Act enables the government to set protection of the environment policies that provide environmental standards, goals, protocols, and guidelines. The Act also establishes a licensing regime for pollution generating activities in NSW. Under section 48, an environment protection licence (EPL) is required for 'scheduled activities', which include coal mining. Accordingly, an EPL for the project will be sought by Hume Coal. The Act also includes a duty to notify relevant authorities of pollution incidents where material harm to the environment is caused or threatened.

3.4 Commonwealth Environment Protection and Biodiversity Conservation Act

The *Environment Protection and Biodiversity Conservation Act* (1999) (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places, which are defined as matters of national environmental significance. The EPBC Act was amended in June 2013 to make water resources a matter of national environmental significance, in relation to coal seam gas (CSG) and large coal mining developments (known as the 'water trigger').

The project was referred to the Commonwealth Department of the Environment for consideration under the 'water trigger' component of the EPBC Act. The water components of the referral document were prepared using an interim numerical groundwater model to estimate impacts. However, since that time, the mine plan and water management regime for the project have been modified, and the groundwater and surface water models have been updated to reflect the changes.

The project was declared to be a 'controlled action' by the Minister's delegate on 1 December 2015 in respect of its potential impact on water resources and listed threatened species. This means the project will require assessment and approval under the EPBC Act before it may proceed.

3.5 Relevant NSW policies and guidelines

Apart from the AIP, a number of other guidelines and policies are relevant to the water assessment. They are discussed in the following sections.

3.5.1 Guidelines for controlled activities on waterfront land

Under the WMA 2000, proponents are required to assess the impact of proposed controlled activities to find out whether no more than minimal harm will occur to waterfront land (DPI Water 2015a). Waterfront land includes the bed and bank of a river, lake or estuary, and all land within 40 m of the highest bank of the river, lake or estuary. If controlled activities are proposed within this corridor, then an approval must be obtained from DPI Water.

The project proposes to construct a conveyor, power line and pipeline and widen an existing roadway over Oldbury Creek, and construct a conveyor and upgrade an existing farm road over Medway Rivulet. These activities aer proposed on waterfront land and meet the criteria for requiring a controlled activity approval. However, as the project is a State Significant Development, (once development consent is granted) it will be exempt from requiring an approval to undertake work on waterfront land under section 4.41(1)(g) of the Environmental Planning and Assessment Act 1979. Despite that, the assessment of these activities has been considered in accordance with the policies and guidelines in respect of waterfront land and riparian corridors.

Riparian corridors (RC) are the transition zone between land and a watercourse. In July 2012, new rules commenced that provide more flexibility in how RCs can be used and assessed. For first, second, third and fourth order and greater watercourses, a vegetated riparian corridor (VRC) has been pre-determined and standardised within the greater RC. Proponents may undertake works within the outer 50% of a VRC, as long as the activity is offset by connecting an equivalent area to the RC within the development site.

The main focuses of these guidelines relate to impacts to water quality and sediment bank erosion and sediment load. These factors have all been assessed in the Surface Water Quality and Surface Water Flow and Geomorphology Assessments (WSP PB 2016b and 2016c).

3.5.2 Risk assessment guidelines for groundwater dependent ecosystems

The risk assessment guidelines for groundwater dependent ecosystems (2012) (GDE Risk Assessment Guidelines) are the NSW requirements for assessment and management of groundwater dependent ecosystems (GDEs) under the WMA 2000. The dictionary to the Metro Groundwater WSP provides that:

> Groundwater dependent ecosystems include ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.

The GDE Risk Assessment Guidelines provide that GDEs:

> explicitly include any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition.

An ecosystem's dependence on groundwater can be variable, ranging from partial and infrequent dependence, ie seasonal or episodic (facultative), to total continual dependence (entire/obligate) (Figure 3.7).

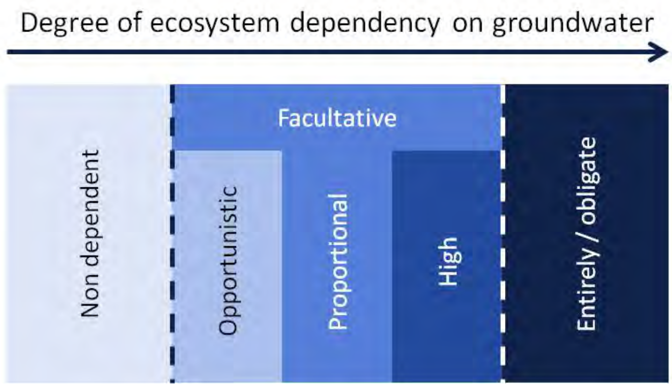


Figure 3.7 Groundwater dependent ecosystem level of dependence on groundwater

A GDE assessment was made for the project, which considered variations in available water and ecosystem types with assessment methods based on the GDE Risk Assessment guidelines. There are no High Priority GDEs listed within the project area. Long Swamp was the only High Priority GDE listed within the Metro Groundwater WSP within the groundwater model domain for the project, about 9 km south-west of the project area. Long Swamp has been studied, and monitored, in detail as part of the water assessment, and there are no impacts predicted to occur at Long Swamp as a result of the project. Long Swamp is discussed in more detail in Section 6.10.2.

3.5.3 State Rivers and Estuary Policy

The NSW State Rivers and Estuary Policy (1993) encourages sustainable management of the state's rivers, estuaries, and wetlands to halt or reduce:

- declining water quality;
- loss of riparian vegetation;
- damage to river banks and channels;
- declining natural productivity;
- loss of biological diversity; and
- declining natural flood mitigation.

The project has been assessed against this policy and component policies and each of the above listed objectives has been specifically considered. In summary, the surface water quality assessment and flooding assessment (WSP 2018, WSP PB 2016b, 2016d) has concluded that:

- the project's water quality effects will be negligible;
- there will be no loss of riparian vegetation or damage to natural river banks and channels;
- surface water resources in the project area will not decline in their natural level of productivity;
- there will be no loss of biological diversity; and
- flooding effects will be negligible and a full flood study for the project has been conducted.

3.5.4 Wetlands Policy

The NSW Wetlands Policy (DECCW 2010) supersedes the 1996 NSW Wetlands Management Policy. The new policy adopts an improved approach to managing natural resources and aligns the management of wetlands to current legislation and challenges.

A wetland is defined as areas of land that are wet by surface and/or groundwater for a sufficient period that plants and animals adapt to and depend on that moisture for at least part of their life cycle. Wetlands can be permanent or ephemeral. The policy contains 12 guiding principles focused on conservation, water and land management, sustainability, prioritisation of significant wetlands, recognition of wetlands' cultural significance, climate change, protection, and reporting.

The project has referenced the 2010 NSW Wetlands Policy in its both ecology and water assessments. There is one identified priority wetland close to the project area, Long Swamp. Further discussion of wetlands is given in Chapter 13 of the *Hume Coal Project Response to Submissions* (EMM 2018) and the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c).

3.5.5 State Groundwater Policy Framework Document

The NSW State Groundwater Policy Framework Document (DLWC 1997) aims to manage the groundwater resources of the state so they can sustain environmental, social, and economic outcomes for the people of NSW. The policy will be considered in resource management decisions made in NSW.

The document is a framework for the following three policies:

- NSW State Groundwater Quantity Management Policy (2001 (unpublished));
- NSW State Groundwater Quality Protection Policy (DLWC 1998); and
- NSW State Groundwater Dependent Ecosystem Policy (DLWC 2002).

This policy establishes the overarching principle for the management of groundwater in NSW, which still remains valid. The principles of sustainability across the three environmental, social, and economic aspects are still referenced in modern water policies released by the NSW Government.

The project's mine design, operation, and rapid rehabilitation and applied mitigation strategies will considerably minimise groundwater inflow and overall groundwater impacts. The design of the mine closely follows the NSW State Groundwater Policy Framework Document objectives of achieving beneficial environmental, social, and economic outcomes for the state of NSW.

3.5.6 State Groundwater Quality Protection Policy

The NSW State Groundwater Quality Protection Policy (DLWC 1998) is a component policy of the NSW State Groundwater Policy Framework Document. The NSW State Groundwater Quality Protection Policy requires that the water quality within groundwater systems is managed in accordance with the management principles given in Table 3.4.

Table 3.4 State Groundwater Quality Protection Policy (1998) principles

Groundwater quality management principles	Hume Coal's consideration of the principle
The most sensitive identified beneficial use (or environmental value) is maintained.	The beneficial use of groundwater is considered to be irrigation, domestic and stock. Groundwater quality impacts of the project will be negligible and the beneficial use category will not change as a result of the project (Appendix I).
Town water supplies are afforded special protection against contamination.	There are no nearby town water supply bores.
Groundwater pollution should be prevented.	Groundwater chemistry post-mining and recovery has been modelled and groundwater pollution will not occur (Appendix I).
For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource.	The project is a State Significant Development, and as such a thorough impact assessment has been made. Baseline environmental monitoring and assessment of the project's potential impacts has been occurring continuously for over five years.

Table 3.4 State Groundwater Quality Protection Policy (1998) principles

Groundwater quality management principles	Hume Coal's consideration of the principle
Groundwater extractors should be responsible for environmental damage or degradation caused by applying groundwater that is incompatible with soil, vegetation or receiving waters.	Groundwater taken to the surface will be managed within the water management system at the surface.
Groundwater dependent ecosystems are afforded protection.	There is one High Priority Groundwater Dependent Ecosystem within the groundwater model domain for the project – no water quality impacts are predicted at this location. There are no High Priority Groundwater Dependent Ecosystems within the project area.
Groundwater quality and quantity management is integrated.	The assessment of baseline groundwater quantity and quality and potential impacts have been integrated and the impact assessment model includes both chemistry and quantity changes.
The cumulative impacts of developments on groundwater quality should be recognised.	Groundwater quality changes as a result of the project are anticipated to be negligible. As such, cumulative groundwater quality impacts are also not anticipated as a result of the project.
Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.	Post-mining, the mine surface infrastructure will be decommissioned and areas will be rehabilitated to a state where they can support land uses similar to the current land uses.

A water management plan will be prepared for the project; details of the plan are discussed in Section 13.2.2. The water management plan will incorporate ongoing monitoring and modelling required for the project as it progresses. The plan will be prepared in consultation with and, if required, approval by relevant NSW government agencies.

3.5.7 State Groundwater Dependent Ecosystems Policy

The NSW State Groundwater Dependent Ecosystems Policy (DLWC 2002) was used with the more recent GDE Risk Assessment Guidelines (NOW 2012d) to assess ecosystems in the project area that potentially rely on groundwater. There are five principles within the NSW State Groundwater Dependent Ecosystems Policy; these are summarised in Table 3.5 with commentary on how the principle has been applied to the project.

Table 3.5 State GDE Policy principles

Principle	Hume Coal assessment
Principle one The scientific, ecological, aesthetic and economic values of GDEs, and how threats to them may be avoided, should be identified and actions taken to ensure protection of the most vulnerable and valuable ecosystems.	The one high priority GDE (as per the Metro Groundwater Sharing Plan) is Long Swamp, and this system has been specifically assessed. No impacts are predicted to this priority GDE.
Principle Two Groundwater extractions should be managed within the sustainable yield of the groundwater system, to maintain and/or restore ecological processes and biodiversity of their dependent ecosystems.	The project's licensable water take is within the sustainable limits of the respective water sources, and licences will be obtained where and when required.

Table 3.5 State GDE Policy principles

Principle	Hume Coal assessment
Principle Three Priority should be given to ensure sufficient groundwater of suitable quality is available when it is needed for: • protecting known or likely GDEs; and • GDEs that are under immediate or high degree of threat from groundwater related activities.	No impacts to water quality are predicted for Long Swamp, or the groundwater table in the area around the GDEs as a result of the project.
Principle Four The Precautionary Principle should be applied to protect GDEs where scientific knowledge is lacking. Adaptive management systems and research to improve understanding is essential to their management.	In accordance with the precautionary principle, no threat of serious or irreversible harm to GDE has been identified. At any rate, mitigation measures have not been postponed on the basis of lack of full scientific certainty. The GDE, ecology and water studies for the project are rigorous and are ongoing. Adaptive management is proposed for terrestrial ecosystems as required.
Principle Five Planning, approval, and management of developments and land use activities should aim to minimise adverse impacts on GDEs by: • maintaining natural patterns of groundwater flow and not disrupting groundwater levels that are critical for GDEs; • not polluting or causing adverse changes in groundwater quality; and • rehabilitating degraded groundwater systems where practical.	The project contains mitigation strategies to maximise the rate of recovery post mining (ie minimising open active draining panels) which will accelerate the recovery of groundwater pressures and flow paths to pre-mining levels and directions. Geochemistry and hydrogeochemistry studies demonstrate that beneficial use of the water quality will be maintained post-mining (Appendix I).

3.5.8 Water Extraction Monitoring Policy

The NSW Water Extraction Monitoring Policy (DWE 2007) applies to the extraction of water to guarantee equitable sharing of the state's water resources. The policy applies to the extraction of all water in NSW, including regulated rivers, unregulated rivers, groundwater systems and return flows under Section 76 of the WMA 2000.

The principles state that monitoring of water extraction should be accurate and appropriate for the scale and extraction methods proposed. The policy indicates that flow meters are preferable (due to their high level of accuracy) but alternative options (provided they are calibrated to water extraction volumes) are also acceptable and include: electricity consumption, pump operating hours, pump revolutions, pumping diaries, and volume and number of water trucks.

Water extraction for the project will be monitored and recorded in accordance with the NSW Water Extraction Monitoring Policy using flow meters. The water extraction components for the project are:

- groundwater inflow to the mine sump – this water will be pumped either behind bulkheads or to the surface. Flow meters will be installed and maintained on these pumps;
- groundwater extracted from bores for water supply – bores that supply water for the project will have meters installed to monitor groundwater extraction;

- rain water harvesting – the internal catchment area of the site has been calculated with reference to the NSW harvestable rights guidelines and is within the minimal allowable take;
- water pumped from the primary water dam (PWD) to the various water users on site (the CPP, the administration and workshop area, underground machinery, fire-fighting supplies) will be monitored using flow meters; and
- surface water captured in mine water dams – with the exception of the PWD, all mine water dams will be pumped back to the PWD, and this water movement will be monitored using flow meters.

3.5.9 Groundwater monitoring and modelling

A groundwater monitoring and modelling plan (GMMP) is required as a standard condition of licence for exploration (drilling) under the Mining Act 1992 and Petroleum (Onshore) Act 1991. The project's GMMP (EMM 2017b) has been prepared in accordance with the *Groundwater Monitoring and Modelling Plans – Information for prospective mining and petroleum exploration activities* (NOW 2014).

The GMMP conceptualises the groundwater regime in the project area and describes how the design of the groundwater monitoring network responds to this. Details of the monitoring regime, including duration, frequency and location of monitoring, are included to demonstrate that the network will meet the requirements of the AIP. The numerical groundwater flow modelling has been designed to meet the requirements of the AIP.

The GMMP will be refined over time as a staged and project specific plan, and will evolve from the original plan (prepared by Parsons Brinckerhoff in April 2013), coinciding with establishing the project's monitoring network. The current version (November 2017 (EMM 2017b)) has been prepared following the analysis of monitoring data and the initial development of the project-specific numerical model. Feedback from DPI Water has also been incorporated into the latest version. The GMMP will continue to be updated as the project progresses, including during rehabilitation.

3.5.10 Code of Practice for Coal Seam Gas Well Integrity

This code of practice (DTIRIS 2012a) does not apply to the project as there are no extractive gas reserves in the Wongawilli coal seam within the project area.

3.5.11 Code of Practice for Coal Seam Gas Fracture Stimulation

This code of practice (DTIRIS 2012b) does not apply to the project as there are no extractive gas reserves in the Wongawilli coal seam within the project area.

3.5.12 State Environmental Planning Policy (SEPP) (Sydney Drinking Water Catchment)

AR 78: Specifically address clauses 9(1) and (2) and 10(1) of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011. In particular, the EIS must describe and justify how the development would have a neutral or beneficial effect on water quality

The State Environmental Planning Policy (SEPP) (Sydney Drinking Water Catchment) 2011 is applicable as the project is within the Sydney drinking water catchment area. The policy aims to maintain healthy water catchments that will deliver high quality drinking water while permitting development. It provides that a consent authority must not grant consent to development under Part 4 of the Environmental Planning and Assessment Act 1979 on land in the Sydney drinking water catchment unless it is satisfied that it would have a neutral or beneficial effect (NorBE) on water quality.

3.5.13 Independent Inquiry into the Hawkesbury Nepean River System

In 1998, the Healthy Rivers Commission made an independent inquiry into the health of and activities with potential to cause degradation of the Hawkesbury Nepean River system (HRC 1998). The inquiry proposed that targets be set for environmental flows, river health, and nutrient and algael concentrations in river water. Priority locations for further management were also identified.

The inquiry paved the way for future policies and management of the Hawkesbury Nepean River System, leading to the establishment of the Sydney Catchment Authority (SCA) in 1999. The SCA's role was to manage and protect the drinking water catchments and catchment infrastructure, and to supply bulk water to Sydney Water and a number of local councils. On 1 January 2015 the SCA was abolished and its functions were transferred to WaterNSW.

The findings of the independent inquiry, particularly the principles of NorBE (neutral or beneficial effects on water quality), were taken into account in the project's planning stage. This is discussed in the following section and also in Section 9.

3.5.14 Neutral or Beneficial Effect on Water Quality Assessment Guideline

The Neutral or Beneficial Effect on Water Quality Assessment Guideline (SCA 2015) outlines the assessment and approval process made by the SCA in applying the principles of NorBE. A neutral or beneficial effect on water quality means any introduced water will be comparable to or will have better quality than the receiving water body, thereby having no identifiable negative impact on the receiving water quality.

Achieving NorBE has been a fundamental goal for the project, and it has received detailed consideration in the mine design and water infrastructure and management. A primary objective has been to minimise water releases from the project area. There are only two locations where the occasional release of storm water to Oldbury Creek may occur during very high rainfall events. These are discussed in detail in Section 2.3. The principles of NorBE have been firmly applied and sampling and inspection of both the collected water and the receiving water body will occur before water is released.

During very high rainfall water may be released from the PWD to manage on-site water in emergencies. This water would be treated in a purpose-built water treatment plant before release, with treatment being to a standard that complies with NorBE for Oldbury Creek (Section 2.3). Water balance modelling demonstrates, however, that the PWD has enough capacity to contain all surplus water and treatment and release of water from the PWD is not required. Refer to Section 8 for further details.

It is noted that the NorBE Tool (SCA 2015) is not applicable to the Hume Coal Project, given it is a State Significant Development (SSD) and, as such, is not a Designated Development.

Clause 10(2) of the (SEPP) (Sydney Drinking Water Catchment) 2011 provides that the NorBE Tool must be used "if the proposed development is one to which the NorBE Tool applies". Section 4.5 of SCA (2015) states that the development types to which the NorBE Tool apply are listed in Appendix 1 - Table A1. Table A1 includes 'designated development', but does not include SSD.

Although an underground coal mine can be a 'designated development' per Schedule 3, clause 11 of the EP&A Regulation, Section 4.10(2) of the EP&A Act specifically excludes SSD from being a designated development, "despite any such declaration". As such, an underground coal mine that is a SSD is not a designated development. Therefore, the Hume Coal project does not fall into any of the classes of development listed in table A1 of SCA (2015), and as such, the NorBE Tool does not apply to the Hume Coal Project.

The conclusion that the NorBE Tool does not and ***should not*** apply to SSDs was accepted by the Land and Environment Court in *4nature Incorporated v Centennial Springvale Pty Ltd* [2016] NSWLEC 121 (at paragraph 143) and not overturned by the New South Wales Court of Appeal in *4nature Incorporated v Centennial Springvale Pty Ltd* [2017] NSWCA 191 (at paragraph 60).

3.5.15 Floodplain Development Manual and Flood Prone Land Policy

The Floodplain Development Manual and Flood Prone Land Policy (DIPNR 2005) were developed to provide guidance to local councils during the development and implementation of detailed local floodplain risk management plans. The manual clearly sets out the floodplain risk management process to be used by local councils.

The flood assessment for the project has considered flooding changes with regard to the above-mentioned manual (WSP PB 2016d). Further discussion on the flood assessment is included in Section 8.2.1.

3.5.16 Wingecarribee Local Environmental Plan

The Wingecarribee Local Environmental Plan was prepared in accordance with the Environmental Planning and Assessment Act 1997 and Environmental Planning and Assessment Regulation 2000. The plan aims, among other things, to: minimise flood risk to life and property associated with the use of the land; allow development that is compatible with the land's flood risk, taking into account projected climate change; and avoid significant adverse impacts on flood behaviour and the environment.

The project's flooding assessment for the project considers these objectives of the Wingecarribee Local Environmental Plan. With appropriate mitigation measures in place, the flood assessment indicates that the project will have: negligible impacts on flood levels in the Medway Rivulet catchment; flood level impacts are within acceptable limits for public roads and private land in the Oldbury Creek catchment during mine operation; and negligible changes on flood levels in the Oldbury Creek catchment during mine rehabilitation.

3.5.17 Water Management (General) Regulation

AR 37: Applicability of any exemptions under the Water Management (General) Regulation 2011 to the project

Clause 18 (1) of the Water Management (General) Regulation 2011 with item 12 in Schedule 5 of that Regulation, provides an exemption from the requirement to hold a water access licence in circumstances where surface water is taken by a landholder by means of an excluded work referred to in any of items 1–9 of Schedule 1 of the Regulation. It is not expected that Hume Coal will rely on any of these exemptions.

Section 4.41(1)(g) of the *Environmental Planning and Assessment Act 1979* exempts a State Significant Development authorised by a development consent from requiring a water use approval under section 89, a water management work approval under section 90, or an activity approval (other than an aquifer interference approval) under section 91 of the WMA 2000. These exemptions apply to the project.

3.5.18 Draft regulation establishing water return flow rules

Section 75 of the WMA 2000 provides for a regulation to be made to establish water return flow rules. Section 76 provides for such a regulation to allow water used under a licence to be 'regained'. In 2014, DPI Water stated its intention to make a regulation on return flows across NSW. The current DPI Water website (DPI Water 2015a) states:

> 'Return flow rules are likely to be made for aquifer access licences before the end of 2014. Once these rules are put in place, licence holders will be able to receive a credit to their water allocation account for water returned to the same groundwater source from which it was taken, providing specific conditions are met. Licence holders will only need to hold enough licence shares to account for the net amount of water extracted, ie the amount of water initially extracted minus the amount of water returned. Water usage fees will only be applied to the net amount of water extracted.'

The draft form of the proposed return flow regulation was discussed at a public information session in September 2014 (J Gill 2014, pers. comm., September). At the public information session 'frequently asked questions' sheets explaining how the regulation would work were distributed, and various plans were outlined, including an intention the flow regulation would have state-wide application. Once enacted, this regulation would provide Hume Coal with a means to redistribute licence shares to other users within the Nepean Zone 1 groundwater source. Technically, these rules will not change the operation or impact of the mine; however, administratively, they would allow more licence holders to take groundwater from Zone 1, as the groundwater removed during the project will be put back into the water source after it is taken.

Until a water return flow regulation is made under Section 75 of the WMA 2000, the obvious benefits of such a scheme will not be available to the community.

3.5.19 Stormwater first flush pollution

The NSW EPA provides guidelines about the definition and design of stormwater pollution control systems (NSW EPA 2013). Pollutants deposited onto an exposed area can be picked up and carried in rainfall-runoff. Usually stormwater that runs off an area in the early periods of rainfall is more polluted than the stormwater that runs off later, after the rainfall essentially cleans or washes the catchment. First flush is defined as the stormwater that contains this initial high pollutant load.

First flush collection can form an important part of a stormwater pollution control system by minimising the availability of pollutants in stormwater runoff, particularly in small catchments, especially if a large proportion of the catchment is impervious (paved surfaces and roads). Collection of the first flush can also act as an emergency backup if there is a pollutant spill, reducing the risk of pollution entering the receiving environment.

First flush should be collected and separated from stormwater runoff, as discussed in NSW EPA (2013). This water should be re-used or disposed of quickly and properly. The amount of rainfall suggested to be contained depends on the potential pollutants present and the catchment surfaces. For all types of pollutants and pervious surfaces (including natural ground surfaces) it is recommended the first 20 mm of rainfall be contained as the first flush.

First flush criteria for non-direct coal contact catchments in the project have been designed in accordance with these guidelines. Refer to Section 2.3.2 for more details.

3.6 Relevant Commonwealth guidelines

3.6.1 Australian Groundwater Modelling Guidelines

The Australian Groundwater Modelling Guidelines, National Water Commission (NWC) (Barnett et al. 2012) provide a consistent and sound approach for the development of groundwater flow models in Australia. The guidelines 'propose a point of reference and not a rigid standard' and provide direction on scope and approaches while acknowledging that techniques are continually evolving and innovation is to be encouraged. The guidelines provide a confidence-based classification system that defines three different classes of model:

- class 1 – low confidence in model predictions, suitable for use in low value resource or low risk developments;
- class 2 – high confidence in model predictions, suitable for use in high value resources or projects with medium to high risk developments; and
- class 3 – high confidence in model predictions, suitable for use in high value resources and projects such as regional sustainable yield assessments.

The guidelines provide information on the data requirements for each model class, such as spatial distribution of bores and temporal groundwater level data. Groundwater resource assessments at major development sites generally require the use of a class 2 model. The onerous data requirements to achieve a class 3 model (ie reliable metered extraction and the duration of the prediction to be not more than three times the calibration data period) mean that for most major projects in NSW a full class 3 model is practically unattainable.

The numerical groundwater model for the project is a class 2 model with many elements classified as meeting class 3 requirements. The numerical model has been prepared in accordance with the Australian modelling guidelines and peer reviewed using the structure of the 'review checklist' as per Chapter 9 (Table 9-2) of the modelling guidelines. Two independent pre-eminent hydrogeologists, Dr Frans Kalf and Dr Noel Merrick, were engaged to peer review the EIS numerical model. Dr Merrick stated in his peer review of the model:

> "The reviewer finds that the modelling study is fully compliant with guidelines, and often goes beyond state of the art techniques" (HydroAlgorithmics 2016).

The EIS model was judged by both peer reviewers to be fit for purpose in accordance with the guidelines and their professional judgement. The peer review reports, Merrick (HydroAlgorithmics 2016) and Kalf (2016), are included in Appendix G. Subsequent to the submissions process, NSW Government independent expert peer reviewer concluded that:

> "The model software, design, extent, grid, boundaries and parameters form a good example of best practice in design and execution" (Hydrogeologic 2017).

The model has since been updated and revised to incorporate suggestions raised during the exhibition period (refer to Section 8.6).

3.6.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Agriculture and Resource Management Council of Australia and New Zealand and the Australian and New Zealand Environment and Conservation Council (ANZECC & ARMCANZ) 2000 describe the water quality objectives for marine and freshwater environments, aquatic ecosystems, primary industries, and recreational water.

The guidelines should be considered when setting water quality objectives for natural and semi-natural water resources in Australia and New Zealand sustaining current or likely future environmental values (uses). They also set out a framework for the application of water quality trigger levels.

The guidelines are a generic reference and should be used accordingly, ie only as a default reference. It is recommended to collect and use site-specific baseline data to establish baseline conditions and develop trigger levels. Project impacts should be assessed using site-specific baseline data and not the generic guidelines. The project has enough data to establish appropriate baseline water quality conditions and trigger levels for ongoing water monitoring and management planning. Further details on baseline monitoring are included in Chapter 4.

3.6.3 Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

The Commonwealth Government released impact guidelines to assist any proponent who proposes to take an action that involves a coal seam gas development or a large coal mining development to decide whether the action will have or is likely to have a significant impact on a water resource (DoE 2013). According to the guidelines, a referral to the Commonwealth Department of the Environment (DoE) for a decision by the Minister on approval is required.

In the case of the project, these guidelines were examined before referral documentation was lodged with the DoE (EMM 2015b).

3.6.4 Information Guidelines for Independent Expert Scientific Committee Advice on Coal Seam Gas and Large Coal Mining Development Proposals

The Independent Expert Scientific Committee (IESC) is a statutory body established under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The IESC provides advice to the Commonwealth Government on water-related matters for projects referred to the Commonwealth under the EPBC Act 'water trigger', and also on projects referred to the IESC by state authorities.

The IESC provides advice upon request from either the Commonwealth or state governments. The advice is scientific and not regulatory or political. The IESC published guidelines (IESC 2015) to outline its role in providing its scientific advice. The IESC guidelines provide a checklist of information requirements to adequately assess a project's impacts. The project considered these requirements; they have been fully considered in the impact assessment to ensure it addresses the guidelines.

3.6.5 Draft Explanatory Note, Uncertainty Analysis in Groundwater Modelling - a report prepared for the IESC

The IESC published a draft note on undertaking uncertainty analysis in March 2018 (Middlemis & Peeters 2018). The note recommends different levels of uncertainty analysis for various project complexities, with the most robust and detailed option being 'stochastic modelling with Bayesian probability quantification'. This detailed uncertainty analysis produces "an ensemble of model predictions ... based on a large number of model evaluations with different parameter values that are all consistent with the observations" (Middlemis & Peeters 2018). It is noted that this type of analysis is not currently industry standard. It is undertaken using cloud-based processors due to the significant computer processing power needed to undertake the work. It is a new and evolving area of groundwater modelling and computer science.

In the revised groundwater modelling work (HydroSimulations 2018), Hume Coal undertook this detailed complex and robust uncertainty analysis using methods aligned with the IESC (Middlemis & Peeters 2018). Hume Coal undertook this work to ensure that the modelling undertaken and resulting predictions as accurate and appropriate as possible to provide confidence and reassurance to the government, the local community and other relevant stakeholders.

3.6.6 National Water Quality Management Strategy Guidelines for Groundwater Quality Protection in Australia

The National Water Quality Management Strategy Guidelines for Groundwater Quality Protection in Australia (NWQMS 2013) provides a risk-based management framework to protect and enhance groundwater quality for the maintenance of specified environmental values. The framework involves the identification of specific beneficial uses and values for the major groundwater systems, and a number of protection strategies that can emerge to protect each aquifer, including monitoring for all aquifers.

The guidelines, including defined environmental values and water quality objectives, have been referenced in the project's groundwater quality impact assessment (Geosyntec 2016).

3.6.7 Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines (ADWG) (NHMRC 2016) apply to water intended for drinking and include health and aesthetic values for metals, pesticides and organic compounds. The guidelines aim to guarantee safety at the point of use based on current scientific evidence.

The project references these guidelines as the project is within the drinking water catchment areas for the Sydney metropolitan area.

3.6.8 Australian Rainfall and Runoff – a Guide to Estimation

The Australian Rainfall and Runoff – a Guide to Estimation (IEA 1987) is the national guideline to estimate design flood volumes and velocities in Australia. It provides robust estimates of flood risks to avoid development in high risk areas and sound design of infrastructure in flood-prone areas, and has been referenced as part of the project's flood impact assessment (WSP PB 2016d).

4 Baseline monitoring program

This chapter provides an overview of the baseline surface water and groundwater monitoring for the project. The monitoring results are presented in subsequent sections.

AR 49: Sufficient baseline monitoring for groundwater quantity and quality for all aquifers and GDEs to establish a baseline incorporating typical temporal and spatial variations

AR 69: The EIS must assess the impacts of the development on water quality, including:
a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.
b. Identification of proposed monitoring of water quality.

AR 70: The EIS must assess the impact of the development on hydrology, including:

- *a. Water balance including quantity, quality and source*
- *b. Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas*
- *c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems*
- *d. Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (eg river benches)*
- *e. Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water*
- *f. Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options*
- *g. Identification of proposed monitoring of hydrological attributes*

AR 79: A full description of the development including those aspects which have the potential to impact on the quality and quantity of surface and groundwaters at and adjacent to the site, including:

- *the mining proposal and mine layout*
- *the location, mapping and geomorphology of all creeks and water resources overlying and adjacent to the proposed mining area*
- *the hydrogeological fluxes between surface and groundwaters, including the filling of pine feather voids*
- *the location, management and storage of all hazardous materials- the disposal of wastes from the treatment of mine waters in the mine water treatment plant*
- *the management of dirty water from the washing and preparation of coal for transport*
- *the location, sizing and description of all water quality management measures*
- *the location and description of all water monitoring points (surface and ground waters)*
- *on-site domestic (sewage) wastewater management*

AR 80: A detailed assessment of the development on water resources which considers the design, construction, operational and decommissioning phases and have regard for operation during periods of wet weather and include:

- *details of measured and predicted coal mine, preparation area and stockpile area performance with respect to water quality management*
- *details of measures proposed to be adopted to offset impacts associated with construction activities eg earthworks, vegetation clearing and track construction*
- *impacts on overlying and adjacent creeks and water resources within risk management zone associated with subsidence*
- *impact of the proposed on-site domestic (sewage) wastewater management and associated effluent disposal area*
- *pre-development and post development run off volumes and pollutant loads from the site*
- *details of the measures to manage site water associated with processing coal and coal reject, general stormwater runoff and any human activities likely to affect water quality at the site, and how neutral or beneficial effect on water quality (NorBE) principles will be assessed and applied*
- *assessment of the impacts of the development on receiving water quality and volume, both surface and groundwater including from the filling of pine feather voids and associated impact on interaction and baseflows of surface waters*
- *details of the structural stability, integrity, ongoing maintenance and monitoring of all site water management measures including dams over the life of the project*
- *details of proposed monitoring of groundwater levels, surface water flows, groundwater and surface water quality, along with information as to how the proposed monitoring will be used to monitor, and, if necessary, mitigate impacts on surface water and groundwater resources*

-the principles outlined in the 'Managing Urban Stormwater - Soils and Construction - Mines and Quarries' Manual prepared by the Department of Environment and Climate Change (2008)

Surface water and groundwater monitoring are essential components in characterising the project area's baseline, pre-mining, hydrogeological and hydrologic environments. Baseline water level and water quality field data collected from the various groundwater systems and watercourses has been used to determine the overall water chemistry, flow paths, recharge and discharge characteristics, and groundwater–surface water connectivity. Field data has been an important input to validate the hydrogeological and hydraulic conceptual and numerical models.

A comprehensive water monitoring network has been designed and used to establish enough baseline data for the project, incorporating temporal and spatial variations. Monitoring began in 2011 as per the project's original groundwater monitoring and modelling plan *(GMMP)* (PB 2011). Subsequent iterations of the GMMP have been developed, the most recent one being by EMM (2016b), which have been prepared in accordance with the *Groundwater Monitoring and Modelling Plans – Information for prospective mining and petroleum exploration activities 2014* (NOW 2014).

4.1 Surface water monitoring

4.1.1 Surface water monitoring network

A dedicated surface water quality and flow monitoring network has investigated the hydrologic conditions in the project area, providing over four years of baseline data (2012 – 2016, inclusive for this assessment). Monitoring is continual is currently up to 6 years of data is available at some sites. The project surface water monitoring network consists of 11 stream flow gauging locations and 24 water quality monitoring locations (Figure 4.1) (WSP PB 2016e). The network has added more monitoring locations over time to increase the spatial data coverage. The monitoring locations were developed in consultation with DPI Water (formerly NOW) to:

- create spatial representation across the project area, including upstream and downstream locations, and different land use scenarios;
- characterise major drainages (ie larger stream orders) and streams that will be undermined;
- examine the potential for surface water–groundwater interaction; and
- monitor key potentially sensitive receptors, including Medway Dam and Long Swamp (Figure 1.4).

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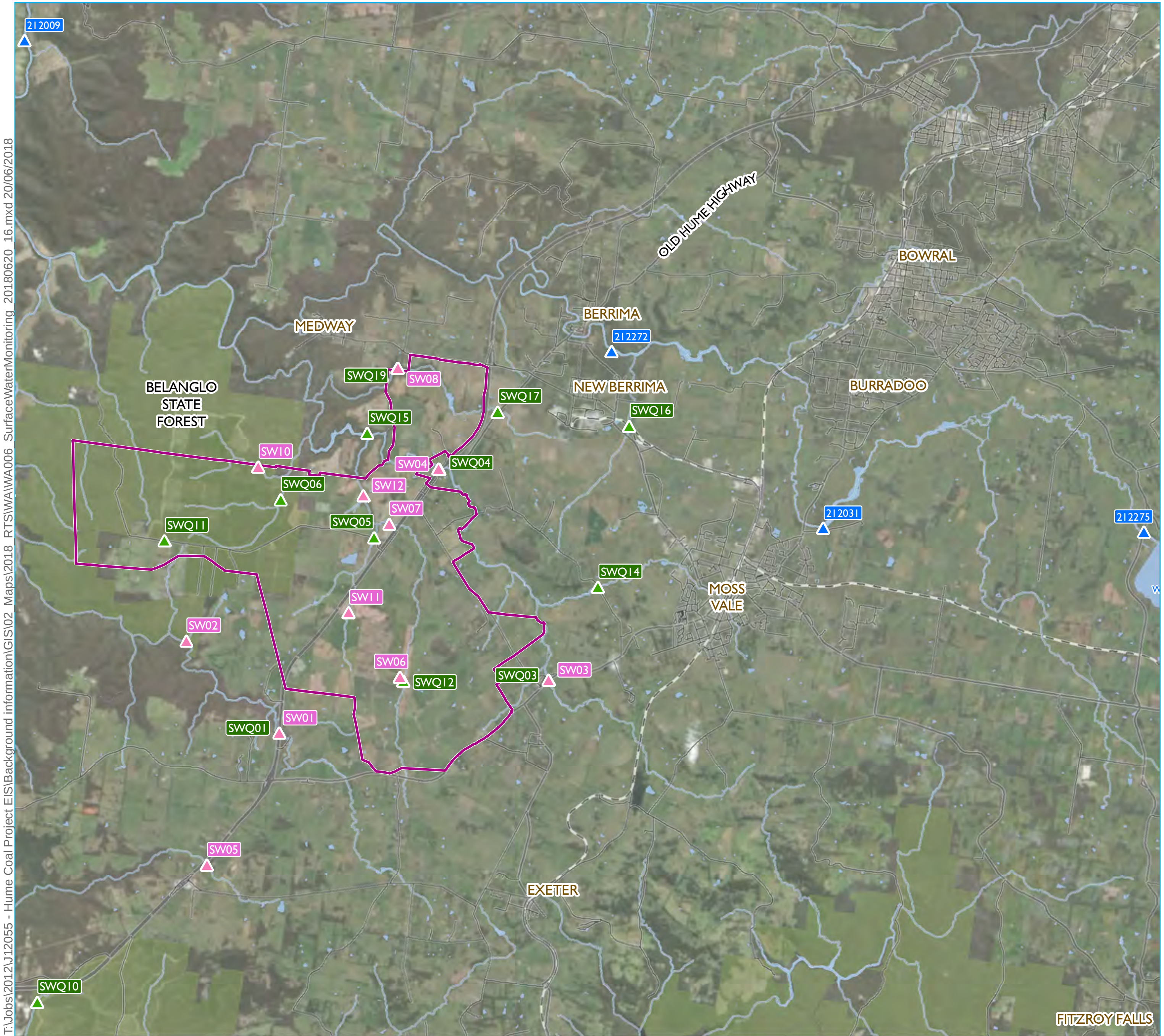


Source: EMM (2018); DFSI (2017); Hume Coal (2017)

0 2.5 5 km
GDA 1994 MGA Zone 56 N

KEY

- Project area

Surface water monitoring locations

- Surface water flow gauge
- Surface water quality monitoring location
- Water NSW surface water gauge

Existing features

- Main road
- Local road
- Rail line
- Drainage line
- State forest
- Waterbody

Surface water monitoring locations

Hume Coal Project
Revised Water Assessment
Figure 4.1

4.1.2 Surface water level monitoring

Surface water level monitoring began in January 2012 at three project-specific stream flow gauges and later expanded to 11 level monitoring locations. An overview of the project's surface water flow monitoring data range is provided in Figure 4.2. Gaps in the monitoring occurred when equipment malfunctioned.

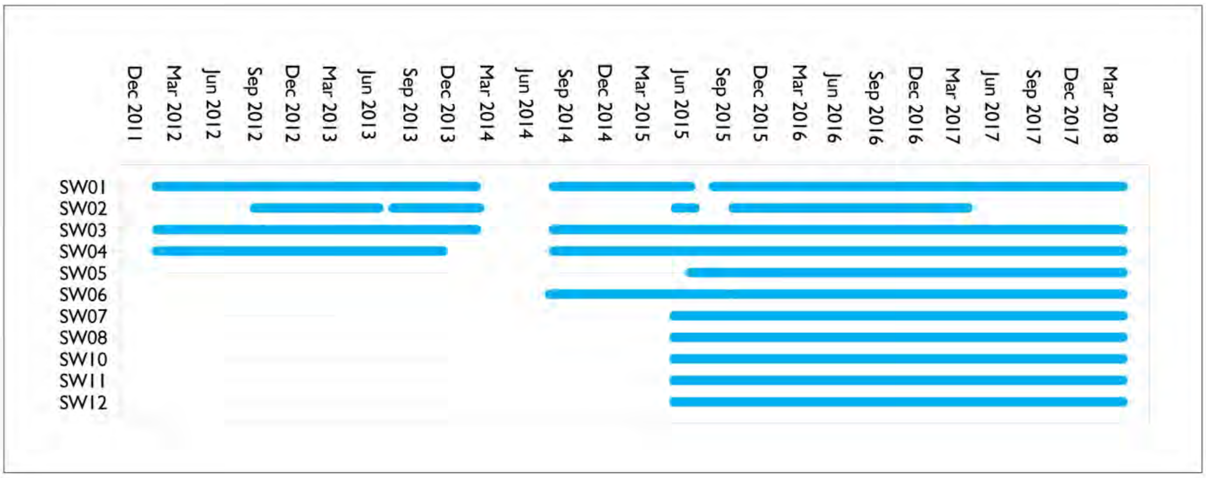


Figure 4.2 Surface water level monitoring overview

Bubbler system and pressure transducer installations at each surface water level monitoring site record water level data. Data collected included flow rates and flow volumes, commonly referred to as stage-discharge rating curves. WSP PB (2016c) reduced and refined uncertainty in the rating curves, as a result of complex topography, by including additional water level, transect, and flow velocity measurements for each monitored section of the watercourses.

Three Sydney Catchment Authority (SCA) flow gauging stations in the project area (Figure 4.2) provided additional flow data:

- Wingecarribee River at Bong Bong Weir 212031;
- Wingecarribee River at Berrima 212272; and
- Wingecarribee River at Greenstead 212009.

4.1.3 Surface water quality monitoring

Australian Laboratory Services (ALS) has completed monthly baseline surface water quality monitoring since April 2012. Monitoring has included samples for laboratory analysis and field physicochemical parameters (WSP PB 2016e). These results have contributed to the understanding of potential groundwater and surface water connectivity in the project area. The surface water quality monitoring timeline is shown in Figure 4.3. Several surface water quality monitoring sites are no longer included in the monitoring network as they are outside the amended project area boundary and considered unlikely to be affected by the project as they were regularly dry sites (SWQ07, SWQ08, and SWQ13) or they became too difficult to access (SW02).

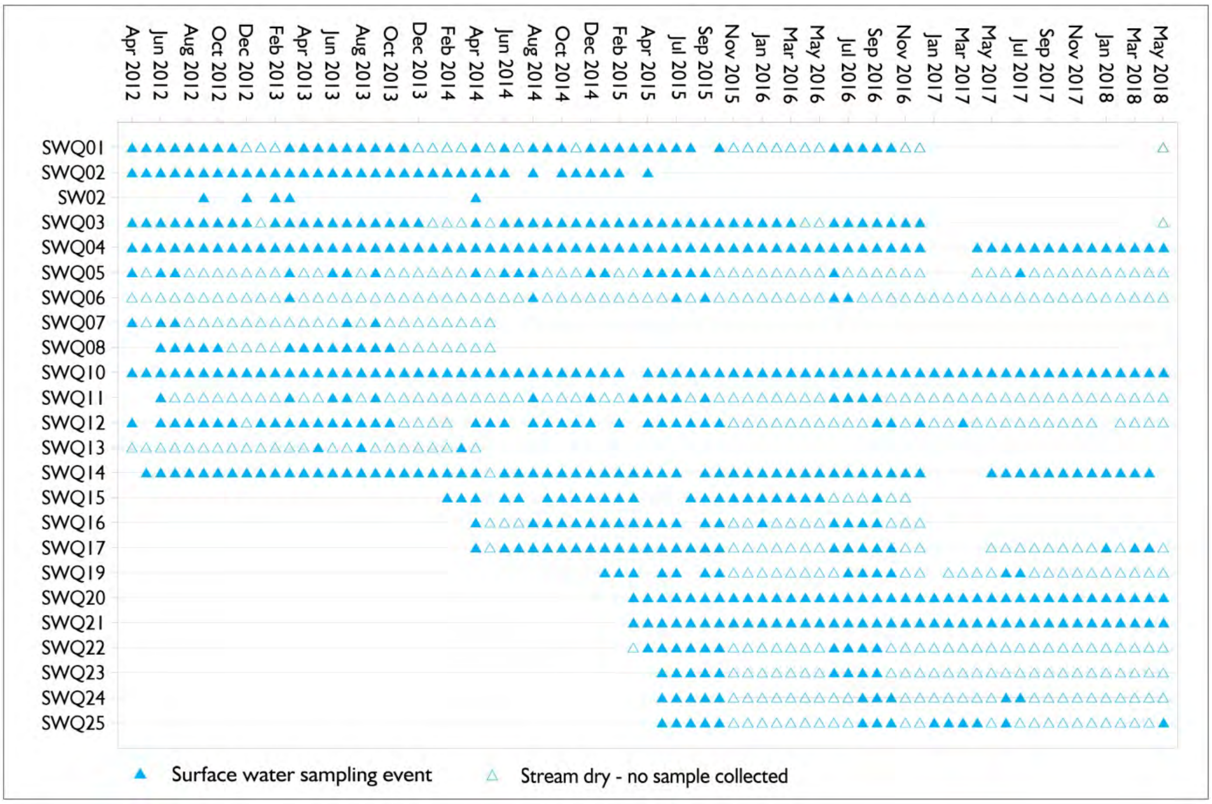


Figure 4.3 Surface water quality monitoring overview

The field physicochemical parameters monitored included: pH, electrical conductivity (EC), oxidation reduction potential (redox), temperature and dissolved oxygen. The laboratory analytes included: physical parameters, major cations and anions, alkalinity, dissolved metals, nutrients, oil and grease, aromatic hydrocarbons (benzene, toluene, ethyl-benzene, xylene and naphthalene (BTEXN)), and total recoverable and petroleum hydrocarbons. Isotopes (radiocarbon, oxygen-18, and tritium) were also analysed in 2013 to provide additional understanding of groundwater and surface water connectivity at three locations (one at Medway Rivulet and two at Wells Creek) (WSP PB 2016b).

Result accuracy, reliability, and precision were established by implementing field and laboratory quality assurance and quality control (QA/QC) procedures. These QA/QC procedures included: analysis of unstable parameters in the field, calibration of equipment, delivery of samples to the laboratory within holding times, collection of blind duplicate samples, maintenance of samples at a cool temperature, collection of blind duplicate samples, analysis of spiked and control samples, and use of gloves during sampling (WSP PB 2016b).

i Surface water assessment criteria

WSP PB (2016b) used the ANZECC and ARMCANZ water quality guidelines (2000) as assessment criteria for baseline surface water quality. Application of these guidelines considers the environment type (in this case: freshwater aquatic ecosystems), environmental values and existing condition, as well as the level of acceptable change. The toxicant trigger values for the protection of 95% of species have been used, as the project area's existing environment condition is classified as slightly to moderately disturbed. Default trigger values for the physicochemical constituents (ie EC and ammonia) for upland rivers in south-east Australia were adopted, with trigger values also derived from ecosystem data for unmodified or slightly disturbed ecosystems.

The trigger values in the drinking water guidelines (NHMRC 2016) were also considered (WSP PB 2016b). This is a requirement as the Wingecarribee River catchment is a southern (upstream) sub-catchment of the larger Hawkesbury-Nepean River catchment, which is within the Warragamba Drinking Water Catchment, where reference to the water quality objectives in the State Environmental Planning Policy (SEPP) (Sydney Drinking Water Catchment 2011) and NSW Healthy Rivers Commission of Inquiry into the Hawkesbury-Nepean River catchment (HRC 1998) is required.

4.1.4 Geomorphology assessment

Field geomorphology surveys were conducted between May 2012 and October 2015 (WSP PB 2016c). These surveys verified desktop assessments of river styles and geomorphic features within the project area.

The assessment collected geomorphological observation data, including bed and bank composition (where accessible), extent of riparian vegetation, geomorphological units and flow characteristics at the catchment and reach scale. The geomorphic assessment was completed using principles and terminology of the River Styles Framework (WSP PB 2016c).

The study area for the geomorphology assessment included streams in the surface infrastructure areas and above the proposed underground mining area, as well as pertinent streams surrounding the project area and streams potentially influenced by the project. The streams selected for the geomorphology assessment provided a catchment-based perspective for assessment. Site selection was based on the following criteria:

- headwaters originating within the project area;
- areas with key underlying geology and groundwater;
- representative reaches based on desktop assessment (aerial photography);
- areas with key surrounding land use characteristics;
- range of stream order; and

- the location of the existing surface water quality monitoring sites.

4.2 Groundwater monitoring

4.2.1 Groundwater monitoring network

Parsons Brinckerhoff designed and implemented a dedicated project groundwater monitoring network to investigate hydrogeological conditions in the project area (WSP PB 2016e). Currently up to eight years of baseline data is available for some sites. However, to maintain consistency with the original EIS the same data set was adopted for the revised assessment. Baseline hydrogeological data continues to be collected in the Hume Coal monitoring bore network. The network was developed with ongoing consultation with DPI Water (then NOW), and Currently DI Water, both directly and via the GMMP (EMM 2017b).

The groundwater monitoring network includes groundwater monitoring bores, vibrating wire piezometers (VWPs), and landholder bores located within and around the project area. Project monitoring bores and VWPs are positioned to provide spatial coverage, investigate the major hydrogeological environments, and monitor potentially sensitive features. Specifically, the groundwater network was designed to:

- identify and characterise water bearing units and aquitards in the project area, with particular focus on characterising groundwater flow and quality within the main groundwater bearing unit, Hawkesbury Sandstone, and the mining target, Illawarra Coal Measures;
- provide spatial representation and flux of pressure heads across the project area to investigate potential vertical hydraulic gradients and connectivity between water bearing units and the underlying target coal seam;
- investigate the potential for surface water–groundwater interaction; and
- monitor potential sensitive features, including Medway Dam, Long Swamp, landholder bores and potential groundwater dependent ecosystems.

The Hawkesbury Sandstone, which directly overlies the Wongawilli Coal Seam (mining target), is the main water bearing zone monitored due to its dominance in the geological setting and use by landholders.

4.2.2 Monitoring bores

AR 47: Bore construction information is to be supplied to DPI Water by submitting a "Form A" template. DPI Water will supply "GW" registration numbers (and licence/approval numbers if required) which must be used as consistent and unique bore identifiers for all future reporting

i Installation

Highland Drilling Pty Ltd (drilling contractor), under the supervision of Parsons Brinckerhoff hydrogeologists, completed all of the project groundwater monitoring bore drilling and installation, and where applicable decommissioning, in accordance with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2012) and the relevant DI Water (formerly DPI Water) monitoring bore licence conditions. Drilling mostly used open hole rotary drilling techniques, with clean water for the drilling fluid. However, deeper boreholes, ie those intersecting the Illawarra Coal Measures, and boreholes for VWP were fully or partially diamond cored with drilling muds and additives.

The groundwater monitoring bores were installed to intersect the most productive water bearing zones and were effectively sealed from overlying formations.

During drilling, the supervising hydrogeologist completed:

- geological appraisal at 1 m intervals, based on visual inspection of drill cuttings or drill core, and production of bore log;
- recording of water interceptions and airlift yields at each water bearing zone intersected;
- measurement of water quality for all major water bearing zones intersected, including measurement of field physio-chemical parameters and selected samples undergoing more detailed laboratory analysis; and
- specific design of the monitoring installation.

Monitoring bore licences were obtained from DI Water before drilling works began. *Form A: Particulars of Completed Works* forms (drilling completion forms) were submitted to DI Water after the monitoring bores and vibrating wire piezometers were complete.

Water used and produced during drilling was managed in accordance with the Hume Exploration Project Review of Environmental Factors (REF) (Hume Coal 2011, 2012, and 2014). Water for drilling was sourced from licensed supply or farm dams. There were no instances of uncontrolled release of water; water was discharged only when it met the water quality limits specified in the REF. All drilling scraps, drilling fluids and water that did not comply with REF limits was contained in above-ground tanks and disposed of at a licensed waste facility.

ii Geophysical logging

Geophysical data is useful to identify fine details within the geological units (notably the precise location of coal), and inferred hydrogeology via changes in conductivity.

Downhole geophysical logging took place at 20 of the deep project bore holes at nested locations (WSP PB 2016e). The bore holes are identified in Table 4.1. The geophysical tools used included calliper, gamma, resistivity and neutron. The gamma logs are included in the summary bore logs (Appendix K). Gamma radiation emitted from coal and shale is greater than from other sedimentary rocks; coal and shale units can be identified in a gamma log by an elevated gamma signal.

iii Monitoring bore details

AR 34: Details on all bores and excavations for the purpose of investigation, extraction, dewatering, testing and monitoring

The groundwater monitoring network installation occurred between September 2011 and October 2014 (WSP PB 2016e). Consultation with the NSW water regulator frequently occurred via formal meetings, phone calls and the preparation of the GMMP, and this consultation focused on ensuring the network was considered ‘fit for purpose’ by the NSW regulator.

The baseline monitoring network is adequate for the purpose of the assessment and the modelling work that underpins this assessment. Coffey (2017a) describes the baseline data set as 'extensive', with up to 5 years of continuous data in some monitoring bores used in the model. The recommended requirement from the NSW Government is 2 years of data, so the project has more than double the duration than the recommendation at most sites. The understanding of surface and groundwater connectivity, as it pertains to baseflow is considered in detail using baseline monitoring of surface and groundwater as well as robust statistical and analytical techniques.

The groundwater monitoring network is tailored to ensure it is monitoring within the different geological units in the area (ie sandstone, basalt, shale etc). This has enabled hydrogeological characterisation of each unit and consideration of connectivity.

The network consists of:

- 54 groundwater monitoring bores at 22 locations. Often multiple monitoring bores are installed next to one another at the same location; this is called a nested location. Each bore at a nested location is installed to a different depth, monitoring a different zone within the groundwater systems. Nested sites provide information on the vertical hydraulic gradients and inferred vertical connectivity at that location.

- 11 vibrating wire piezometer (VWP) sensors within three bores. The sensors collect information on pore pressure within a geological formation that can infer groundwater pressure. Similar to nested bores, positioning the sensors at different depths provides an understanding of vertical hydraulic gradients.

- Three landholder bores, two within the project area and one to the north. All monitor the Hawkesbury Sandstone.

Table 4.1 and Figure 4.4 show details and locations of the groundwater monitoring bores. Summary bore logs are included in Appendix K.

Table 4.1 Groundwater monitoring bores overview

Bore ID	Ground level (mAHD)	Total depth (mgbl)	Screen interval (mbgl)	Monitored formation	Lithology	Licence number
Project monitoring bores						
HU0018PZA[2]	691.7	108	96–99	Illawarra CM	Wongawilli coal seam	10BL604639
HU0018PZB	692.0	90	76–88	Hawkesbury SST	Sandstone	
HU0019PZA[2]	720.7	108	100.5–103.5	Illawarra CM	Wongawilli coal seam	10BL604640
HU0019PZB	720.5	84	70–82	Hawkesbury SST	Sandstone	
HU0020PZA	703.3	79.5	71.5–77.5	Hawkesbury SST	Sandstone	10BL604639
HU0020PZB[2]	703.7	88	80–86	Illawarra CM	Wongawilli coal seam	
HU0023PZA[1,2]	680.5	139.5	136.5–138.7	Illawarra CM	Wongawilli coal seam	10BL604919
HU0023PZB[1]	680.6	130	118–130	Hawkesbury SST	Sandstone	
HU0023PZC[1]	680.8	97.6	85–97	Hawkesbury SST	Sandstone	
HU0032LDA[2]	646.6	121	108–114	Illawarra CM	Wongawilli coal seam	10BL605105
HU0032LDB	646.6	89	58–88	Hawkesbury SST	Sandstone	

Table 4.1 Groundwater monitoring bores overview

Bore ID	Ground level (mAHD)	Total depth (mgbl)	Screen interval (mbgl)	Monitored formation	Lithology	Licence number
HU0035PZA[2]	681.4	152	54–78	Hawkesbury SST	Sandstone	10BL605140
HU0035PZB	680.8	35	16–34	Ashfield Shale	Siltstone	
HU0037PZA	703.8	111	102–105	Illawarra CM	Siltstone	10BL605073
HU0037PZB	703.8	90	72–87	Hawkesbury SST	Sandstone	
HU0038PZA[2]	658.5	116.9	104.9–107.9	Illawarra CM	Wongawilli coal seam	10BL605142
HU0038PZB	658.4	78	74–77	Hawkesbury SST	Sandstone	
HU0038PZC	658.3	63	56– 62	Hawkesbury SST	Sandstone	
HU0042PZA[2]	702.5	162	156–159	Illawarra CM	Wongawilli coal seam	10BL605170
HU0042PZB[1]	702.7	141	134–140	Hawkesbury SST	Sandstone	
HU0042PZC	702.0	150	143–149	Hawkesbury SST	Sandstone	
HU0043XPZA[2]	692.0	111	95–101	Illawarra CM	Wongawilli coal seam	10BL605222
HU0043XPZB	691.8	87	77–86	Hawkesbury SST	Sandstone	
HU0044XPZA	641.9	12	8–11	Illawarra CM	Wongawilli coal seam	10BL605223
HU0044XPZB	647.0	5	4–4.5	Hawkesbury SST	Sandstone	
HU0056XPZA[1,2]	735.4	150	143.5–144	Illawarra CM	Wongawilli coal seam	10BL605256
HU0056XPZB	735.5	140	133–139	Hawkesbury SST	Sandstone	
HU0056XPZC	735.5	26	19–25	Robertson Basalt	Basalt	
HU0072PZA	640.1	129	124–127	Illawarra CM	Wongawilli coal seam	10BL605181
HU0072PZB	640.5	99	92–98	Hawkesbury SST	Sandstone	
HU0072PZC	640.9	46	39–45	Hawkesbury SST	Sandstone	
HU0073PZA[2]	655.8	172	151–169	Illawarra CM	Sandstone	10BL605329
HU0073PZB	655.1	124	119–122	Illawarra CM	Wongawilli coal seam	
HU0073PZC	654.9	86	79–85	Hawkesbury SST	Sandstone	
HU0088PZA[2]	655.4	148	143–146	Illawarra CM	Wongawilli coal seam	10BL605235
HU0088PZB	655.3	128	121–127	Hawkesbury SST	Sandstone	
HU0096PZA[2]	699.2	121	111–120	Illawarra CM	Tongarra coal seam	10BL605407
HU0096PZB	699.1	101.3	92.3–98.3	Illawarra CM	Wongawilli coal seam	
HU0096PZC	699.04	89	6–87	Hawkesbury SST	Sandstone	
HU0098PZ[1.3]	699.06	108	69–87	Hawkesbury SST	Sandstone	10BL605407
HU0118PZA[2]	612.5	15.3	7.3–13.3	Hawkesbury SST	Sandstone	10BL605497
HU0129PZA[2]	679.1	171	167–170	Illawarra CM	Wongawilli coal seam	10BL605509
HU0129PZB	679.2	153	146.5–152.5	Hawkesbury SST	Sandstone	
HU0133PZA[1, 2]	648.2	127	120–126	Illawarra CM	Tongarra coal seam	10BL605568
HU0133PZB[1]	648.2	112.5	108.5–111.5	Illawarra CM	Wongawilli coal seam	
HU0133PZC[1]	648.0	83.8	79.8–82.8	Hawkesbury SST	Sandstone	
HU0136PZA	718.5	204	200–203	Illawarra CM	Wongawilli coal seam	10BL605498
HU0136PZB[1]	718.5	167.8	157.8–166.8	Hawkesbury SST	Sandstone	
HU0136PZC	718.5	59.6	52.6–58.6	Roberson Basalt	Basalt	

Table 4.1 Groundwater monitoring bores overview

Bore ID	Ground level (mAHD)	Total depth (mgbl)	Screen interval (mbgl)	Monitored formation	Lithology	Licence number
HU0142PZA	672.4	130.7	127–129	Illawarra CM	Wongawilli coal seam	10BL605572
HU0142PZB	672.3	119	112–118	Hawkesbury SST	Sandstone	
HU0142PZC	672.2	85	81–84	Hawkesbury SST	Sandstone	
HU0143PZA	649.6	125.8	118.8–124.8	Illawarra CM	Siltstone	10BL605606
HU0143PZB	649.6	113	109–112	Illawarra CM	Wongawilli coal seam	
HU0143PZC	649.4	95.9	91.9– 94.9	Hawkesbury SST	Sandstone	
HU0147PZAA[2]	651.8	230	215 - 227	Illawarra CM	Sandstone	10BL605838
HU0147PZAB[2]	651.8	170	158–167	Illawarra CM	Sandstone	
HU0147PZB[1,2]	652.6	228	–	Illawarra CM	Sandstone	
Vibrating wire piezometers						
HU0040CH[2]	656.5	98	V1–120.1	Wongawilli seam	Coal	10BL605428
			V2–106.9	Hawkesbury SST	Sandstone	
			V3–81	Hawkesbury SST	Sandstone	
			V4–40	Hawkesbury SST	Sandstone	
HU0077CH[2]	689.7	128	V1–87	Wongawilli seam	Coal	10BL605427
			V2–72	Hawkesbury SST	Sandstone	
			V3–58	Hawkesbury SST	Sandstone	
HU0122CH[2]	634.5	120	V1–112.2	Wongawilli seam	Coal	10BL605569
			V2–86	Hawkesbury SST	Sandstone	
			V3–45	Hawkesbury SST	Sandstone	
			V4–15	Hawkesbury SST	Sandstone	
Landholder bores						
GW106652	652.3	120	25–120	Hawkesbury SST	Sandstone	10BL162638
GW108194	-	121.5	42–121.5	Hawkesbury SST & Wongawilli seam	Sandstone & Coal	10BL164544
GW106710	672.4	115	64–108	Hawkesbury SST	Sandstone	10BL106710
DPI Water monitoring bores						
GW075032	679.2	91	24–29	Hawkesbury SST	Sandstone	-
			73–88	Illawarra CM	Shale	
GW075034	665	101	90–100	Hawkesbury SST	Sandstone	-
GW075036	670.4	100	73–84	Hawkesbury SST	Sandstone	-
GW072401	-	32	-	Hawkesbury SST	Sandstone	10BL156071

Notes: *Source: WSP PB 2016e, DPI Water Groundwater monitoring network database (DPI Water 2016b).*

SST = Sandstone, CM =Coal Measures, VWP = vibrating wire piezometer

mAHD = metres Australia Height Datum, mbgl = metres below ground level.

1 = decommissioned bore.

2 = geophysical log completed.

3 = bore installed for pump testing only and was decommissioned– bore was not part of the ongoing monitoring network.

- = unknown.

4.2.3 Hydraulic testing

A diverse range of hydraulic tests was conducted to provide site-specific information on the hydraulic properties of the groundwater systems. The hydraulic testing methods used are comparable to those used for other NSW mining projects, and the data and field testing methods for the Hume Coal Project are considered to be industry best practice. Hydraulic testing undertaken for the Hume Coal project includes:

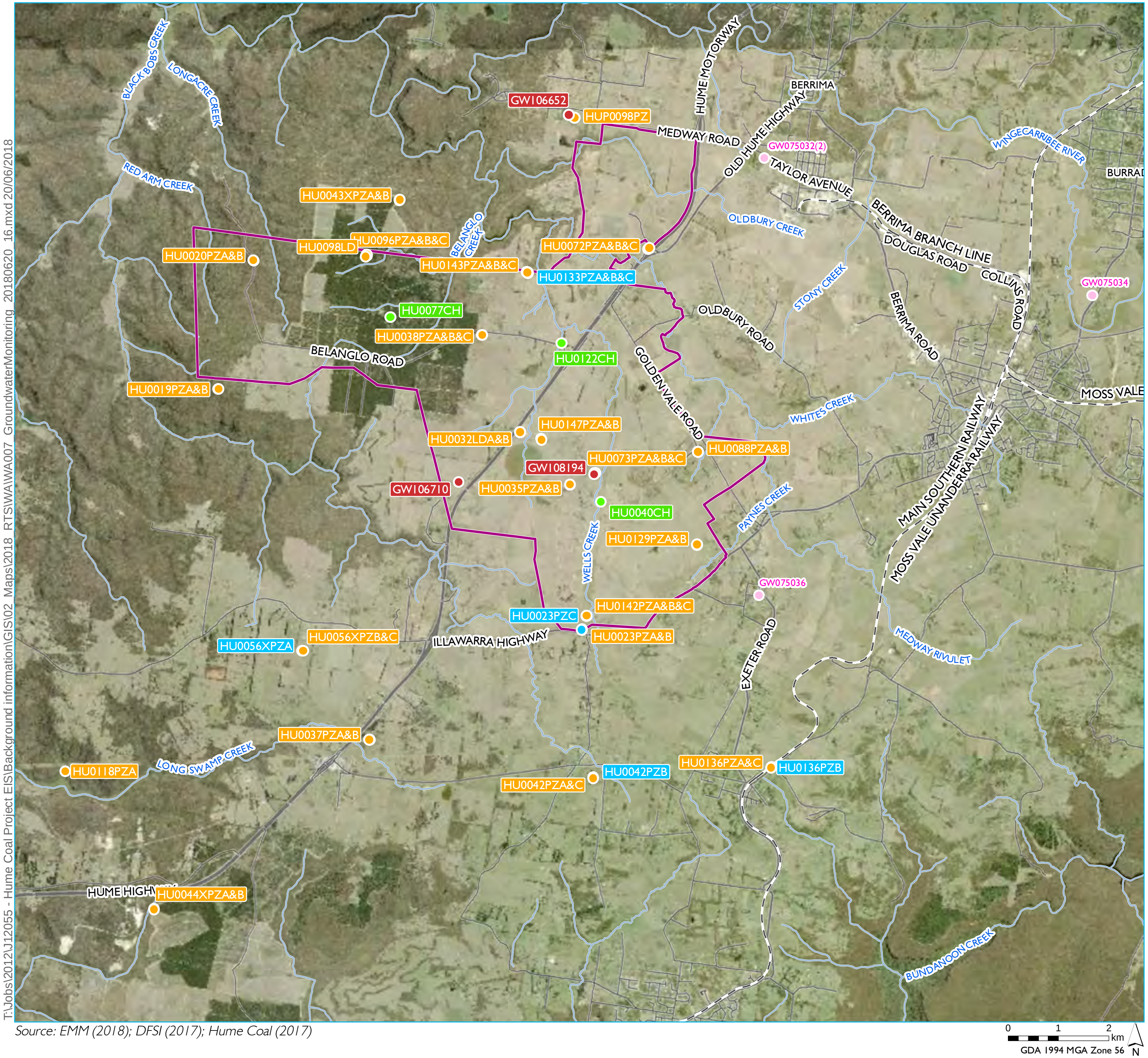
- slug testing;
- packer tests;
- core laboratory tests; and
- in situ pumping tests (step drawdown and constant rate pumping tests).

In addition, specific capacity data from government records has also been referenced.

The combination of analysis of all these different datasets allows for a comprehensive assessment to be made of hydraulic conductivity (K) across the different hydrogeological units in the project area (Coffey 2016a). The locations of the various tests completed for the project are shown in Figure 4.5.

i Slug testing

Slug tests provided an indication of the hydraulic parameters of the formation in the immediate vicinity of the screened interval of a monitoring bore. Slug tests were carried out at 42 project groundwater monitoring bores (Figure 4.5). This involved installing an electronic water level logger in the bore, displacing water in the bore using a slug (comprising a solid bailer), and recording the water level change over time. The results provide an indication of the rock's bulk hydraulic conductivity, or rate of groundwater flow, in the immediate vicinity of the screened interval.



Source: EMM (2018); DFSI (2017); Hume Coal (2017)

KEY
- Project area
- Monitoring bore or bore nest
- Decommissioned monitoring bore or bore nest
- Vibrating wire piezometer
- Landholder bores utilised for monitoring
- DI water monitoring bore

Existing features
- Main road
- Local road
- Rail line
- Drainage line

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Groundwater monitoring locations

Hume Coal Project
Revised Water Assessment
Figure 4.4

HUMECOAL PROJECT
EMM

ii Packer testing

Packer testing provided information on the hydraulic properties of the rock mass at specific depth intervals (generally at thicknesses of between 6.5 and 8.5 m). The results are indicative of the primary permeability of the rock mass as well as secondary permeability that may be associated with joints and fractures. Packer testing was conducted on open boreholes by Strata Control Technology in September 2013, and March and April 2015. In October 2017, packer testing at a newly drilled corehole (HU0147PZB) was also undertaken.

Within three key open boreholes, 28 depth intervals were tested, representing a range of geological conditions (Figure 4.5). Packer testing used double packers and injected water into a sealed test interval and measured the rate of water flow (or pressure build up and decay) over a period of time.

iii Laboratory core permeability

Laboratory core permeability testing provided information on the hydraulic properties of the rock mass at specific depth intervals (about 0.1 m intervals). The results are indicative of the primary permeability of the rock mass and do not account for the effects of secondary permeability that may be associated with joints and fractures.

Core Laboratories Australia tested a total of 39 samples from 16 core hole locations (Figure 4.5) (WSP PB 2016e). Between one and ten core samples were selected from each borehole and were tested for vertical and horizontal permeability. The core samples were representative of the range of lithologies and permeabilities throughout the stratigraphic profile across the project.

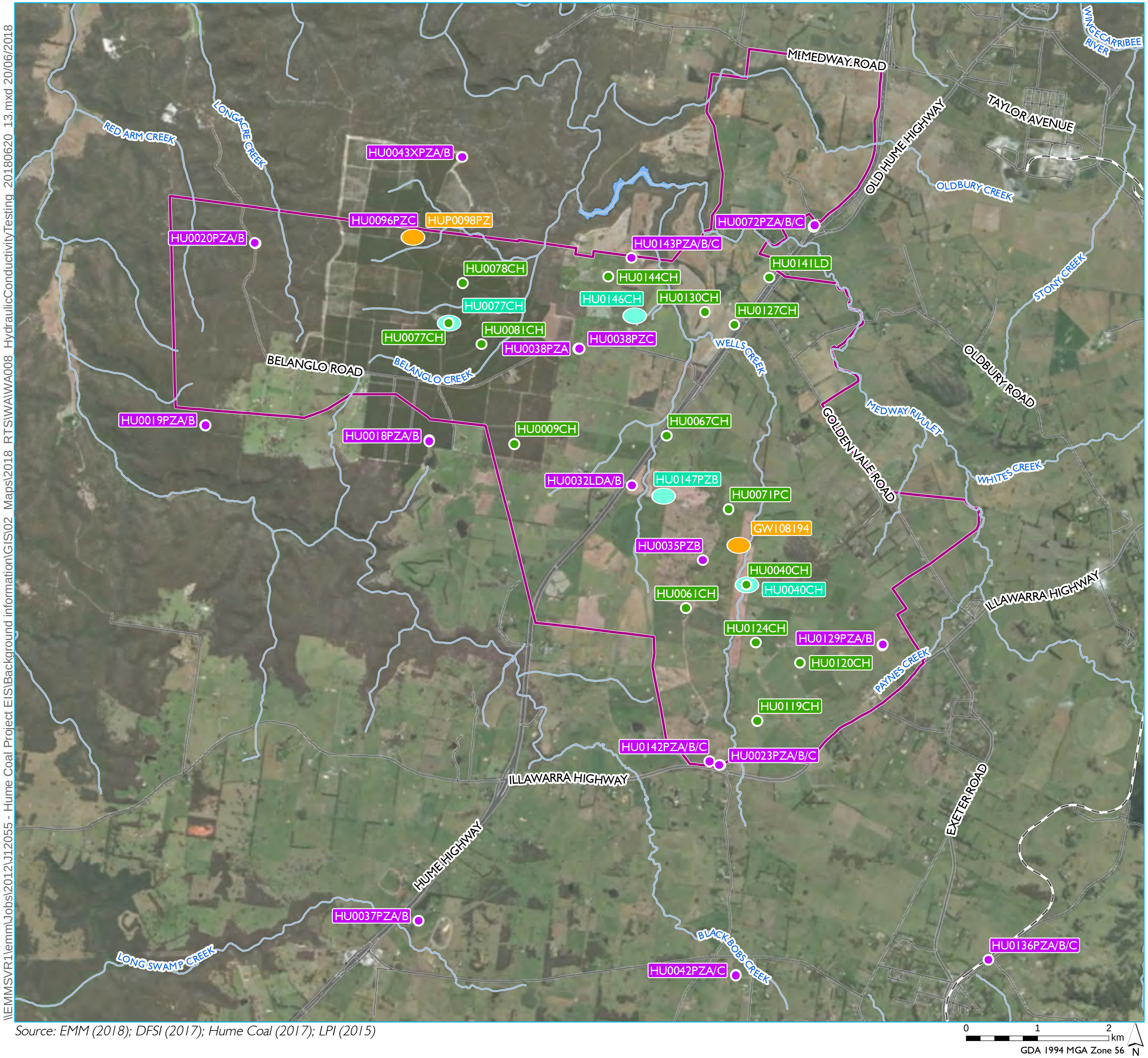
iv Pumping tests

Pumping tests pumped water from a test bore at a suitable constant rate and for enough time for a significant drawdown response in nearby monitoring bores. Pumping tests were a direct and reliable method to obtain estimates of groundwater system hydraulic properties, including storativity, transmissivity and horizontal hydraulic conductivity. Pumping tests also provided information on the extent and sustainability of the aquifer and the degree of connection with nearby surface water sources if they were present.

Two constant rate pumping tests were conducted in the project area: a 24-hour test at HU0098PZ and a 7-day test at GW108194. Coffey (2016a) assessed the groundwater level observations from the test and monitoring bores using the computer-based 'WTAQ' algorithm for confined/unconfined groundwater systems.

v Specific capacity

A specific capacity analysis was undertaken using available data from pumping tests in the area to provide a relationship between bore yield and specific capacity for the aquifers local to the project. This relationship can then be used to convert a bore yield estimate into hydraulic parameters. This locally derived formula was then applied to 129 records of bore yields within the DI Water database.



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Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015)

Groundwater hydraulic conductivity testing

Hume Coal Project
Revised Water Assessment
Figure 4.5

4.2.4 Groundwater level monitoring

Groundwater level monitoring began in November 2011 at six project monitoring bores and later at other monitoring locations following installation (WSP PB 2016e). The duration of the groundwater level monitoring period at each project monitoring bore, VWP, and landholder bore is shown in Figure 4.6. For a majority of locations there is over two years of groundwater level monitoring data. Groundwater level data has also been obtained from six DPI Water monitoring bores at four locations near the project area.

Solinst pressure transducers and data loggers are installed in all the project groundwater monitoring bores and monitor groundwater levels every six hours. When the loggers were downloaded, manual groundwater level measurements were also recorded to calibrate the logger data. A barometric data logger installed above the water table at HU0018PZA records changes in atmospheric pressure. Data from this logger is used to correct for the effects of changing barometric pressure and barometric efficiency on groundwater levels.

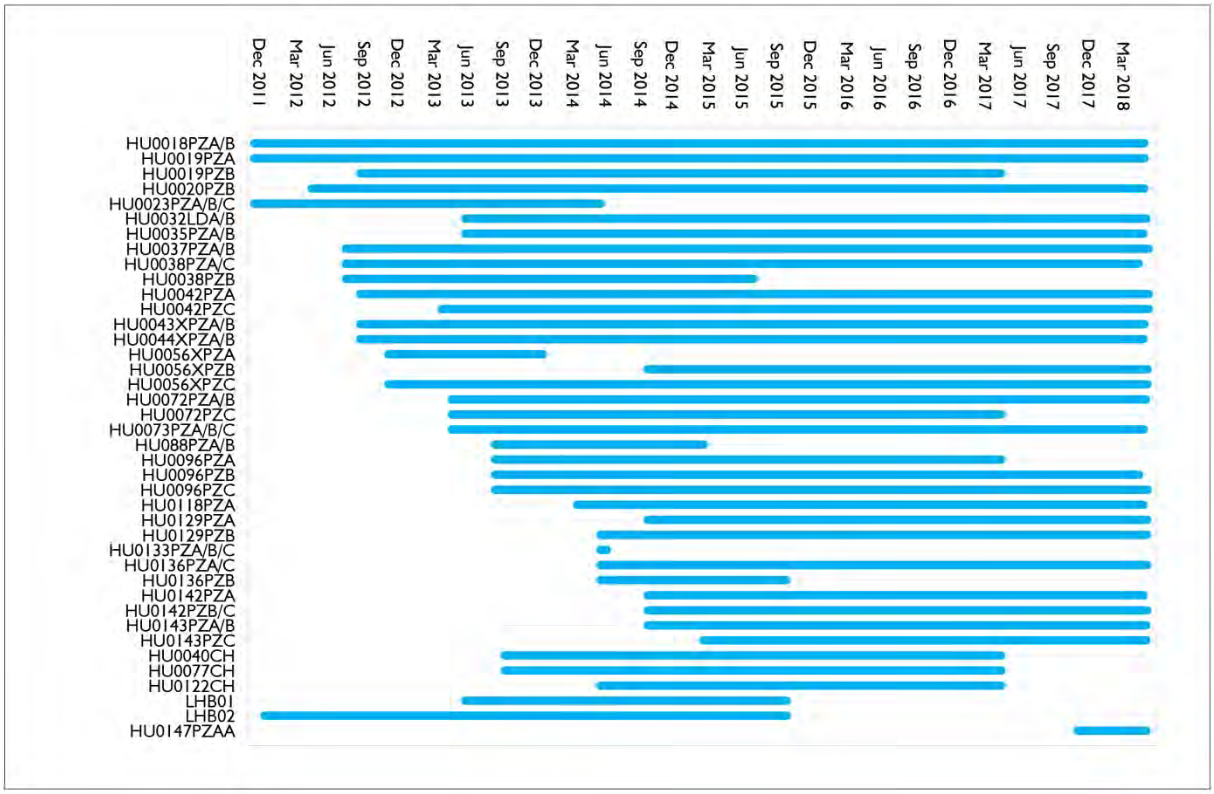


Figure 4.6 Groundwater level monitoring overview

4.2.5 Groundwater quality monitoring

An initial round of groundwater quality monitoring was completed following each monitoring bore installation. Groundwater quality monitoring has continued at either a quarterly (ie every three months) or annually (WSP PB 2016e). The schedule of groundwater quality monitoring is shown in Figure 4.7.

The groundwater sampling method used at each bore was determined based on the depth of the bore, the depth to groundwater, and the hydraulic conductivity of the screened formation. The sampling techniques and criteria for selection are shown in Table 4.2.

Table 4.2 Sampling techniques and criteria for selection

Criteria for sampling technique	Sampling techniques	Description
Higher yielding, shallower monitoring bores	Submersible pump	Typically, three well volumes are purged before sampling to allow a representative groundwater sample to be collected. If purged until dry, the bore is allowed to recharge and the recharge water is sampled. Water quality parameters (including pH, temperature and electrical conductivity (EC)) are measured during purging and pumping to monitor water quality changes, and to indicate representative groundwater suitable for sampling and analysis.
Low yielding bores, or deeper bores with high purge volumes	Micro-purge™ system	The micro-purge™ system allows groundwater to be drawn into the pump intake directly from the screened portion of the groundwater system, eliminating the need to purge relatively large volumes of groundwater from these bores. Water quality parameters (including pH, temperature and electrical conductivity (EC)) are measured during purging and pumping to monitor water quality changes, and to indicate representative groundwater suitable for sampling and analysis.
Shallow bores	Disposable bailer	Bailers are used to purge three well volumes before sampling to allow a representative groundwater sample to be collected. If purged until dry, the bore is allowed to recharge and the recharge water is sampled. Water quality parameters (including pH, temperature and electrical conductivity (EC)) are measured during purging to monitor water quality changes, and to indicate representative groundwater suitable for sampling and analysis.
Bores with deep groundwater levels	Snap sampler	A snap sampler is a dedicated in-well sampling device that provides a representative groundwater sample by passively sampling groundwater that flows through the screened section of the well where it is positioned. The device is removed from the well to collect the groundwater samples, and is then replaced in the well to allow for sample collection during the next sampling round.
When pumps malfunction	HydraSleeves™ or double check bailer	Used to collect groundwater samples from within the screened interval of wells when pumps malfunctioned. The sleeve or bailer is lowered into the well, and following equilibration of the well the sample is collected. HydraSleeves™ have a one-way reed valve that collapses when the sleeve is full, preventing groundwater from the upper sections of the bore mixing with the sample in the sleeve during retrieval.

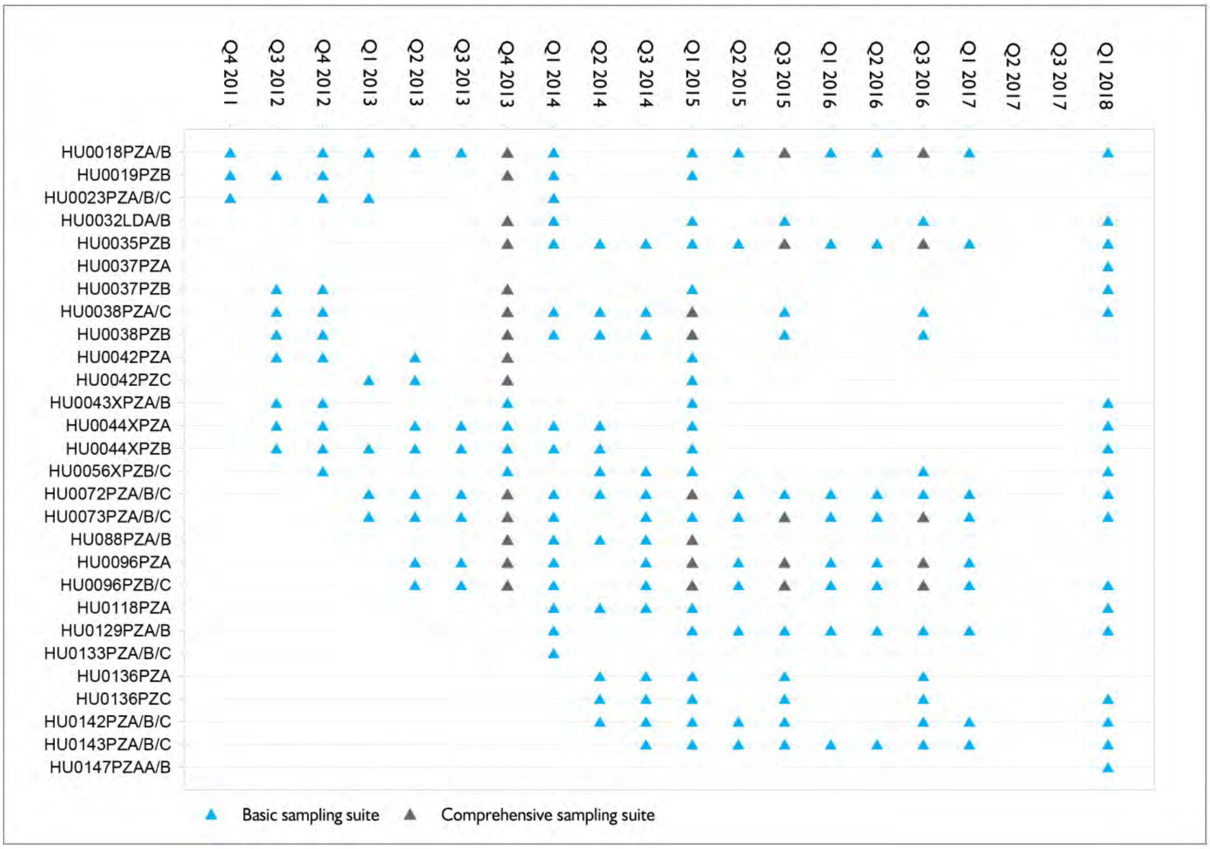


Figure 4.7 Groundwater quality sampling overview

Water quality samples were collected in laboratory provided sample bottles, with appropriate preservation. Samples undergoing dissolved metal analysis were filtered through a 0.45 µm filter in the field before collection in nitric acid preserved plastic sample bottles. Samples were stored on ice and sent to the laboratory under appropriate chain-of-custody protocols.

Groundwater samples are analysed by ALS Environmental, a NATA-accredited analytical laboratory, for either the standard or comprehensive suite of analytes shown in Table 4.3. Standard quarterly samples were collected from a representative 23 monitoring bores for the dataset used in the EIS water quality assessment (Geosyntec 2016). The comprehensive analytical suite is collected annually operational monitoring bores, or when additional water quality data is required. Following preparation of the EIS, groundwater sampling has continued at a reduced frequency.

Table 4.3 Standard and comprehensive analytical suites

Suite	Analytes
Standard	Field parameters (pH, EC, redox potential, DO, temperature)
	EC, TDS, TSS
	Major ions (calcium, magnesium, sodium, potassium, sulfate, chloride, alkalinity, acidity) and silica
	Dissolved metals (aluminium, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, fluoride, iron, ferrous iron, lead, magnesium, manganese, molybdenum, nickel, selenium, strontium, zinc)[1]
	Total metals (iron, manganese)[2]
Comprehensive	Standard suite
	Turbidity, BOD
	Nutrients (ammonia as N, nitrite as N, nitrate as N, reactive phosphorous, phosphorous, total phosphorus)
	TRH/BTEX
	PAHs, phenols
	Pesticides (OCPs, OPPs)
	Total coliforms, faecal coliforms and *E. Coli*

Notes: 1 = Before December 2013 only iron and manganese were analysed and ferrous iron has been included since June 2015.

2 = Not analysed prior to 2015.

TDS – total dissolved solids, TSS – total suspended solids, BOD – biochemical oxygen demand, TRH – total recoverable hydrocarbons, BTEX – benzene, toluene, ethylbenzene, xylene, PAH – polycyclic aromatic hydrocarbons, OCPs – organochlorine pesticides, OPPs – organophosphorous pesticides.

Field and laboratory QA/QC procedures are used to establish accurate, reliable and precise results. Some QA/QC procedures included: analysis of unstable parameters in the field, calibration of equipment, submitting laboratory samples within holding times, collection of blind duplicate samples, keeping samples chilled and wearing gloves during sampling (WSP PB 2016e).

Groundwater was also sampled for isotopes (radiocarbon, oxygen-18, and tritium) to determine groundwater system dynamics, recharge/discharge processes, groundwater system connectivity, groundwater–surface water linkages and potential ecosystem dependence on groundwater. Isotopes were analysed in samples from 15 groundwater monitoring locations in 2011 and 2013 (WSP PB 2016e).

i Groundwater assessment criteria

a. Ecological water quality criteria

The methodology and criteria for ecological water quality assessment in Australia are presented in the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ 2000).

The guidelines present assessment criteria (referred to as 'trigger values') for a range of organic and inorganic chemicals, which are applicable to both protection of aquatic ecology, and suitability for primary industries. While the guidelines are not specifically 'groundwater criteria', they apply at the point of use or exposure and are therefore relevant where an aquatic ecosystem is partially or wholly dependent on groundwater, or where groundwater supply supports primary industry.

b. Health-based water quality criteria

The methodology and criteria for health-based assessment of drinking water quality in Australia are presented in the National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC)'s Australian Drinking Water Guidelines (NHMRC 2016). The ADWG lists health-based and aesthetic criteria for various organic and inorganic chemicals. Because groundwater systems within the study area are accessed for potable water supply, both the health-based and aesthetic criteria have been considered in this assessment.

4.2.6 Ecology surveys

Extensive ecology surveys and assessments have been completed for the project; the details and results of the field surveys are in the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c). The ecology survey considered threatened species as well as mapping the baseline ecology across the greater project area.

Paddys River Swamps (comprising Long, Hanging Rock, Mundego, and Stingray Swamps) and Wingecarribee Swamps are identified as high priority GDEs in the Metropolitan Groundwater WSP. These GDEs are, however, some kilometres from the mine area, being 9 km to the south-west and 17 km to the east, respectively (Figure 1.4). The National Atlas of Groundwater Dependent Ecosystems (BoM 2012) was also considered.

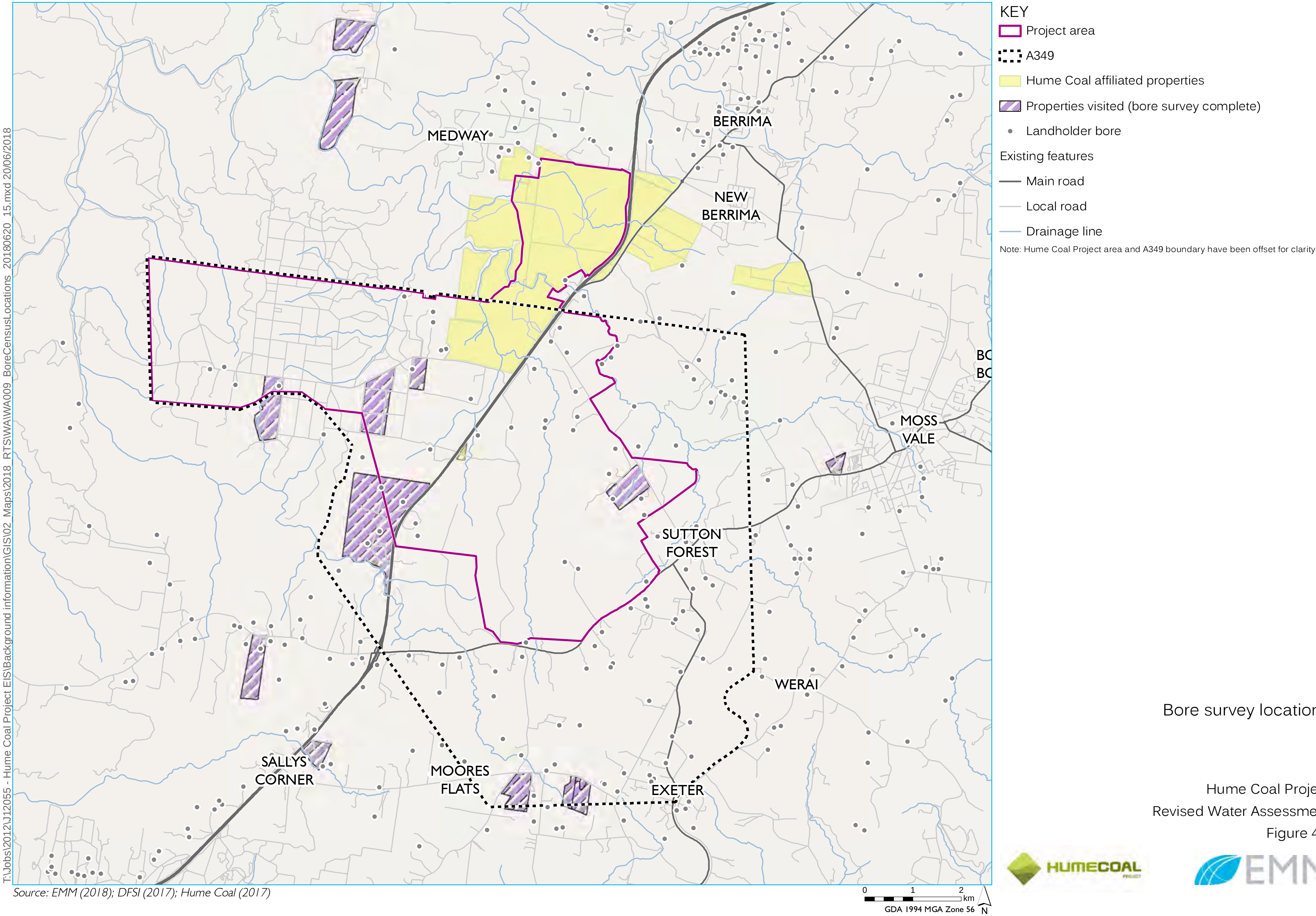
Although the GDEs are at a distance from the mine, the design of the surface water and groundwater monitoring network has considered these GDEs, with shallow monitoring and water quality sampling from the nearest swamp area.

Stygofauna sampling assessed 19 groundwater monitoring bores (8 within the project area and 11 outside it) in 2013 and 2014 (EMM 2017c). The bores sampled ranged in depth from 5 to 172 metres below ground level (mbgl), allowing for spatial characterisation of the potential for stygofauna in the Robertson Basalt, Wianamatta Group, Hawkesbury Sandstone, and Illawarra Coal Measures.

4.2.7 Bore census

Bore surveys were completed in March and April 2014 at properties in the project area and in May and June 2015 at properties near the former Berrima Colliery (WSP PB 2016e). The locations of the properties are shown in Figure 4.8.

Bore surveys involved visiting the homes of landholders within about 2 km of the proposed mine to question them about the bores on their property, their groundwater use, and possible effects from mining on groundwater levels at bores near Berrima Colliery. Where possible, baseline groundwater level and quality information was also collected.



Source: EMM (2018); DFSI (2017); Hume Coal (2017)

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Bore survey locations

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Figure 4.8

5 Surface water

This chapter describes the surface water features, geomorphology, and surface water use within the project area.

AR 60: Scaled plans showing the location of:

- *wetlands/swamps, watercourses and top of bank*
- *riparian corridor widths to be established along the creeks*
- *existing riparian vegetation surrounding the watercourses (identify any areas to be protected and any riparian vegetation proposed to be removed)*
- *the site boundary, the footprint of the proposal in relation to the watercourses and riparian areas*
- *proposed location of any asset protection zones*

AR 61: Photographs of the watercourses/wetlands and a map showing the point from which the photos were taken.

AR 68: The EIS must describe background conditions for any water resource likely to be affected by the development, including:
a. Existing surface and groundwater.
b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.
c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters.
d. Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government.

AR 71: The EIS must map the following features relevant to water and soils including:
a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).
b. Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment).
c. Groundwater.
d. Groundwater dependent ecosystems.
e. Proposed intake and discharge locations.

AR 72: Identify relevant water quality objectives for surface and groundwater, including indicators and associated trigger values or criteria, in accordance with National Water Quality Management Strategy Guidelines. Reference the water quality objectives for the Wingecarribee River catchment in the "NSW Healthy Rivers Commission of Inquiry into the Hawkesbury Nepean Catchment". Identify any downstream users and uses of the discharged water classified in accordance with relevant ANZECC 2000.

AR 79: A full description of the development including those aspects which have the potential to impact on the quality and quantity of surface and groundwaters at and adjacent to the site, including:

- *the mining proposal and mine layout*
- *the location, mapping and geomorphology of all creeks and water resources overlying and adjacent to the proposed mining area*
- *the hydrogeological fluxes between surface and groundwaters, including the filling of pine feather voids*
- *the location, management and storage of all hazardous materials- the disposal of wastes from the treatment of mine waters in the mine water treatment plant*
- *the management of dirty water from the washing and preparation of coal for transport*
- *the location, sizing and description of all water quality management measures*
- *the location and description of all water monitoring points (surface and ground waters)*
- *on-site domestic (sewage) wastewater management*

AR 80: A detailed assessment of the development on water resources which considers the design, construction, operational and decommissioning phases and have regard for operation during periods of wet weather and include:

- *details of measured and predicted coal mine, preparation area and stockpile area performance with respect to water quality management*
- *details of measures proposed to be adopted to offset impacts associated with construction activities eg earthworks, vegetation clearing and track construction*
- *impacts on overlying and adjacent creeks and water resources within risk management zone associated with subsidence*
- *impact of the proposed on-site domestic (sewage) wastewater management and associated effluent disposal area*
- *pre-development and post development run off volumes and pollutant loads from the site*
- *details of the measures to manage site water associated with processing coal and coal reject, general stormwater runoff and any human activities likely to affect water quality at the site, and how neutral or beneficial effect on water quality (NorBE) principles will be assessed and applied*
- *assessment of the impacts of the development on receiving water quality and volume, both surface and groundwater including from the filling of pine feather voids and associated impact on interaction and baseflows of surface waters*
- *details of the structural stability, integrity, ongoing maintenance and monitoring of all site water management measures including dams over the life of the project*
- *details of proposed monitoring of groundwater levels, surface water flows, groundwater and surface water quality, along with information as to how the proposed monitoring will be used to monitor, and, if necessary, mitigate impacts on surface water and groundwater resources*
- *the principles outlined in the 'Managing Urban Stormwater - Soils and Construction - Mines and Quarries' Manual prepared by the Department of Environment and Climate Change (2008)*

AR 84: The EIS should provide a description of the location, extent and ecological characteristics and values of the identified water resources potentially affected by the project

5.1 Overview of surface water features

AR 39: Identification of all surface water features including watercourses, wetlands and floodplains transected by or adjacent to the proposed project

AR 40: Identification of all surface water sources as described by the relevant water sharing plan

The project area is mostly located within the Wingecarribee River catchment of the Upper Nepean and Upstream Warragamba Water Source. The Wingecarribee River catchment is a southern (upstream) sub-catchment of the larger Hawkesbury-Nepean River catchment and part of the Warragamba Drinking Water Catchment. The Hawkesbury-Nepean River catchment has an approximate area of 21,400 km^2. Outside of the project area, a small portion of the south-eastern corner of A349 lies within the Bundanoon Creek catchment, a sub-catchment of the Shoalhaven River catchment (of the Shoalhaven River Water Source) (Figure 3.1).

Local sub-catchments of the Wingecarribee River catchment within the project area ultimately discharge into the Wingecarribee River, at least 5 km downstream from the project area. These include:

- Medway Rivulet catchment, incorporating the Oldbury Creek sub-catchment, where most of the project area and the surface infrastructure are located; and
- Black Bobs Creek catchment, incorporating Red Arm Creek and Longacre Creek sub-catchments.

The drainage lines (including creeks) within the project area (shown in Figure 1.4) generally drain in a north to north-westerly direction and flow into the Wingecarribee River. The Wingecarribee River flows east to west, north of the project area. The median flow in the Wingecarribee River (about 30 ML/day) is higher than the median flow in both Medway Rivulet (about 5 ML/day) and Oldbury Creek (about 2.5 ML/day) (WSP PB 2016c).

Medway Rivulet is the main creek in the project area. Its major tributaries include Oldbury Creek, Paynes Creek, Wells Creek, Wells Creek tributary and Whites Creek (Figure 1.4). The headwaters of Medway Rivulet begin near Moss Vale. Surface water flow is influenced by several in-stream storages, or ponded sequences, that impede continuous flow within the upper catchment. Near the project surface infrastructure area, Medway Rivulet is confined by steep gullies (WSP PB 2016c). Downstream of the project area, Medway Rivulet has been dammed to create a 1,350 ML reservoir, Medway Dam. The reservoir is part of the Wingecarribee Shire Council's water supply system. The Wingecarribee Shire Council holds a 900 ML WAL to take water from Medway Dam for town water supply; however, the Medway Water Treatment Plant has not been operational since 2013 (WSP PB 2016c).

The dam and water treatment plant is a third tier source of supply within the partially interconnected water supply system of the Wingecarribee Shire. The dam receives direct point source discharge from Moss Vale Sewage Treatment Plant, as well as agricultural runoff which has resulted in prolonged periods of toxic cyanobacteria blooms within the reservoir (Beca 2010). A report commissioned by Wingecarribee Shire Council in 2010 found that "the risk of waterborne disease causing organisms in the treated water from the Medway water treatment plant is between 100 and 1,000 times greater than is considered acceptable where indirect potable reuse [of sewage discharge] is planned" (Beca 2010). Based on information obtained from the Wingecarribee Shire Council in 2016 through the *Government Information (Public Access) Act 2009,* the water treatment plant was shut down on 12 June 2013, with a plant upgrade included in the Wingecarribee Shire Council's draft budget in coming years.

Oldbury Creek begins near New Berrima and joins Medway Rivulet 1.5 km downstream from the reservoir. Similarly to Medway Rivulet, the creek is characterised by several in-stream storages that impede continuous flow within the upper catchment. A large agricultural in-stream storage dam is next to the proposed CPP area.

There are no known wetlands or swamps within the project area. As noted previously, there are several temperate highland peat swamps about 9 km south-east and 17 km east of the project area. These features are discussed in Section 6.10.1.

Photographs and a map showing the point from which photos of the watercourses and drainage lines were taken within and around the project area are included in Appendix D (WSP PB 2016c).

5.2 Flow and geomorphology

AR 65: Geomorphic and hydrological assessment of water courses including details of stream order (Strahler System), river style and energy regimes both in channel and on adjacent floodplains

Drainage line geomorphology is shown in Figure 5.2. Drainage line behaviour varies markedly at differing flow stages. Low flow, bankfull, and overbank stages were used to define the different behaviour of the local drainage lines. The variety of valley settings, bed/bank composition, and vegetation characteristics result in changes to drainage line behaviour. Most of the local drainage lines are classified as 'confined valley setting with occasional floodplain'. 'Confined valley' settings dominate where the mine surface infrastructure is proposed (WSP PB 2016c).

The upper reaches of the drainage lines have low elevation gradients, resulting in low flow energy. The low flow energy restricts channel geometry changes and erosion ability. As watercourses transition to partly-confined valley settings, erosion and geometry change is localised and limited to reaches with increased flow energy. Channels with non-cohesive bed and bank materials are more sensitive to changes in geometry and erosion (WSP PB 2016c).

Streamflow data from WaterNSW and Hume Coal gauges were analysed for flow duration curves and volumetric runoff coefficients (ie the percentage of rainfall that becomes stormwater runoff from a particular surface) (WSP PB 2016a). Depending on the ground cover, ground slope, and rainfall intensity, the run-off coefficient could be negligible (eg low rainfall intensity on flat, sandy soil) or higher than 80% (eg high rainfall on sloping, clay soil) (WSP PB 2016c). Of the flow data analysed, runoff coefficients varied greatly between gauge locations and over time. The lowest runoff coefficient was 18% for the long-term average at a WaterNSW gauge on the Wingecarribee River (212009). The highest runoff coefficient was 88% for a 5 month period in 2015 at a Hume Coal gauge located on Medway Rivulet (SW04).

A flow duration curve represents how often any given flow discharge is likely to be equalled or exceeded. The x-axis corresponds to probabilities of exceedance, while the y-axis corresponds to streamflow discharges. Daily flow duration curves for the WaterNSW gauging stations in the Wingecarribee River are shown in Figure 5.1 (WSP PB 2016a). The x-axis represents the likelihood of exceedance, and the y-axis represents stream flow discharges as runoff depths. Only 1% of the daily runoff depths are greater than 7 mm/day at all gauging sites. Flow occurs in the river (ie non-zero flow) for about 90% of the time at each gauge.

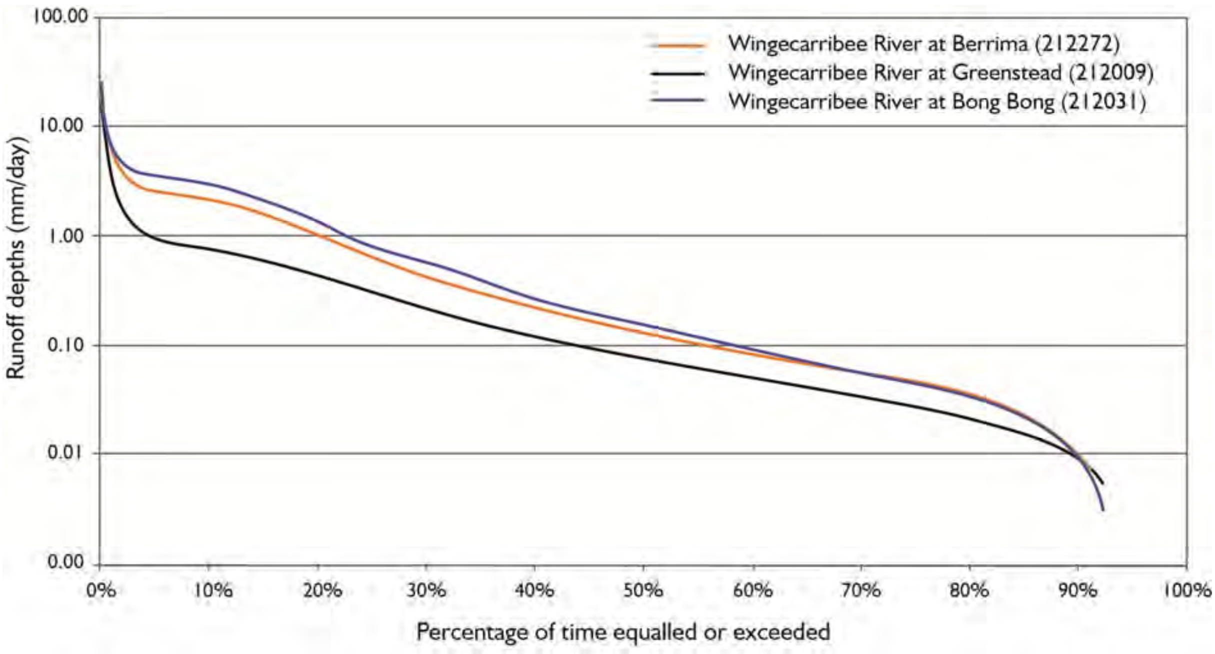
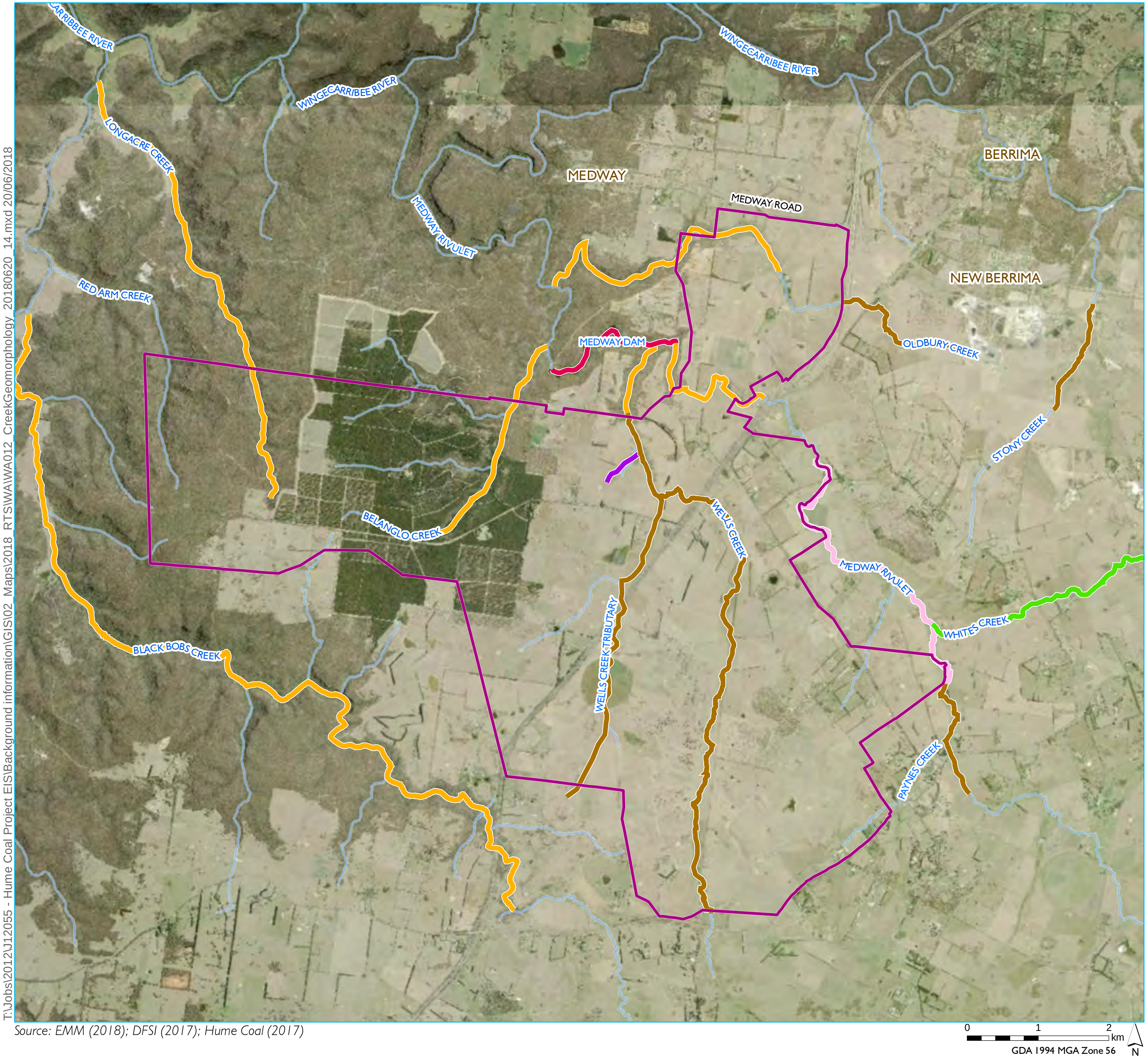


Figure 5.1 Flow duration curves for Wingecarribee River (WaterNSW gauges)

The Strahler stream classification system was applied to a subset of the Land and Property Information *Topographic dataset – Hydroline feature class* (LPI 2014) spatial dataset (WSP PB 2016c). This is a method of classifying waterways according to the number of tributaries associated with each. Numbering begins at the top of a catchment where the headwaters of the system start. As the stream order increases the contributing catchment area and channel size also increase. The lower downstream limit for flow assessment was determined to be the area where the Wingecarribee River joins the Wollondilly River.

When two 1st order streams join, the watercourse downstream is classified as a 2nd order stream, and so on. At its confluence with Medway Rivulet, downstream of the project area, Oldbury Creek is a 4th order stream under the Strahler stream classification. At its confluence with the Wingecarribee River, Medway Rivulet is a 5th order stream. Stream order classification is shown in Figure 5.3.



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KEY

- Project area
- Partly confined valley setting - Bedrock controlled discontinuous floodplain
- Confined Valley Setting - flooded gorge
- Laterally unconfined valley setting - low-sinuosity fine grained
- Confined valley setting - occasional floodplain pockets
- Laterally unconfined - channelised fill
- Partly-confined valley setting - low-sinuosity planform controlled discontinuous floodplain
- Drainage line

Source: EMM (2018); DFSI (2017); Hume Coal (2017)

Drainage line geomorphology

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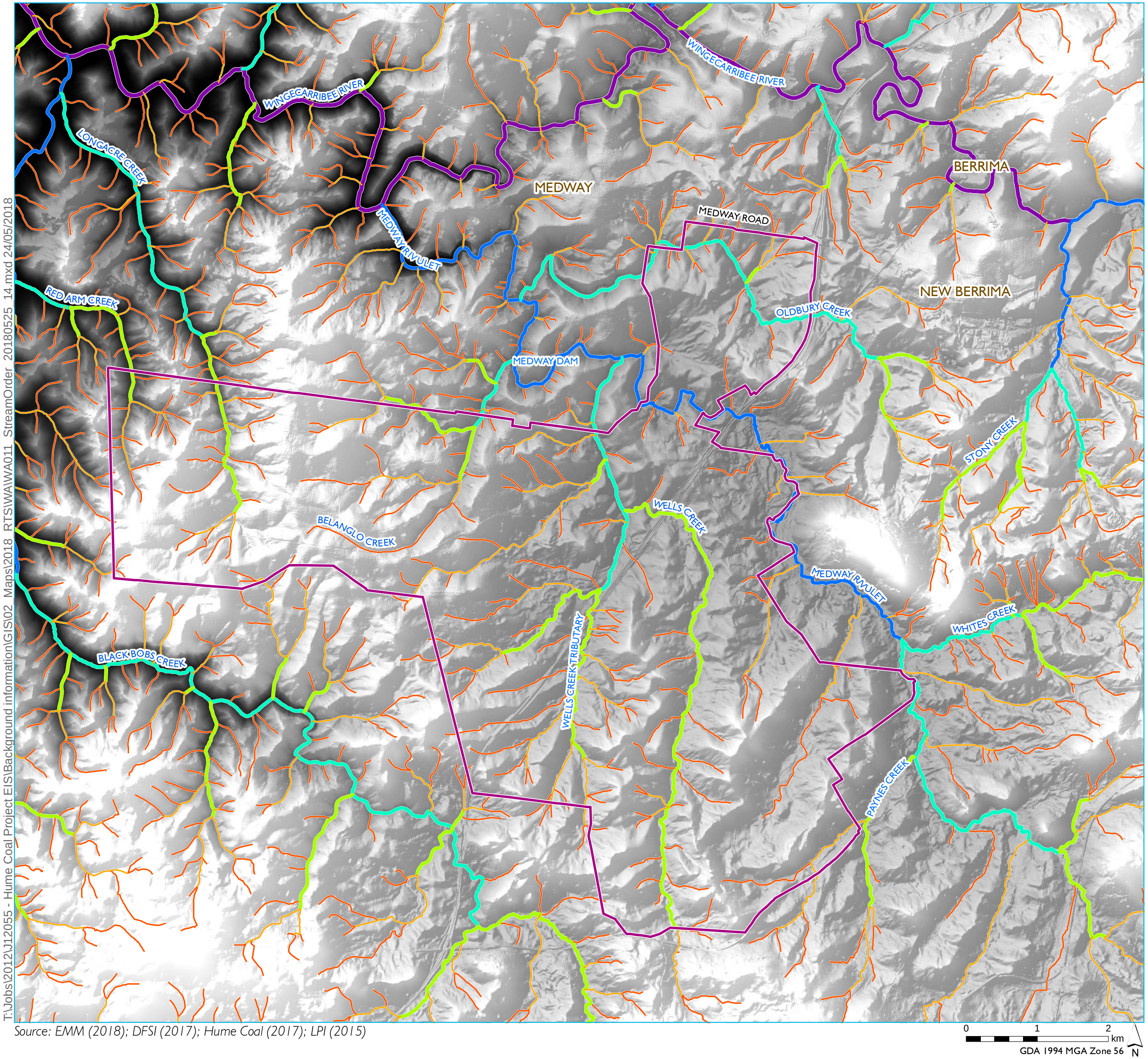
Figure 5.2

HUMECOAL PROJECT

EMM



KEY

Project area

Strahler stream order class

1

2

3

4

5

6

Elevation (m AHD)

800

300

Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015)

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Stream order

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Figure 5.3

5.3 Surface water quality

Baseline water quality data has been collected from April 2012 through until April 2018 and continues to be collected. Data collected between April 2012 and September 2015 from the Hume Coal surface water monitoring program are included and comprehensively analysed in Appendix D (WSP PB 2016b) (this was the period of data used for the EIS assessment). The results from baseline monitoring will continue to be collected up to the start of project construction for future analysis. Data collection will continue during the project's construction and operation. Section 4.1.3 details the surface water quality monitoring program. Table 5.1 summarises the baseline water quality data for each surface water system on which this assessment has been based. The sections below summarise the surface water quality data.

Table 5.1 Summary of baseline surface water quality data per system used for the EIS water quality assessment

Management zone	Drainage line	Number of water quality monitoring locations	Total number of water quality samples collected[3]	Data range[4]
Medway Rivulet	Medway Rivulet	4	90	Feb 2012–Sep 2015
	Oldbury Creek	5[1]	45	Apr 2012–Sep 2015
	Wells Creek and Wells Creek tributary	4	55	Apr 2012–Sep 2015
	Whites Creek	1	38	May 2012–Sep 2015
	Belanglo Creek and Planting Spade Creek	2	8	Mar 2013–Sep 2015
Lower Wingecarribee River	Wingecarribee River	1[2]	na	na
	Black Bobs Creek	4	72	Apr 2012–Aug 2015
	Longacre Creek	1	12	Jun 2012–Sep 2015
	Stony Creek	1	13	Apr 2014–Sep 2015
Lower Wollondilly river	Wollondilly River	1[2]	na	na
	Long Swamp Creek and Hanging Rock Swamp Creek	2	51	May 2012–Sep 2015
Bundanoon Creek	Indigo Creek	1	3	Jun 2013–Apr 2014

Notes: 1.Includes three farm dam monitoring locations.

2. WaterNSW monitoring location – samples not collected as part of the project.

3. Represents the maximum number of samples collected; however, not all parameters were necessarily used for analysis.

4. Data collection has continued for most monitoring points since compilation of the EIS baseline dataset occurred in September 2015 (refer to Figure 4.2 and Figure 4.3).

5.3.1 Summary of surface water quality

Baseline data has been compared against the Australian Drinking Water Guidelines (ADWG) (NHMRC 2016) and the ANZECC and ARMCANZ (2000) guidelines for irrigation, livestock drinking, aquatic ecosystems, and recreation; nutrients were compared against the recommended water quality objectives in HRC (1998). Within Medway Rivulet and Oldbury Creek in the project area, surface water typically complies with the most conservative guideline values, with the exception of the following:

- Salinity – although water is typically fresh, electrical conductivity (EC), a measure of salinity, typically exceeds the ANZECC and ARMCANZ (2000) guideline for aquatic ecosystems. The shale geology, underlying much of the project area, is a likely contributor to the salinity levels in surface water systems.

- Nutrients – most nitrogen and phosphorus samples exceed the WQOs recommended in HRC (1998). Agricultural practices and town effluent discharges into local streams are likely contributors to elevated nutrient levels.

- Metals – elevated levels of iron are typically observed compared to the ANZECC and ARMCANZ (2000) guideline for irrigation. Silver is typically elevated in Oldbury Creek compared with the ANZECC (2000) guideline for aquatic ecosystems. Some elevated levels of copper have been observed in Medway Rivulet and some elevated levels of aluminium in both Medway Rivulet and Oldbury Creek compared with the ANZECC and ARMCANZ (2000) guideline for aquatic ecosystems. Some elevated levels of manganese have been observed in both Medway Rivulet and Oldbury Creek compared with the ANZECC and ARMCANZ (2000) guideline for recreation. The Triassic rocks (shale and sandstone) underlying much of the project area are typically high in iron and manganese and are a likely contributor to elevated metals.

No BTEX chemicals (benzene, toluene, ethylbenzene, and xylene) were detected in baseline samples in either Medway Rivulet or Oldbury Creek.

A useful way of representing water quality data distribution is by box and whisker plots for key parameters. The box (the rectangle) represents the data range for the middle 50% of values (the data between the first and third quartiles). The horizontal line in the middle of the box represents the median value. The whiskers (the vertical lines extending up and down from the box) represent the data range for the 25% highest and lowest values, respectively (ie the data above and below the third and first quartiles). The bold numbers shown in the centre of the box represents the number of data points used.

Box and whisker plots of TDS concentrations sampled from drainage lines in the project area are presented in Figure 5.4. The results show that all streams in the project area are fresh, with TDS less than 500 mg/L. Belanglo Creek, Planting Spade Creek, Longacre Creek, Long Swamp Creek and Hanging Rock Swamp Creek are typically fresher than other streams in the project area with TDS generally less than 100 mg/L.

Box and whisker plots of pH sampled from drainage lines in the project area are presented in Figure 5.5. pH is generally between 5.5 and 8.0. pH is typically higher in drainage lines within agricultural land (eg Medway Rivulet, Oldbury Creek and Stony Creek) and lower in streams within natural or forested catchments (eg Belanglo Creek, Planting Spade Creek, Longacre Creek, Long Swamp Creek and Hanging Rock Swamp Creek). pH can be below the lower guideline value of 6.5 in some of the drainage lines with natural or forested catchments.

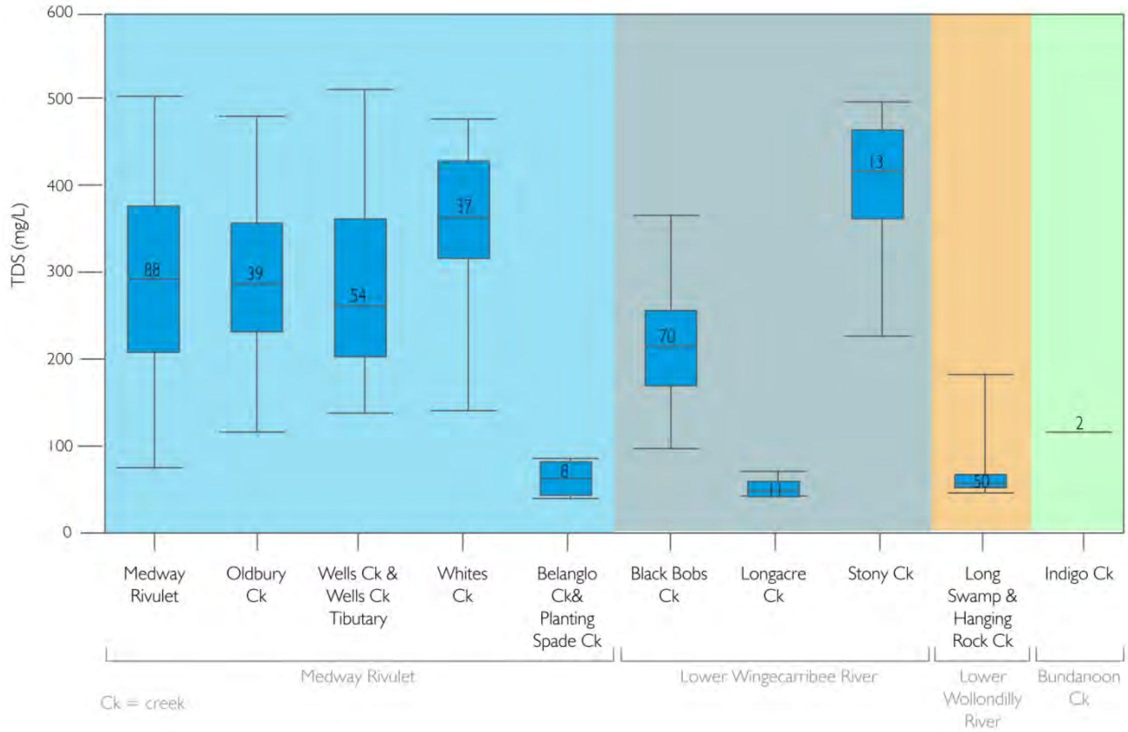


Figure 5.4 Baseline TDS

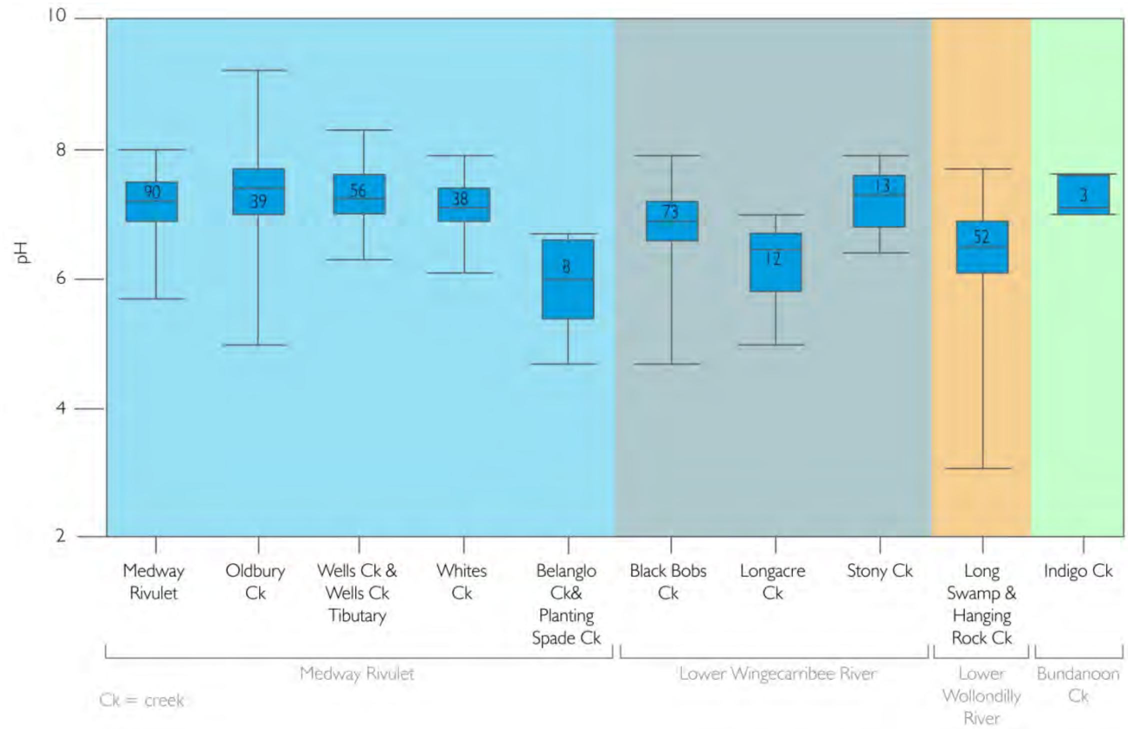


Figure 5.5 Baseline pH

5.4 Environmental values

Environmental values (EVs) are established by the community for what is considered important for water use (HRC 1998). EVs for the Hawkesbury River Catchment are set out in the Healthy Rivers Commission Independent Inquiry into the Hawkesbury Nepean River System (HRC 1998).

Regional EVs are assigned based on land use regions within the Hawkesbury-Nepean River catchment. Table 5.2 shows the land use regions within the project area and applicable EVs (WSP PB 2016c).

Site specific preliminary water quality objectives for Medway Rivulet and Oldbury have been developed from baseline surface water quality monitoring to reflect the existing environmental values. Details of these objectives are included in Appendix D.

Table 5.2 Environmental values and uses for surface water in and downstream of the project area

Land use regions	Regional environmental values
Predominately forested	Aquatic ecosystems Primary contact recreation Secondary contact recreation Visual amenity Homestead water supply Livestock water supply
Mixed-use rural and drinking water with clarification and disinfection	Aquatic ecosystems Primary contact recreation Secondary contact recreation Visual amenity Drinking water – clarification and disinfection Irrigation water supply Aquatic foods (cooked)

Source: HRC 1998.

5.5 Surface water use

AR 35: Details on existing dams/storages (including the date of construction, location, purpose, size and capacity) and any proposal to change the purpose of existing dams/storages

AR 41: Detailed description of dependent ecosystems and existing surface water users within the area, including basic landholder rights to water and adjacent/downstream licensed water users

5.5.1 Human water use and water-related assets

Within and down gradient of the project area, surface water is used by landholders, council and ecosystems. Surface water diversion works (pumps) and storages are used to extract and store surface water for water supply. There are 188 WALs within the six surface water management zones applicable to the project area. The average share component for stock and domestic, and unregulated use is 44 units (WSP PB 2016c).

The surface water-related assets in the region are:

- storages used for town water supply, including: Medway Reservoir (Medway Dam) (1,350 ML) and Lake Burragorang (Warragamba Dam) (more than 2,000,000 ML) downstream of the project area; and Wingecarribee Reservoir (24,130 ML), Bundanoon Creek Dam (2,000 ML), and Fitzroy Reservoir (9,950 ML) upstream of the project area;
- Shoalhaven transfer scheme, a dual-purpose water supply and hydro-electric power generation scheme that allows water collected in the Fitzroy and Wingecarribee Reservoirs and the Tallowa Reservoir (on the Shoalhaven River) to be transferred to Sydney water supply;
- Highlands Source Pipeline, an 80 km pipeline linking Wingecarribee Reservoir to Goulburn;
- town sewage treatment plants, including Boral, Robertson, Berrima and Moss Vale;
- various weirs on Wingecarribee River;
- diversion works (pumps) and storages used by local water users to extract surface water for water supply;
- landholders with basic water rights; and
- ecosystems with potential to be impacted by changes in surface water quality including:
  - instream ecosystems; and
  - riparian ecosystems exposed to overbank flows and flooding.

Sewage treatment plants within the Wingecarribee Local Government Area that discharge into local creeks are summarised in Table 5.3.

Table 5.3 Sewage treatment discharges within Wingecarribee Shire

Treatment plant	Capacity (as per EPL)	Discharge location
Berrima	100–219 ML	Oldbury Creek
Bowral	1,000–5,000 ML	Wingecarribee River (with wet weather overflows into Mittagong Creek)
Bundanoon	219–1,000 ML	Reedy Creek (which drains into Paddys River, which drains into Wollondilly River)
Mittagong	1,000–5,000 ML	Sheepwash Creek and Iron Mines Creek (which drain into Nattai River)
Moss Vale	219–1,000 ML	Whites Creek (which drains into Medway Rivulet upstream of Medway Dam)
Robertson	15–150 ML	Wingecarribee River

Notes: Sourced from treatment plants' Environment Protection Licences.

Most of the diversion works and dams are used for irrigation (WSP PB 2016c). The second most common use for dam water is to conserve water. The second most common uses for pumps are for town water supply and industrial use.

There are 11 pumps and 6 dams associated with WALs within the Medway Rivulet Management Zone. Figure 5.6 shows the location of diversion works and storages with associated WALs in the Medway Rivulet, Lower Wingecarribee River, Lower Wollondilly, and Bundanoon Creek management zones. Table 5.4 lists the diversion works and storages in each management zone (WSP PB 2016c).

Table 5.4 Water management zones and users

Water Source	Management zone	Number of diversion works (pumps)	Number of storages (dams)	Total annual volume (ML)
Shoalhaven	Bundanoon Creek	5	4	1,007
Upper Nepean and Warragamba	Lower Wingecarribee River	29	12	1,072
	Lower Wollondilly River	86	32	4,138
	Medway Rivulet	13	7	1,027

Within the Upstream Warragamba and Upper Nepean, and the Shoalhaven Unregulated River Water Sources basic water rights includes:

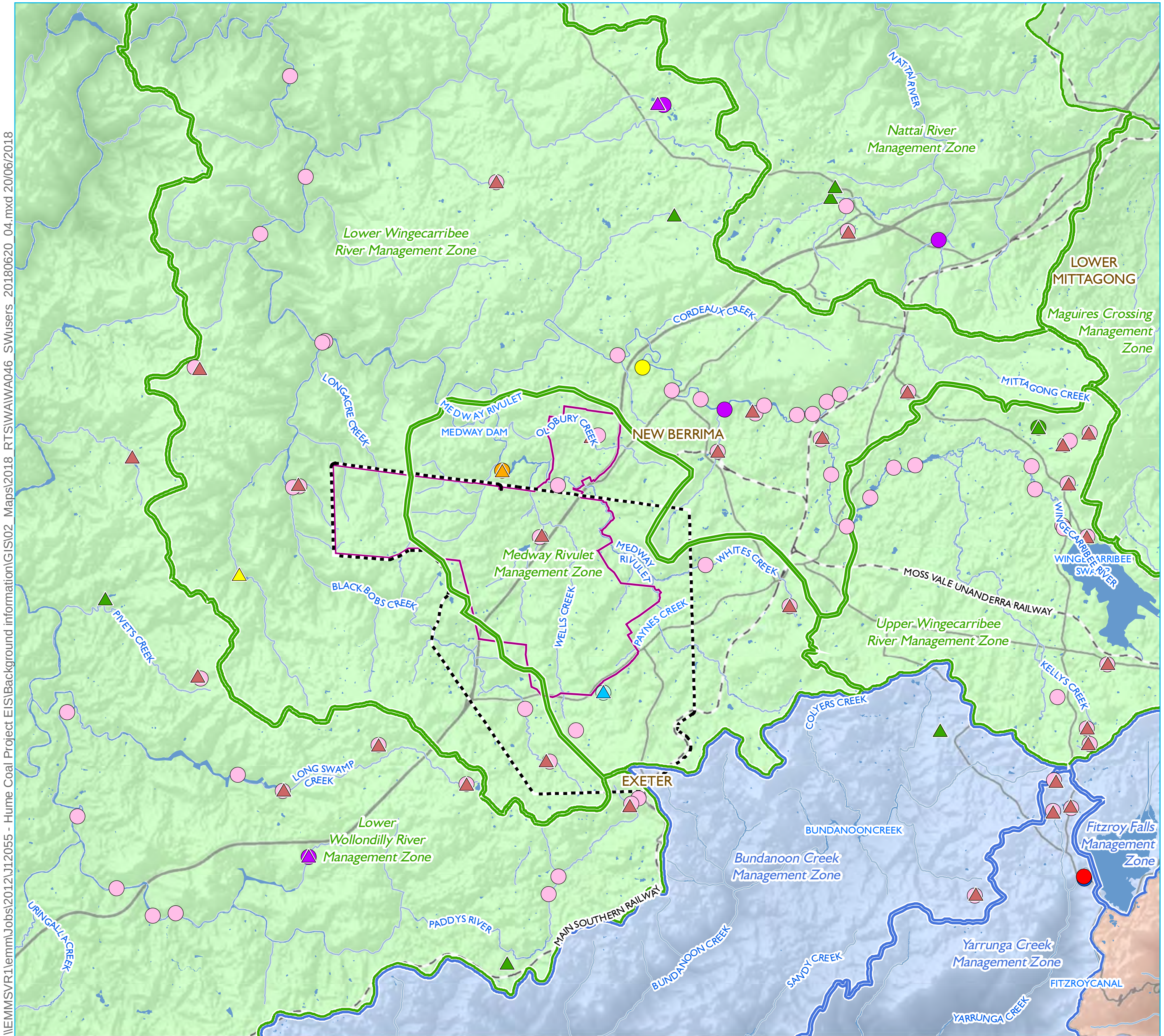
- Domestic and stock rights– landholders with stream frontage can take water without a licence for use in households, gardens and/or stock drinking water. The Greater Metropolitan Region Unregulated Water Sources Water Sharing Plan 2011 estimates water requirements for domestic and stock rights to be:
    - 13.6 ML/day in the Shoalhaven Unregulated River Water Source; and
    - 21 ML/day in the Upstream Warragamba and Upper Nepean and Water Source.
- Harvestable rights – landholders are allowed to build dams on minor streams that capture 10% of the average regional rainfall-runoff on their property.
- Native title water rights – there are no native title water rights licences within the region.

5.5.2 Ecosystems that potentially rely on surface water

The ecosystems that are potentially reliant on surface water include: instream ecosystems that depend on streamflow (including in-stream ecosystems reliant on groundwater baseflow), and riparian ecosystems that depend on surface water and overbank flows.

The *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c) describes in detail ecosystems that potentially rely on surface water, including details on wetlands, proposed locations of asset protection zones, riparian corridor widths, native vegetation extent, and aquatic ecology.

The surface water ecological sensitive features in the region include temperate highland peat swamps and pine plantations surrounding Stingray and Hanging Rock Swamps (Figure 1.4). Temperate highland peat swamps listed as endangered ecological communities under the EPBC Act, include: Paddys River Swamps (comprising Long, Mundego, Stingray and Hanging Rock Swamp) and Wingecarribee Swamp (Figure 1.4). Paddys River Wetlands and the Wingecarribee Swamp are listed in the *Directory of Important Wetlands in Australia* (Environment Australia 2001). Temperate highland peat swamps on sandstone, are high priority groundwater dependent ecosystems listed in the Metropolitan Groundwater WSP.



Source: EMM (2018); DFSI (2017); Hume Coal (2017); DPI (2013); PB (2013)

0 2.5 5 km
GDA 1994 MGA Zone 56
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KEY

Project area

A349

Storage location type
- Stock
- Irrigation
- Industrial
- Recreation
- Town water supply
- Conservation of water

Pump type
- Stock
- Irrigation
- Industrial
- Fire fighting
- Recreation
- Town water supply
- Domestic
- Conservation of water

Greater Metropolitan Water Sharing Plan, Unregulated Rivers
- Shoalhaven River Water Source
- Management zone within the Shoalhaven River Water Source
- Upper Nepean and Upstream Warragamba Water Source
- Management zone within the Upper Nepean and Upstream Warragamba Water Source

Existing features
- Main road
- Rail line
- Watercourse
- Drainage line

Surface water users

Hume Coal Project
Revised Water Assessment
Figure 5.6

HUMECOAL PROJECT

EMM

6 Groundwater

This chapter describes the geological and hydrogeological setting, including groundwater recharge, flow, and use.

AR 48: A description of the watertable and groundwater pressure configuration, flow directions and rates and physical and chemical characteristics of the groundwater source (including connectivity with other groundwater and surface water sources)

AR 68: The EIS must describe background conditions for any water resource likely to be affected by the development, including:
a. Existing surface and groundwater
b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations
c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters
d. Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government

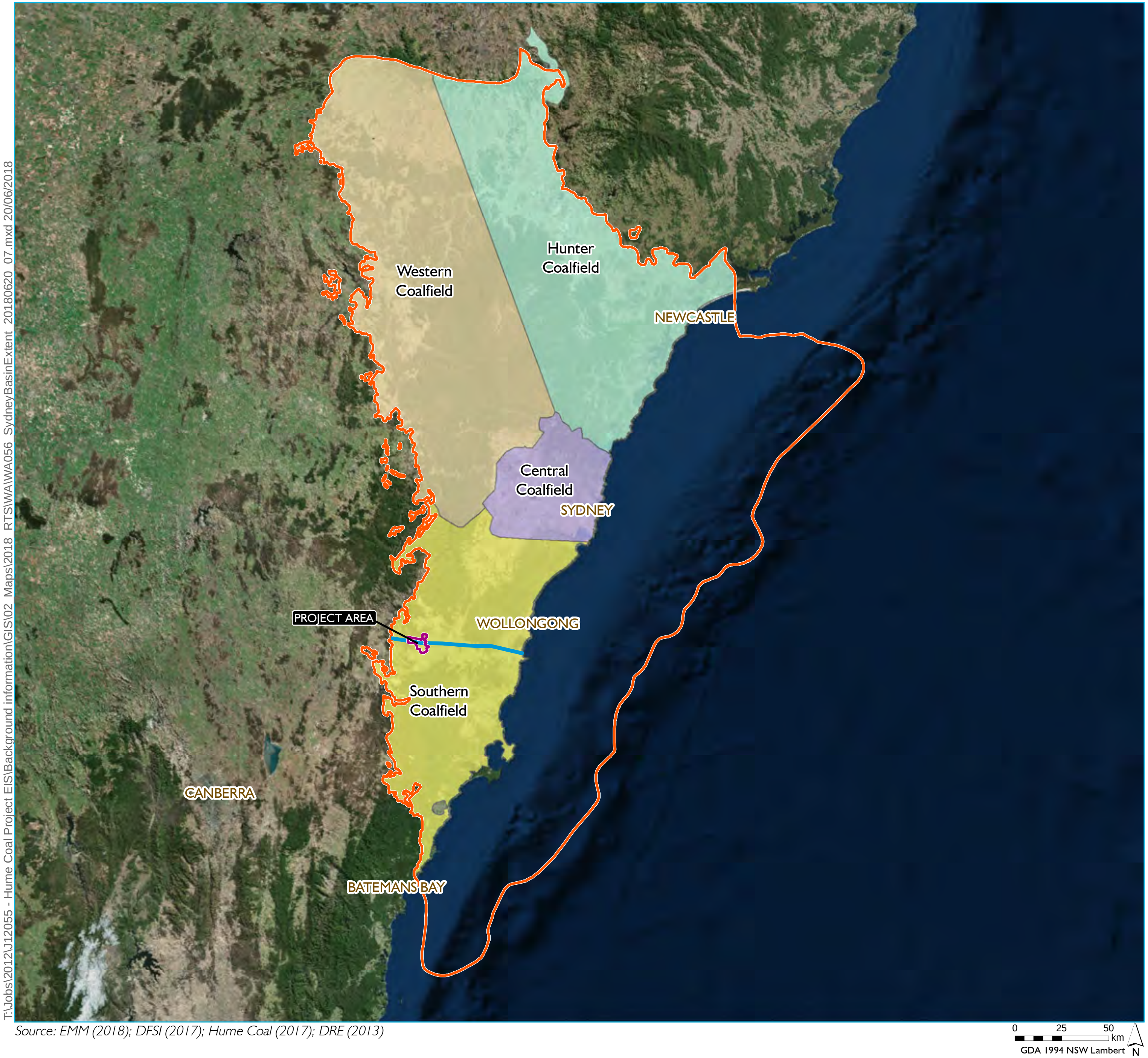
AR 71: The EIS must map the following features relevant to water and soils including:
a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map)
b. Rivers, streams, wetlands, estuaries (as described in Appendix 2 of the Framework for Biodiversity Assessment)
c. Groundwater
d. Groundwater dependent ecosystems
e. Proposed intake and discharge locations

AR 72: Identify relevant water quality objectives for surface and groundwater, including indicators and associated trigger values or criteria, in accordance with National Water Quality Management Strategy Guidelines. Reference the water quality objectives for the Wingecarribee River catchment in the "NSW Healthy Rivers Commission of Inquiry into the Hawkesbury Nepean Catchment". Identify any downstream users and uses of the discharged water classified in accordance with relevant ANZECC 2000

AR 84: The EIS should provide a description of the location, extent and ecological characteristics and values of the identified water resources potentially affected by the project

6.1 Regional geological setting

The sedimentary, Permo-Triassic Sydney Basin extends north south along some 350 km of central NSW coastline (from Newcastle to just north of Batemans Bay), and extends to the Great Dividing Range in the west. About one quarter of the basin is offshore to the east of the shoreline (Brunker & Rose 1967). The onshore sedimentary units are thickest (up to 4.5 km) in the northern part of the basin (Geoscience Australia 2016).



KEY

Project area

Sydney Basin extent

Location of cross section (Figure 6.2)

Sydney Basin coalfields

Central Coalfield

Hunter Coalfield

Southern Coalfield

Western Coalfield

Source: EMM (2018); DFSI (2017); Hume Coal (2017); DRE (2013)

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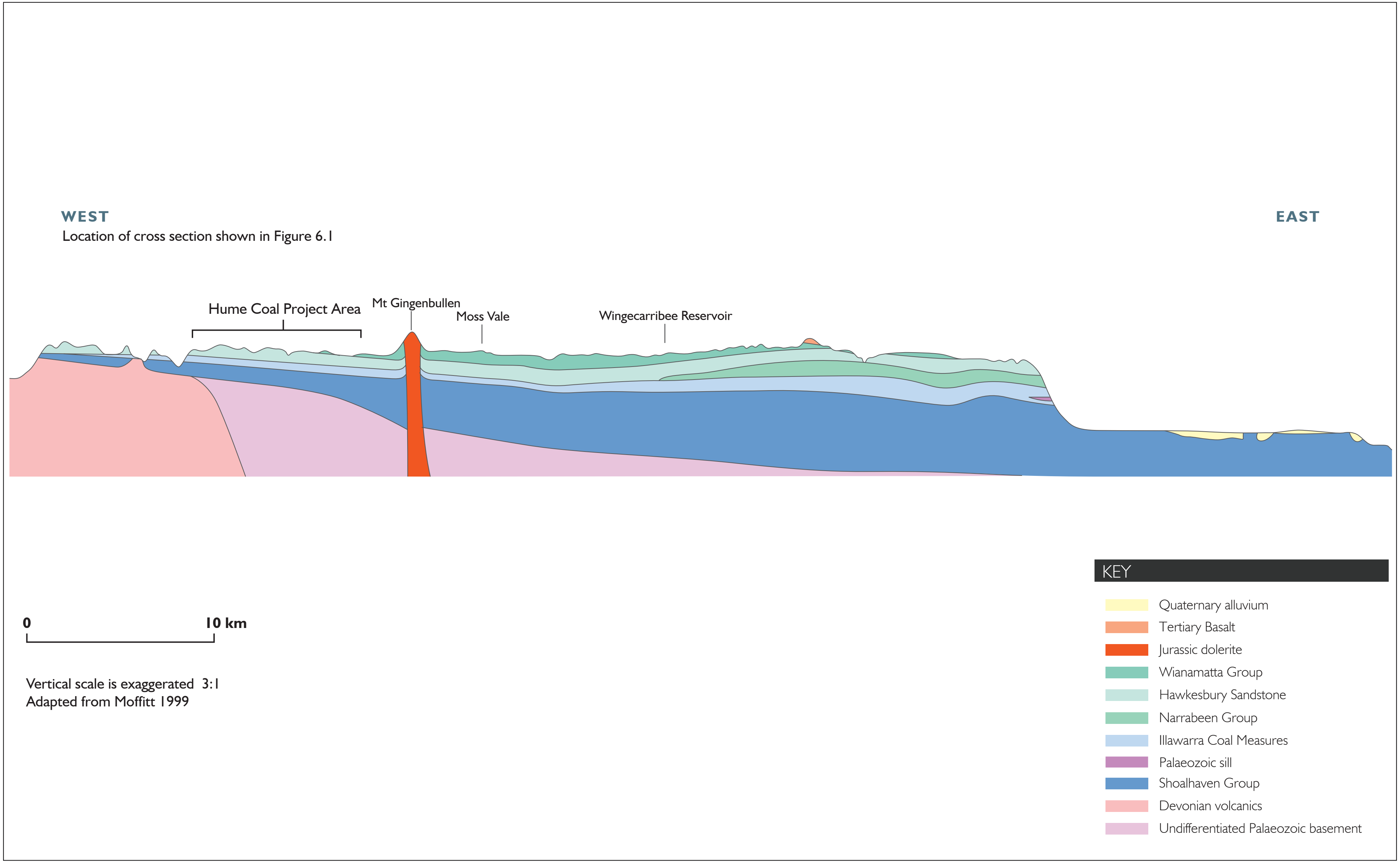
Sydney Basin extent

Hume Coal Project

Revised Water Assessment

Figure 6.1



Regional geological cross section

Hume Coal Project

Revised Water Assessment

Figure 6.2

During the early stages of basin development, marine volcanic sediments and the Permian Shoalhaven group were deposited (Blevin et al. 2007). Swamp environments during a colder climate in the late Permian allowed for deposition of the Illawarra Coal Measures (ICM), which contain the coal seam proposed to be mined – the Wongawilli seam. Subsequently, very large rivers deposited the Triassic Hawkesbury Sandstone (Moffit 1999; Rust & Jones 1987). Shallow marine sediments, and later more river sediments, continued to accumulate in the basin during the Jurassic, although most majority of these younger rocks have since been eroded (Blevin et al. 2007). Although significantly eroded in places, the Wianamatta Group is present in the east of the project area. Post-Triassic volcanism emplaced Jurassic intrusions and Tertiary basalts (McLean & David 2006).

6.2 Local geological setting

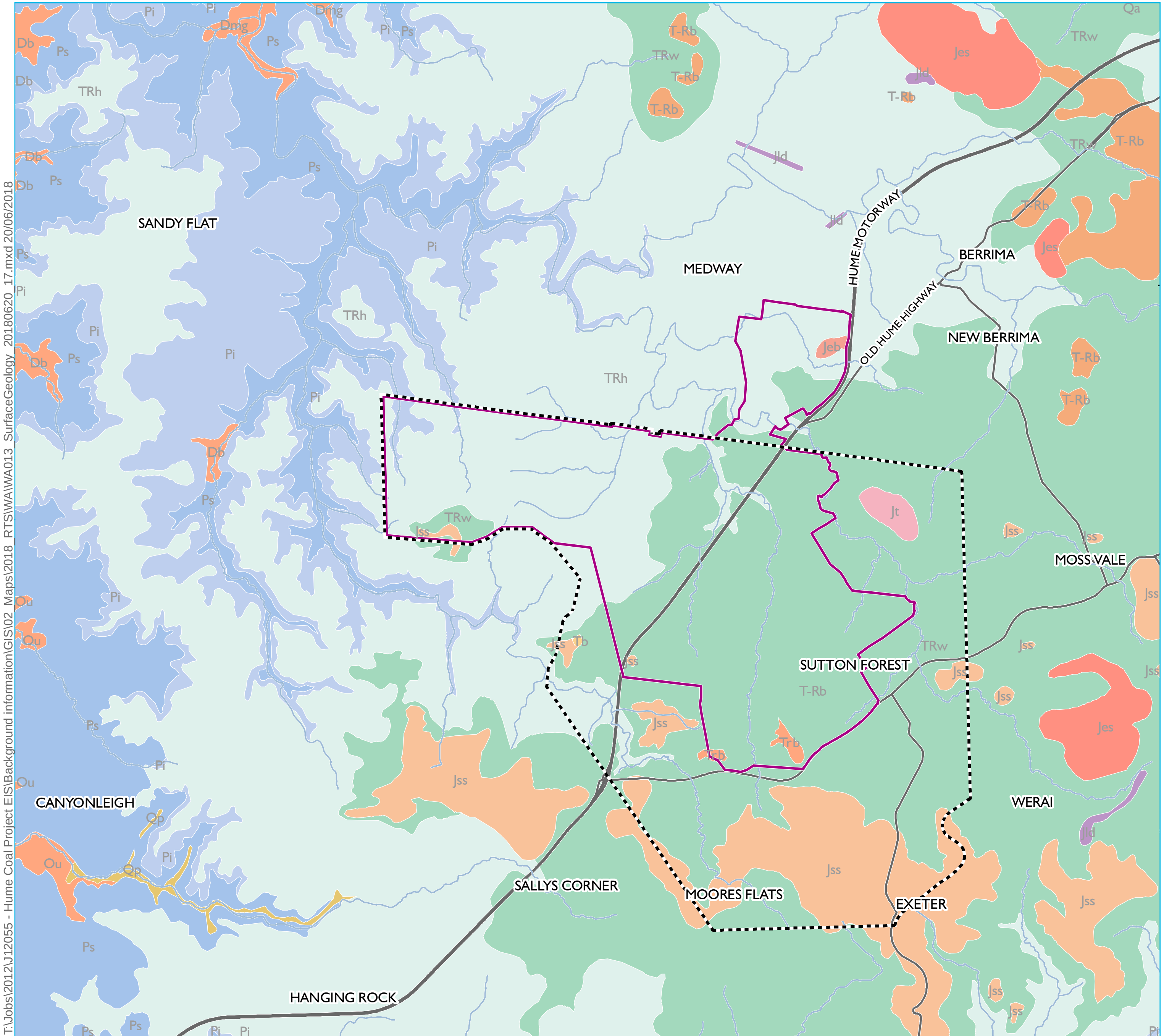
The project area is located in the Sydney Basin's Southern Coalfield underlain by the Triassic sedimentary Hawkesbury Sandstone and the Wianamatta Group's Ashfield Shale (Moffit 1999).

The Ashfield Shale outcrops over much of the eastern part of project area while the Hawkesbury Sandstone is exposed over much of the western part (Moffit 1999). The Hawkesbury Sandstone has been incised by creek channels and, as a result, Permian coal outcrops next to drainage lines in the west. The hills to the immediate south of the project area comprise remnants of thick Tertiary Robertson Basalt flows that overly the Ashfield Shale (Moffit 1999). Surface geology, or outcrop, is shown in Figure 6.3 and is an important consideration for the conceptualisation of the groundwater recharge mechanisms at the site.

Erosion during the mid-Triassic removed the latest Permian and early Triassic interburden in the south-western half of the project area, resulting in the Hawkesbury Sandstone directly overlying the Wongawilli Coal Seam. The interburden increases in thickness to the north-east and is comprised mainly of fine grained sediments, including the uppermost carbonaceous Wongawilli Coal Seam ply (WR ply) and a volcanic tuff, the Farmborough Claystone Member of the Permian Illawarra Coal Measures. In some historical geological assessments, the upper Permian interburden above the Wongawilli seam has been referred to as the basal Triassic Narrabeen Group (sandstone, siltstone, conglomerate and shale); however, it is not mapped to be present within the project area and so is not referenced further in this assessment.

Late Jurassic igneous intrusive activity and Tertiary igneous extrusive activity was significant in the region and resulted in numerous volcanic breccia necks and sills, basalt flows and dykes (McLean & David 2006).

Minor Quaternary alluvium is present the upstream reaches of the Wingecarribee River, north-east of the project area (Moffit 1999).



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Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015); DPI (2010)

KEY
- Project area
- A349

Existing features
- Main road
- Drainage line

Surface geology

Quaternary
- Qp - peat
- Qa - alluvium

Tertiary
- Tb - Basalt
- T-Rb - Robertson Basalt

Jurassic
- Jld - undifferentiated Jurassic intrusion
- Jes - undifferentiated Jurassic intrusion
- Jss - Sutton Forest igneous
- Jeb - Mount Gilbraltar
- Jt - Mount Gingenbullen

Triassic
- TRw - Wianamatta Group shale
- TRh - Hawkesbury Sandstone

Permian
- Pi - Illawarra Coal Measures
- Ps - Shoalhaven Group

Note: Hume Coal Project area and A349 boundary have been offset for clarity

Surface geology

Hume Coal Project
Revised Water Assessment
Figure 6.3

6.2.1 Stratigraphy

The stratigraphy of the project area is provided in Figure 6.4.

Age	Group	Formation	Symbol	Rock type
Tertiary	Robertson Basalt		TRb	Basalt and volcanic breccia
Jurassic		Gingenbullen dolerite	Jt	Dolerite (microsyenite) intrusion
Triassic	Wianamatta Group	Ashfield Shale	TRw	Shale
		Mittagong Formation	TRm	Shale, laminate and sandstone
		Hawkesbury Sandstone	TRh	Quartz sandstone
Permian	Illawarra Coal Measures	Illawarra Coal Measures undifferentiated (where present)	Pi	Shale, sandstone, siltstone and claystone, including WR ply and Farmsborough Member
		Wongawilli Coal Seam	Pi	Coal
		Illawarra Coal Measures undifferentiated	Pi	Shale, sandstone, siltstone and coal
	Shoalhaven Group	Shoalhaven Group undifferentiated	Ps	Sandstone, shale, siltstone
Devonian		Undifferentiated volcanics	Đb	Sediments and volcanics
Ordovician		Undifferentiated volcanics	O	Slate, metamorphic rocks

Figure 6.4 Project area stratigraphy

6.2.2 Geological units

The geological units relevant to the project area are summarised in this section. Only minor alluvium associated with the upstream Wingecarribee River occurs outside the project area, and is not relevant to the project and has not been considered further.

i Tertiary and Jurassic

The hills in the southern part of the project area and immediately outside are capped with remnant, isolated Tertiary Robertson Basalt flows (Moffit 1999). Some 15% of the project area has outcropping basalt (Coffey 2016a). There is also a notable igneous Jurassic intrusion, the Mount Gingenbullen dolerite sill, that has formed a steep hill immediately east of the project area (Thomas, Biggin & Schmidt 2000). Smaller igneous intrusions have been observed during drilling programs and as lineaments in aerial photography (R Doyle 2015, pers. comm., September). The Tertiary basalt outcrops are unrelated to the Mount Gingenbullen intrusion.

ii Triassic

a. Wianamatta Group

Of the Wianamatta Shale Group, the Ashfield Shale dominates within the project area (WSP PB 2016e). This unit comprises dark grey to black shale and siltstone interbedded with lithic sandstones and siltstone, and very minor coal bands. Reference to the borehole logs indicates that the Ashfield Shale can be up to 50 m in thick in the east of the project area; however it tapers towards the centre of the project area and is absent in the west (Appendix K).

b. Mittagong Formation

The Mittagong Formation is a transitional unit of about 6–15 m in thickness (Herbert & Helby 1980) between the Ashfield Shale and the Hawkesbury Sandstone. The unit is floodplain sediments deposited at the end of the Hawkesbury Depositional Episode.

The Mittagong Formation is difficult to identify in borehole logs due to its similarity in appearance to both the Hawkesbury Sandstone and Ashfield Shale. It is generally not mapped as surface outcrop, likely due to the difficult identification in situ.

c. Hawkesbury Sandstone

The Hawkesbury Sandstone is a flat-lying, sheet sandstone between 50 and 120 m thick within the project area (Coffey 2016a; Rust & Jones 1987; Appendix K). The Hawkesbury Sandstone forms the major landform influence in the region and is the main cliff-forming sequence. This unit was deposited in an active fluvial system and, in some locations, deposition has eroded the entire Narrabeen sequence and portions of the underlying Illawarra Coal Measures (O'Neill & Danis 2013).

The Hawkesbury Sandstone is a medium to coarse grained quartz arenite (sedimentary rock with more than 90 % detrital quartz) with minor siltstone, shale, mudstone and laminate lenses (McLean & David 2006; Scheibner & Basden 1998). Layering and cross-bedding is also present.

d. Illawarra Coal Measures

The Illawarra Coal Measures comprise interbedded siltstone, claystone, conglomerate, quartz-lithic sandstone, shales and coal seams (McLean & David 2006). The unit is about 50 m thick in the project area. Within the project area the mining target Wongawilli Seam is the uppermost unit of the Illawarra Coal Measures and is up to 8 m thick. The top of the Wongawilli Seam is about 70–180 mbgl.

Stratigraphy between the Wongawilli Seam and the Hawkesbury Sandstone is largely absent over the south-western half of the project area, but thickens to the north and east. Where present, interburden is comprised of fine grained sediments including the volcanic tuff known as the Farmborough Claystone Member, the carbonaceous Wongawilli Coal Seam ply (WR ply) and the informal Unnamed Member No 3 of the Eckersley Formation.

e. Shoalhaven Group

The Shoalhaven Group's Berry Siltstone comprises sandy grey mudstone, claystone, siltstone and sandstones deposited under shallow marine conditions (McLean & David 2006). This unit is more than 100 m thick and unconformably overlies the strongly folded Palaeozoic basement (Moffit 1999).

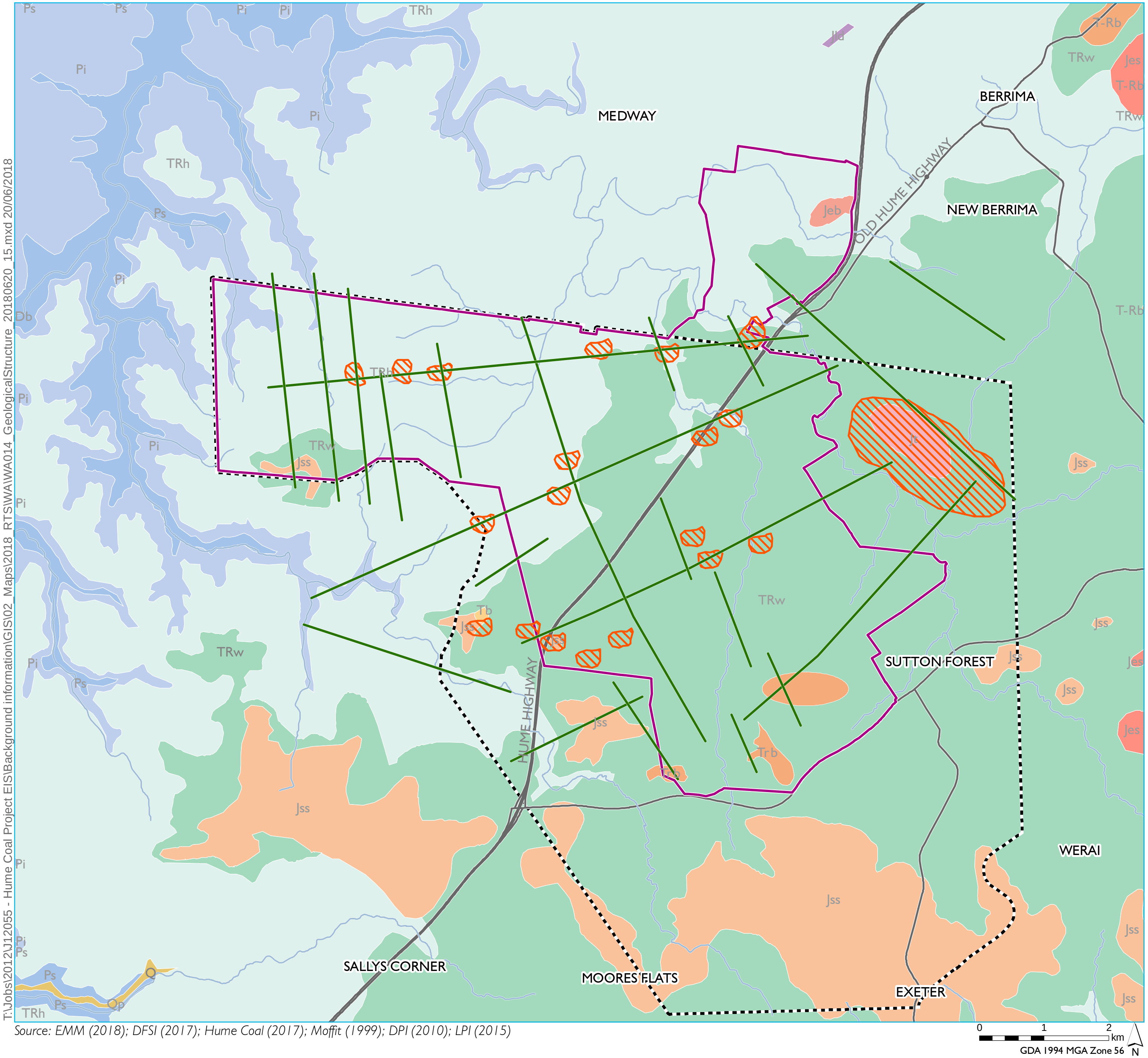
6.2.3 Geological structure

Stratigraphy across the project area is regionally continuous and gently dipping to the east. Moffit (1999) has mapped few structural features within the project area; however, immediately north, a northwest-southeast structure 8 km long is identified as the Cement Works Fault. Hume Coal interprets this as a major fault extending to basement, with a maximum displacement of between 50 m and 65 m (R Doyle 2016, pers. comm., 27 July; Coffey 2016a). The Sydney Basin is unconformably bound by the Devonian Lachlan Fold Belt, which outcrops some 5 km to the west of the project area (Figure 6.3).

On a local scale, Hume Coal has interpreted probable minor faults and structural features that intersect the coal seam within the project area based on results from exploration drilling programs, geophysics, and previous work in the area (Figure 6.5). The dominant alignment is north-north-west to south-south-east, while a secondary faulting direction is shown as east-south-east to west-north-west (R Doyle 2015, pers. comm., September). Most of these probable features are likely to have small offsets and are unlikely to extend to the basement or higher up into the overlying stratigraphy (R Doyle 2016, pers. comm., 12 September).

The Southern Highlands region has a higher density of igneous intrusions than elsewhere in the Sydney Basin (Coffey 2016a). Several igneous intrusions (dykes) are interpreted to radiate to the west and south-west from Mount Gingenbullen, a large Jurassic dolerite sill (R Doyle 2015, pers. comm., September). These dykes are typically spatially associated with minor faulting, although the age of intrusions is unknown. There are numerous diatremes spatially associated with the faults within the project area; Hume Coal interprets the diatremes to have intruded into the existing structures rather than to be synchronous (R Doyle 2016, pers. comm., 27 July).

A Tertiary major sub-vertical structural feature underlying the main Robertson Basalt outcrop around Exeter is interpreted from hydraulic head data, regional lineaments and structural contour surfaces (Coffey 2016a). This feature runs about east-north-east to west-south-west, below the basalt body and was likely a pathway for the basalt extrusion. Weathering and hydraulic conductivity are assumed to be enhanced along its plane (Coffey 2016a).



KEY

Project area

A349

Geological structure

Hume Coal interpreted faults

Diatremes (probable)

Surface geology

Quaternary

Qp - peat

Tertiary

Tb - Basalt

T-Rb - Robertson Basalt

Jurassic

Jld - undifferentiated Jurassic intrusion

Jes - undifferentiated Jurassic intrusion

Jss - Sutton Forest igneous

Jeb - Mount Gilbraltar

Jt - Mount Gingenbullen

Triassic

TRw - Wianamatta Group shale

TRh - Hawkesbury Sandstone

Permian

Pi - Illawarra Coal Measures

Ps - Shoalhaven Group

Existing features

Main road

Drainage line

Source: EMM (2018); DFSI (2017); Hume Coal (2017); Moffit (1999); DPI (2010); LPI (2015)

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Geological structures

Hume Coal Project
Revised Water Assessment
Figure 6.5

6.3 Hydrogeological units

AR 44: The known or predicted highest groundwater table at the site

The groundwater units within the project area are defined as:

- localised low permeability groundwater systems associated with the Robertson Basalt and Wianamatta Group shales;
- regional porous fractured rock groundwater system in the Hawkesbury Sandstone; and
- localised water bearing zones associated with the Illawarra Coal Measures and the Shoalhaven Group.

Localised groundwater systems can be associated with unconsolidated Quaternary alluvium in major streams and river valleys within the region (ie upper reaches of the Wingecarribee River), although not within the project area.

6.3.1 Localised low permeability (shale and basalt)

Both the Robertson Basalt and the Wianamatta Shale are isolated low permeability geological units. Within the project area, the Robertson Basalt overlies the Wianamatta Shale, where present. Spring discharge is observed at the contact between the basalt and underlying Wianamatta Group Shale (McLean & David 2006). The basalt is likely to be a stable, low volume source of recharge to the shale (Coffey 2016b).

The Wianamatta Group shale has low permeability and acts as a regional aquitard, impeding groundwater recharge and restricting downward vertical flow. The rainfall recharge percentage into the shale is low and likely less than 1%. Fracturing within the shale can allow minor hydraulic connection with the underlying Hawkesbury Sandstone and minor supplies of poor quality water (Ross 2014). Groundwater within the shale is generally brackish to saline and bores within the shale are generally very low yielding (DNR 2006).

The hydraulic connectivity between the overlying basalt and shale and the Hawkesbury Sandstone is conceptualised as only allowing a consistent low rate of leakage from the lower permeable shale and basalt into the higher permeable regional sandstone.

The water level in the regional (underlying) Hawkesbury Sandstone varies across the project area. For most of the area where shale is present, the water levels in bores are at elevations within the overlying shale; however, in some bores intersecting the sandstone, the water levels are below the shale, and there are unsaturated conditions in the sandstone above those levels. This is apparent in the area to the south of the project area where there is a sub-vertical structural feature underlying the main area of Robertson Basalt. The major sub-vertical structural feature associated with the Robertson Basalt is assumed to be a flow barrier based on hydraulic head behaviour around the feature (Coffey 2016a).

South of the structural feature there is no connectivity between the basalt and Hawkesbury Sandstone, while north of the feature there is some degree of connectivity (Coffey 2016a).

Regardless of whether or not the localised low permeability geological units are in direct connection with the underlying sandstone, leakage from the upper units to the lower regional sandstone would be limited.

6.3.2 Regional groundwater system (Hawkesbury Sandstone)

The Hawkesbury Sandstone forms a major unconfined to semi-confined porous rock groundwater system and constitutes most of the groundwater storage volume in the Southern Coalfield (McLean & David, 2006; Ross 2014). Confined conditions are greatest where the overlying Wianamatta Group shales and Tertiary Basalt are present and relatively thicker (McLean & David 2006). Unsaturated conditions in the uppermost Hawkesbury Sandstone are widespread, and occur both in areas of sandstone outcrop but also where the Wianamatta Group is present (Coffey 2016a). The unsaturated zone is thickest (about 60 m) to the east of Mount Gingenbullen (Appendix K; Coffey 2016a), highlighting that leakage of groundwater from the overlying Wianamatta Group into the Hawkesbury Sandstone is retarded (ie due to the low permeability of the shale).

Groundwater monitoring bores drilled through the Hawkesbury Sandstone typically intersected multiple water bearing zones associated with bedding plane joints, sub-vertical joints and faults, and to a lesser extent coarse cross-beds (Appendix K). Local zones of perched groundwater can exist associated with bedding planes and shale or siltstone lenses (Coffey 2016a; DNR 2006).

Groundwater within the Hawkesbury Sandstone in the project area is generally fresh (150 – 1000 mg/L) and bores range in yield from low to high (Ross 2014). The median bore yield for bores within a 9 km radius of the centre of the project area are 2 L/sec (DPI Water 2015). As the groundwater within the Wianamatta Group is of poorer quality, it further verifies that most of the groundwater within the Hawkesbury Sandstone is recharged directly at outcrops with limited leakage from the shale.

6.3.3 Localised water bearing zones Illawarra Coal Measures and Shoalhaven Group

The low permeability and porosity of the Permian Illawarra Coal Measures and Shoalhaven Group have generally low hydraulic conductivity, although there are some zones of somewhat higher hydraulic conductivity in the Illawarra Coal Measures. Some groundwater bores in the area extend through the base of the regional Hawkesbury Sandstone systems and into the Wongawilli Seam accessing it for water supply.

Direct hydraulic connection between the Wongawilli Coal Seam and the Hawkesbury Sandstone potentially occurs where there is no interburden between the two units (ie in the southern part of the project area). Locally, the water quality of the Wongawilli Coal Seam is similar to the overlying Hawkesbury Sandstone.

6.4 Hydraulic conductivity

Hydraulic testing (including: in situ pumping, packer, and slug tests at bores within and nearby the project area, data from core laboratory tests, and specific capacity data from government records) has allowed a comprehensive assessment to be made of hydraulic conductivity (K) for the different hydrogeological units in the project area (Coffey 2016a).

Within the project area, tectonic disturbance and igneous activity has resulted in overall relatively higher K compared to elsewhere in the Southern Coalfield and also the Western Coalfield (Coffey 2016a). There is an exponential decrease in K and decrease in storativity with depth due to increasing overburden pressure, except where deformation and intrusions are present (Coffey 2016a). Hydraulic conductivity data considered for the Hume Coal numerical model is presented in Figure 6.6, which compares available hydraulic conductivity data (including nearby studies, Government records and Hume Coal baseline data), and testing methods, and the depth below ground.

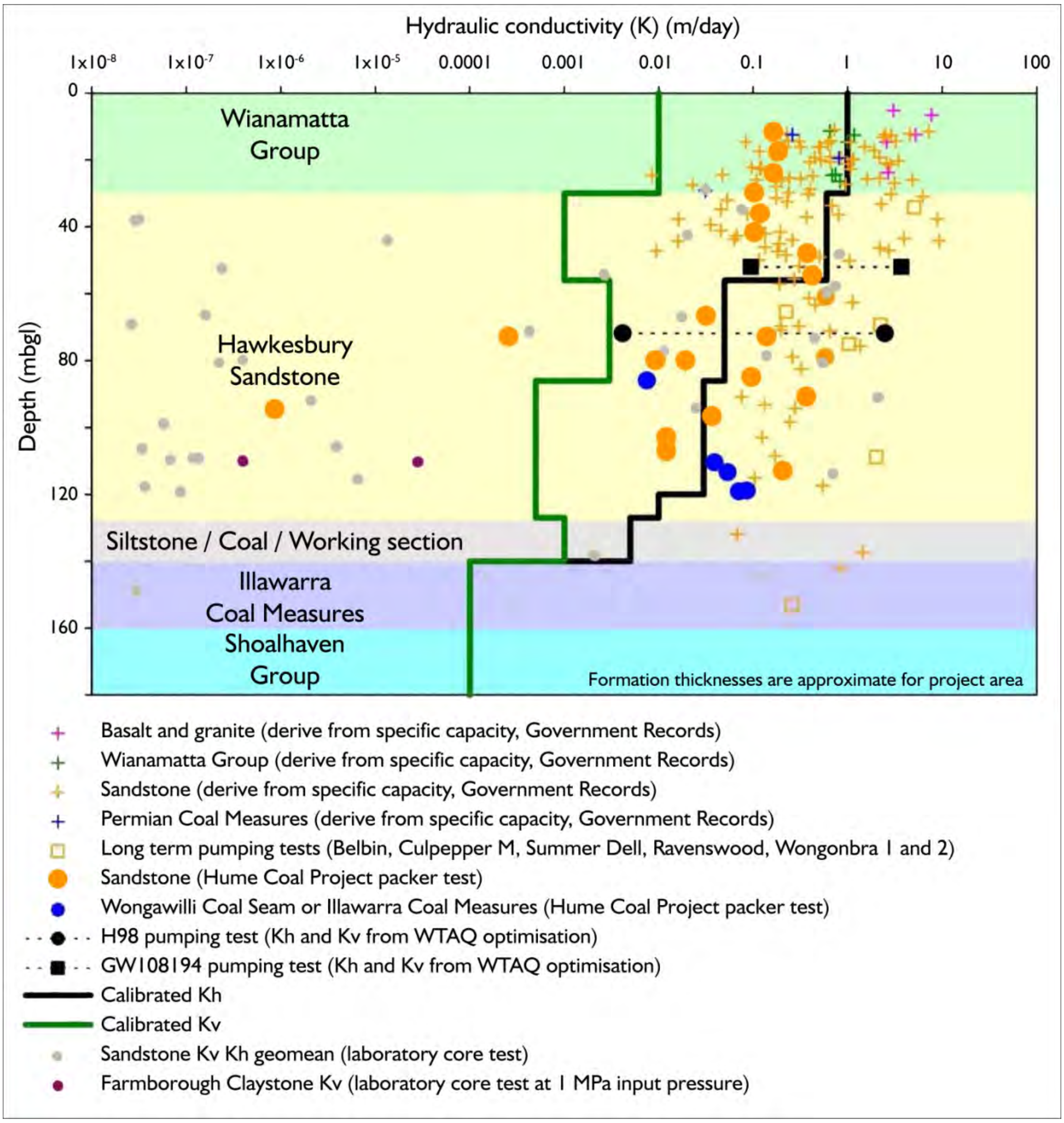

Figure 6.6 Comparison of measured versus calibrated hydraulic conductivity (Coffey 2016a)

The data presented in Figure 6.6 clearly shows a trend in hydraulic conductivity with depth in the Hume Coal and Southern Sydney Basin. A summary of the K values for each hydrogeological unit is shown in Table 6.1 (Coffey 2016a). The heterogeneous and dual porosity nature of the Hawkesbury Sandstone is reflected by a wide range of measured K values (0.001 – 10 m/day). The ratio between vertical K and horizontal K (Kv/Kh) is approximately 0.01 (Coffey 2016a).

Table 6.1 Hydraulic conductivity for hydrogeological units in the project area

Hydrogeological unit	Hydraulic conductivity K (m/day)	Source
Basalt	6	derived from government records and reports
Wianamatta Group	0.9	derived from government records and reports
Hawkesbury Sandstone	0.001–10	measured values from within and nearby the project area
Illawarra Coal Measures	0.01–0.9	measured values from within and nearby the project area

6.5 Groundwater recharge and discharge

6.5.1 Recharge

Direct rainfall infiltration is the primary source of recharge to the groundwater system (Coffey 2016a). Rainfall recharge is greater in un-forested areas and where the Hawkesbury Sandstone is exposed at the ground surface. Rainfall recharge is lowest in areas where Wianamatta Group Shales are present.

Coffey (2016a) analysed the magnitude of rainfall recharge by assessing water table rise following rainfall in shallow monitoring bores. Lower rainfall recharge was indicated for the Wianamatta Group as compared to the Hawkesbury Sandstone and the basalt. For the numerical groundwater model (Section 8.6, Coffey 2016b and HydroSimulations 2018), average annual recharge to the water table across the project area was estimated to be 1.8% of the annual rainfall.

The Metropolitan surface water WSP references slightly higher average recharge, at 6% of annual rainfall, which was determined for the boarder basin. This value incorporates areas of high recharge, such as alluvium and broader areas of outcropping Hawkesbury Sandstone. The rainfall recharge recommended in a NSW Government study of the hydrogeology of the Southern Highlands (Pritchard 2004) was 5% for exposed sandstone and 0.5% for non sandstone areas. The Berrima model assumes 10% rainfall recharge based solely on chloride mass calculations in a groundwater assessment undertaken in 2010 by AGE (EMM 2015a). It should be noted that the Berrima Mine is located mostly on exposed sandstone, with very little shale in the area, and that the 10% is not derived from a calibrated transient model, but from chloride mass balance alone.

The Hume Coal Project area has approximately 50% sandstone and 50% shale surface geology; this has been taken into account in the overall recharge value for the regional numerical model of the project. The rainfall recharge percentage for the Hume Coal Project numerical model is slightly lower than the value adopted for the Berrima Mine model due the increased percentage of shale surface geology in the Hume Coal Project area.

Direct rainfall recharge occur mostly where the Hawkesbury Sandstone is exposed in the western part of the project area, and less where the lower permeability Wianamatta Group shales outcrop (in the eastern part of the project area). Many of the drainage lines in the project area are considered to be gaining streams (Coffey 2016a), via perched water in basalt and shale, and interflow, and therefore direct recharge from streams is likely to be minor. Localised rainfall recharge is likely to occur in the outcropping basalt.

Rainfall recharge is estimated in the numerical model based on both literature review, nearby mines and also via the model calibration. The rainfall recharge percentage applied in the Hume Coal Project numerical groundwater model has been robustly considered and was deduced to be not a particularly sensitive parameter. Both regional and local scale model outcomes are typically not overly sensitive to variations in rainfall recharge values below 10% (EMM 2015a).

The adopted value for rainfall recharge in the numerical model was reviewed as part of the model audit work (HydroSimulations 2018). The value of 1.8% of rainfall was considered appropriate given the literature, the local context, the insensitivity of the model to recharge and the fact the calibration of the model was based on baseflow data.

6.5.2 Discharge

Groundwater discharges via several mechanisms in the region. The discharge mechanisms include:

- drainage to surface water (baseflow): the largest component of discharge of about 1.5% of annual rainfall (Coffey 2016a). Surface water flow has been recorded in the lower reaches of Black Bobs Creek and Medway Rivulet and Wingecarribee River during dry periods, indicating groundwater discharges into these surface water drainage channels (Coffey 2016a);
- extraction of groundwater from existing landholder bores;
- evapotranspiration from the water table, depending on land use and depth to groundwater;
- seepage/springs and increased evaporation along the escarpments, particularly along geological layer boundaries with contrasting vertical hydraulic conductivity (ie the interface between the Hawkesbury Sandstone and Illawarra Coal Measures, and the Ashfield Shale and Hawkesbury Sandstone), particularly along the cliff escarpments in the downstream reaches of Black Bobs Creek and Medway Rivulet;
- groundwater drainage into the existing underground workings of the decommissioned Berrima Colliery to the north; and
- regional groundwater throughflow, to the south-east.

Discharge from the localised low permeability Robertson Basalt occurs at seeps/springs at lithological contact points with the underlying shale or along fractured zones. Seasonal springs are unlikely to be connected to the regional system and do not appear to sustain permanent flows to the upper reaches of nearby creeks. The large differences in groundwater head and quality between the basalt and shale, and deeper Hawkesbury Sandstone indicates that leakage from perched systems into the Hawkesbury Sandstone groundwater is minor (Coffey 2016a).

6.5.3 Baseflow

Baseflow is the component of streamflow that is sourced from groundwater and is released from groundwater system storage. For some streams baseflow dominates during low streamflow conditions. Following major rainfall events or floods, baseflow contribution will decrease with time back to equilibrium, and this decrease is often termed the groundwater recession (Domenico & Schwartz 1990).

Gaining streams are shown in Figure 6.7A and Figure 6.7B. This shows the base of a stream is lower in elevation than the surrounding water table, the stream can therefore gain water from groundwater inflow (ie baseflow). Conversely, as shown in Figure 6.7C and Figure 6.7D, the water table is lower in elevation than the base of a stream, the stream can lose water to the underlying water table; this condition is referred to as a 'losing' stream.

It is important to note that gaining streams may receive baseflow from the regional water table (Figure 6.7A), or from a perched shallow groundwater system (Figure 6.7B). In many cases these perched systems may be disconnected or only marginally connected o the underlying regional groundwater system.

For losing streams, once the groundwater levels are deeper than the base of the stream by more than the capillary fringe, then the stream is termed disconnected losing and the volume of groundwater flux it at a maximum and constant rate. The capillary fringe thickness is dependent on the stream bed material and underlying rock properties and ranges between 0.01 m (for gravel) through to 7.5 m for fine silt (Fetter 1994). Generally a thickness of approximately 2 m is assumed (which equates to typical grain sizes ranges between fine sand to coarse silt).

The relationship between surface water and groundwater can change along the course of a stream channel, and can also change over time. Surface water and groundwater connectivity depends on hydraulic gradients (the slope between the water table and the stream level), stream bed properties and aquifer hydraulic conductivity.

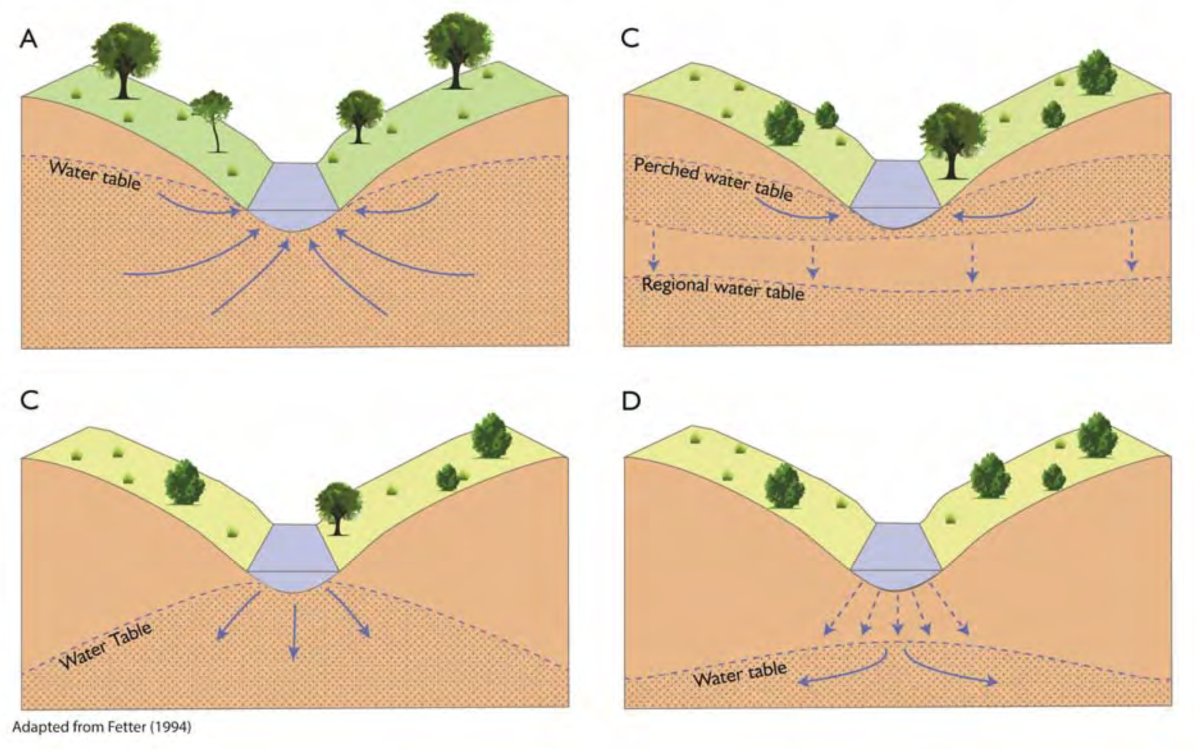

Figure 6.7 Gaining and losing streams

If groundwater is extracted from a groundwater system that is gaining from the regional groundwater system, then drawdown of the water table may occur (Figure 6.7A). If groundwater is extracted from a groundwater system that is gaining from the shallow or perched groundwater system, then drawdown of the water table will not occur (Figure 6.7B).

If groundwater is extracted from a losing stream that is connected (ie the water table is at a level between the stream height and the capillary fringe height below the base of the stream), then drawdown in the water table may occur (Figure 6.7C).

Once the groundwater table is deeper than the capillary fringe height below the base of the stream (Figure 6.7D), then the stream it is considered a 'disconnected' stream which will lose at a constant rate, regardless of where the water table is (ie groundwater pumping has not effect on the stream).

The degree of influence on the water table and intercepted baseflow therefore depends on the relative levels of the groundwater table ad stream height, properties of the groundwater system, properties of the stream bed, distance, depth, rate and volume of groundwater extracted.

The shallow localised groundwater level in the project area is typically higher than the stream beds; hence, the streams in the area are generally classified as gaining streams (WSP PB 2016c). The regional groundwater level (ie in the Hawkesbury Sandstone) is higher than the stream beds in most of the model domain area. However, in some areas it is deeper. Although most streams are classified as gaining, it is important to note that many (ie ones overlying shale) are gaining from shallow and/or perched groundwater (shown in Figure 6.7B), and are not strongly connected to the regional groundwater table.

Groundwater baseflow was analysed by Coffey (2016a) by separating baseflow from total stream flow using the local-minimum method (Wahl & Wahl 1995). The baseflow results are area-averages for an entire catchment. The baseflow analysis indicates that annual baseflow to drainage channels is estimated to be 1.5–2% of annual rainfall for the project area. However, the local geology surrounding the stream bed influences baseflow contributions. Baseflow from the Hawkesbury Sandstone (where it occurs) was calculated to be around 3% of annual rainfall (noting that in many areas the Hawkesbury Sandstone groundwater system is disconnected from overlying streams). Baseflow from the Wianamatta Group is lower and was calculated to be 1–1.5% of annual rainfall. Basalt has significantly enhanced baseflow capacity compared to the sedimentary rocks and was calculated to be up to 30% of annual rainfall (Coffey 2016a).

6.5.4 Deep discharge

Groundwater inflow to Berrima Colliery, north of the project area (Figure 1.4), is considered in this study as deep discharge. Coffey (2016a) reports that, of the groundwater inflow that occurs within the Berrima Colliery workings, the majority drains to the Wingecarribee River with minor volumes extracted and used for non-potable uses. Since mining ceased in 2013, measured discharge from the mine workings has been in the range 1.5–3.2 ML/day.

6.6 Groundwater levels and flow

Groundwater flow in the Hawkesbury Sandstone and the underlying Wongawilli Coal Seam occurs as a dual porosity system comprising connected intergranular pore spaces and structural features including fractures, bedding planes and joints (Ross 2014).

The regional groundwater flow direction in the Hawkesbury Sandstone and Wongawilli Coal Seam is influenced by the location of major hydraulic boundaries in the landscape, including:

- topography;
- recharge areas, particularly along the western project area boundary at elevated areas where the Hawkesbury Sandstone outcrops;

- discharge areas – typically associated with lower or steep topographic gradients, such as cliff escarpments; and

- stratigraphic dip of the geological units.

The main groundwater flow direction in the Hawkesbury Sandstone is regionally from areas of higher elevation in the west towards the east; this is consistent with the regional topography and stratigraphic dip (Coffey 2016a). However, there is some localised groundwater flow to the north towards Medway Dam, to the west from the Wingecarribee Reservoir, and to the west towards the deeply incised gullies of Black Bobs Creek consistent with local topographic decreasing elevations. Regional groundwater levels and flow directions in the upper Hawkesbury Sandstone are shown in Figure 6.8. The data in Figure 6.8 is from late 2013 to early 2014, which was the period of monitoring data with the greatest spatial coverage.

The groundwater flow directions in the overlying low permeability shale and basalt groundwater systems are mostly influenced by local topography and transmissivity, and consequent groundwater gradients typically follow surface topography. Groundwater flow in the basalt is thought to radiate outward from the centre of the basalt outcrop, with most flow within fractures and joint networks and negligible flow through the pore spaces (Coffey 2016a). The groundwater levels and flow direction in the Wianamatta Group is shown in Figure 6.7. The data in Figure 6.7 is from late 2013 to early 2014 (ie same period as Figure 6.8), which was the period of monitoring data with the greatest spatial coverage.

Groundwater levels (hydraulic head) from the Hume Coal groundwater monitoring network show very little change over time, except for periodic drawdown as a result of pumping from private landholder bores (Coffey 2016a). In some locations, small long-term decreases in hydraulic head are observed due to long-term pumping from landholder bores (Coffey 2016a).

North of the project area, in the Berrima Colliery area, drawdown and significant vertical hydraulic head gradients are evident at monitoring bores and private landholder bores as a result of the last phases of the full extraction mining at Berrima Colliery (up to 2013) (Coffey 2016a). The hydraulic head data from bores in the Berrima mine area provide valuable insight on the groundwater systems and their response to dewatering during mining activities. The secondary extraction mining method employed at Berrima mine had significantly more drawdown influence on the overlying groundwater systems than the first workings method proposed for the project due to the different mining procedure and consequent limited vertical extent of caved goaves.

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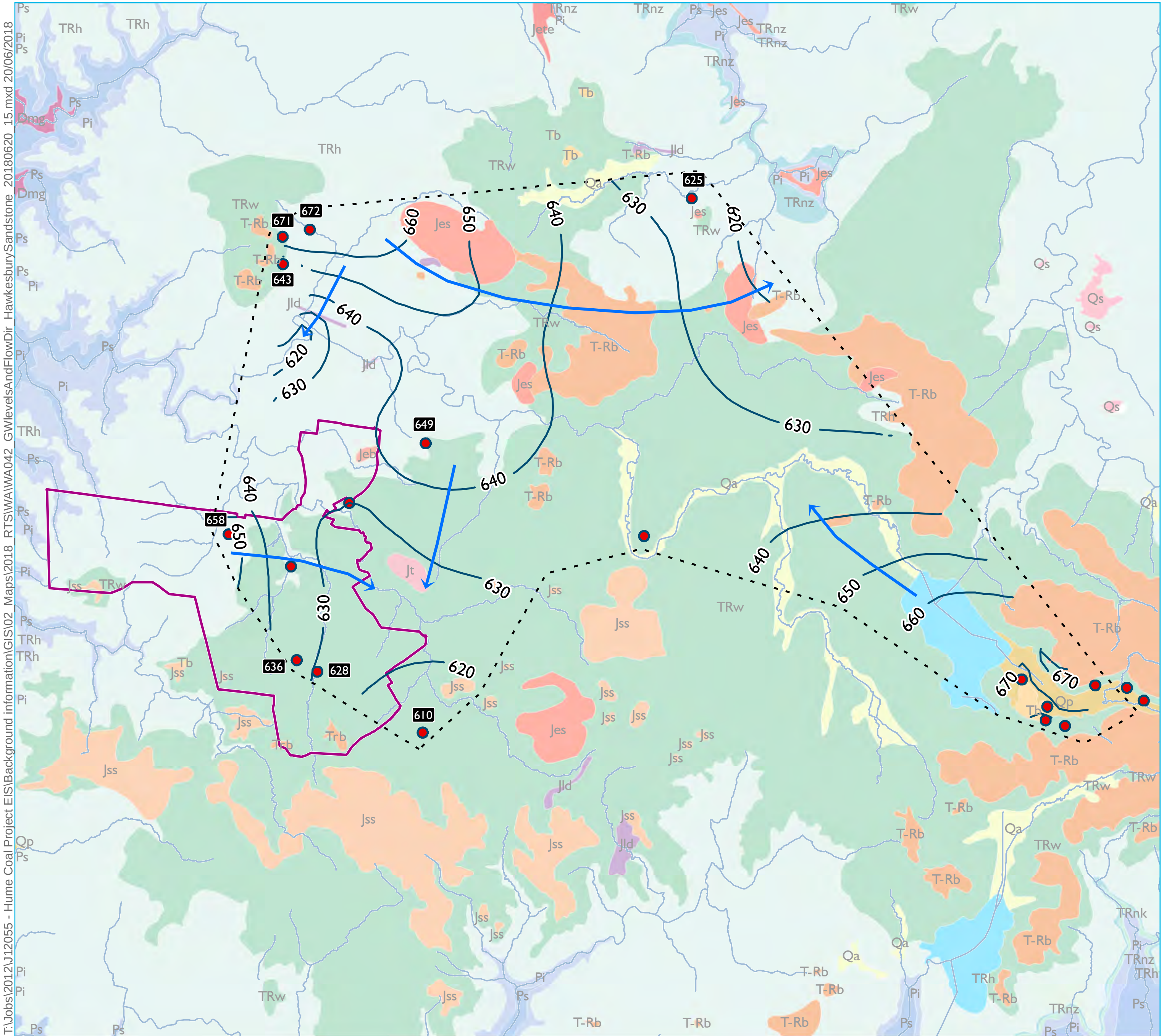

Source: *EMM (2018); DFSI (2017); Hume Coal (2017); DPI (2010); Coffey (2016a)*

0 2.5 5 km

GDA 1994 MGA Zone 56

N

KEY

- Project area
- Interpreted hydraulic head contour (mAHD)
- Data boundary
- Groundwater flow direction
- Observed hydraulic head for late 2013 to early 2014 (mAHD) (Coffey, 2016a)

Quaternary

- Qs - basalt
- Qp - peat
- Qa - alluvium

Tertiary

- Tb - Basalt
- T-Rb - Robertson Basalt

Jurassic

- Jld - undifferentiated Jurassic intrusion
- Jes - undifferentiated Jurassic intrusion
- Jss - Sutton Forest igneous
- Jeb - Mount Gilbraltar
- Jt - Mount Gingenbullen
- Jete - Jurassic intrusive
- Jetr - Mount Flora, Mount Jellore

Triassic

- TRw - Wianamatta Group shale
- TRh - Hawkesbury Sandstone
- TRnz - Narrabeen Group
- TRnk - Kangaloon Sandstone

Permian

- Pi - Illawarra Coal Measures
- Ps - Shoalhaven Group

Devonian

- Dmg - Devonian granite

Other

- Reservoir
- Drainage line

Groundwater levels and flow direction in Upper Hawkesbury Sandstone

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Figure 6.8

HUMECOAL

EMM

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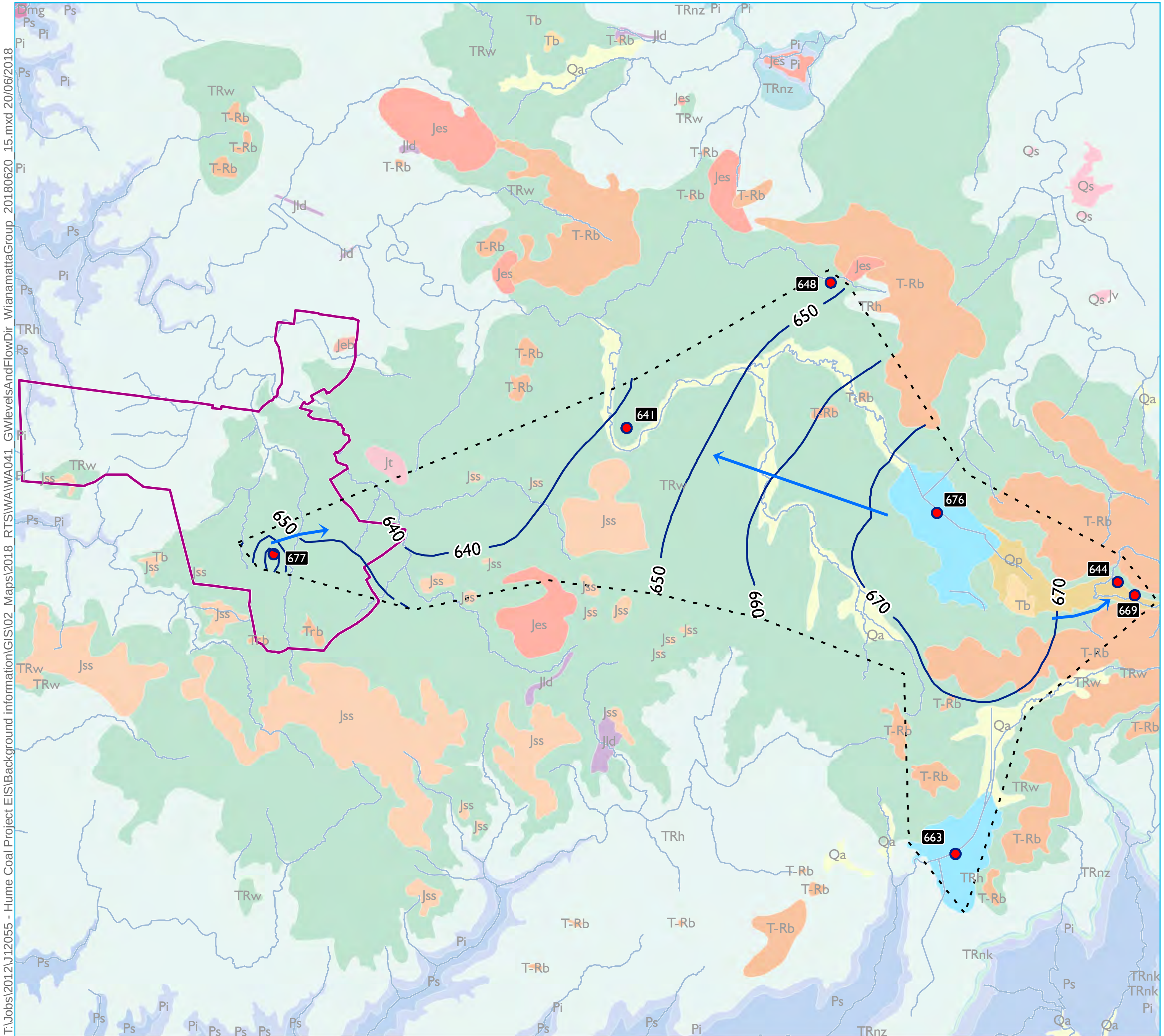

Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015); DPI (2010); Coffey (2016a)

0 2.5 5 km
GDA 1994 MGA Zone 56
N

KEY
- Project area
- Interpreted hydraulic head contour (mAHD)
- Data boundary
- Groundwater flow direction
- Observed hydraulic head for late 2013 to early 2014 (mAHD) (Coffey, 2016a)

Surface geology

Quaternary
- Qs - basalt
- Qp - peat
- Qa - alluvium

Tertiary
- Tb - Basalt
- T-Rb - Robertson Basalt

Jurassic
- Jld - undifferentiated Jurassic intrusion
- Jes - undifferentiated Jurassic intrusion
- Jss - Sutton Forest igneous
- Jeb - Mount Gilbraltar
- Jt - Mount Gingenbullen

Triassic
- TRw - Wianamatta Group shale
- TRh - Hawkesbury Sandstone
- TRnz - Narrabeen Group
- TRnk - Kangaloon Sandstone

Permian
- Pi - Illawarra Coal Measures
- Ps - Shoalhaven Group

Devonian
- Dmg - Devonian granite

Other
- Reservoir
- Drainage line

Groundwater levels and flow direction in Wianamatta Group

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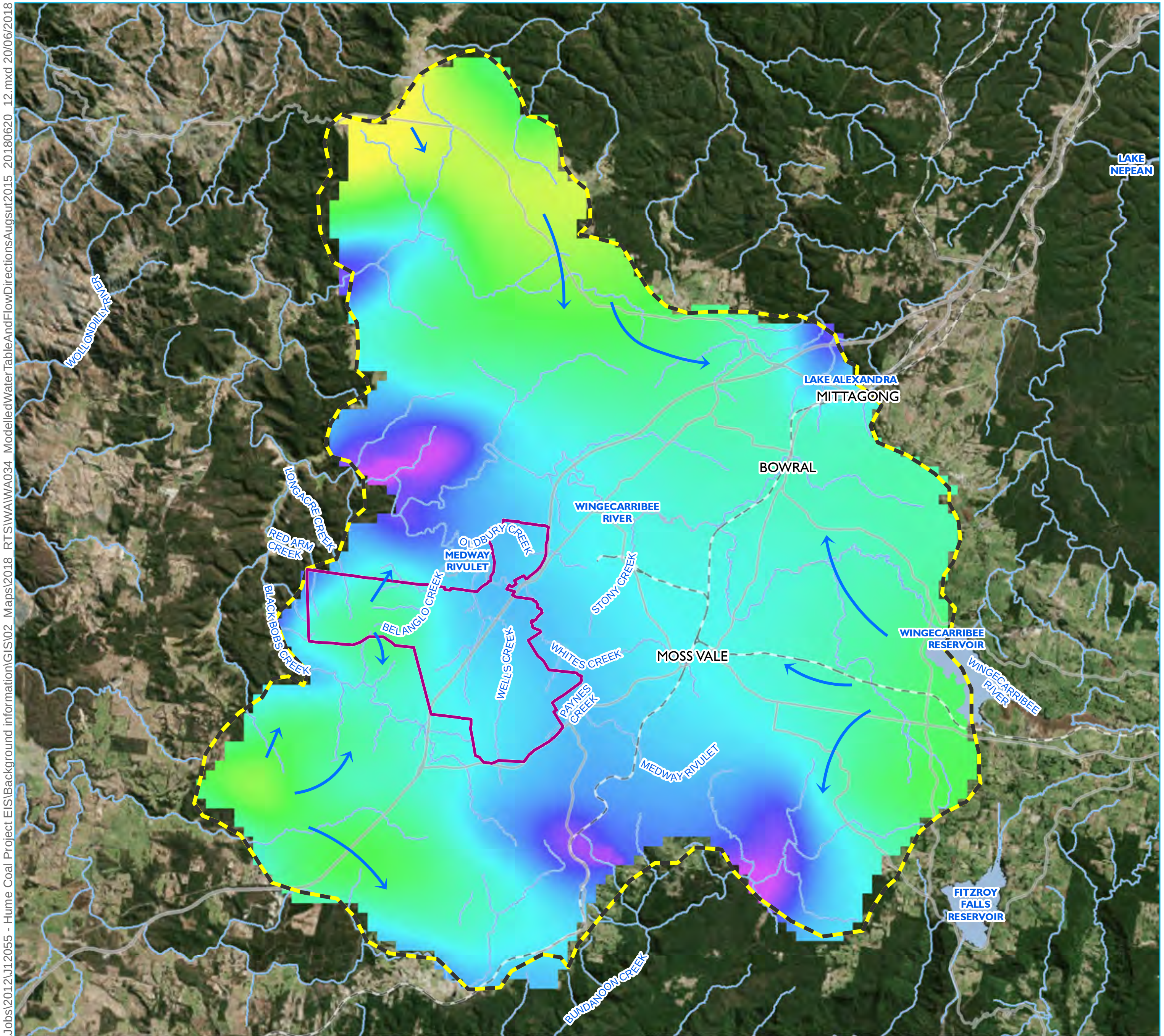
Figure 6.9



KEY

Project area

Model domain

Value

High : 731.079

Low : 563.876

Water table flow direction

Existing features

Main road

Rail line

Drainage line

Lakes and reservoirs

Source: EMM (2018); DFSI (2017); Hume Coal (2017); LPI (2015); Coffey (2016a)

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Modelled water table and flow directions as at August 2015 (EIS Model)

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Figure 6.10

6.7 Vertical head gradients

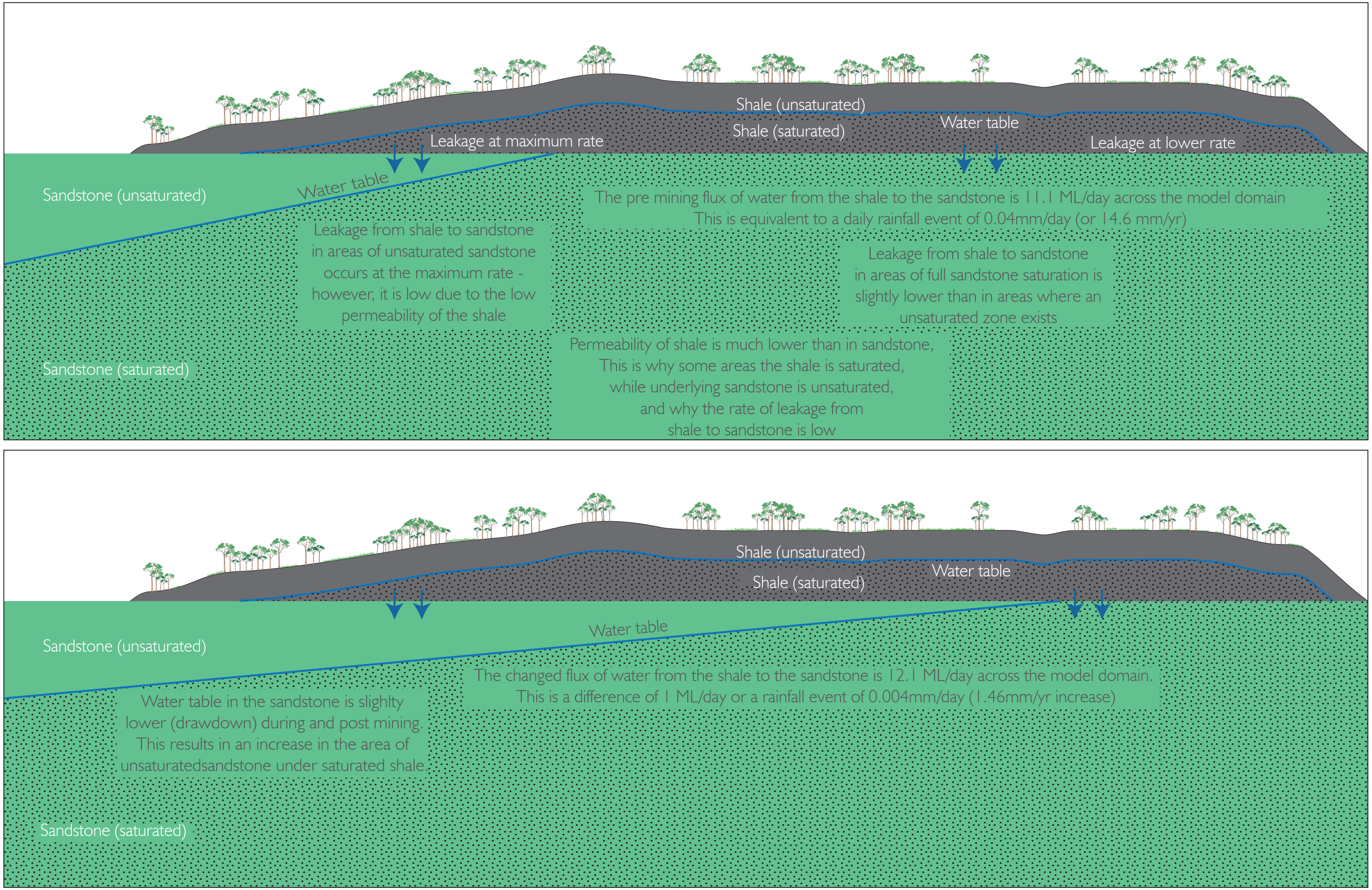
The vertical hydraulic head differences between groundwater units are spatially variable, and reflect the local system, but there are also some overall trends across the regional system. The local systems differences are aspects such as: recharge areas; cliff escarpment discharge; and local groundwater systems within the Hawkesbury Sandstone. Groundwater level monitoring data regionally and locally indicates (Coffey 2016a):

- downward trending vertical gradients are present in the north-western part of the project area, consistent with areas of recharge;
- significant vertical hydraulic head gradients exist north of the project area, and desaturation associated with the full extraction mining and related deformation in the overlying units at the Berrima Colliery. This effect has not migrated south into the northern end of the project area due to incised watercourses that act as groundwater flow barriers;
- steep vertical hydraulic gradients generated by discharge at seepage faces are present next to escarpments;
- significant, downward vertical hydraulic gradients are present in the Wianamatta Group where overlain with Robertson Basalt;
- small vertical hydraulic head gradients exist in the central part of the project area, due to distance from mining and escarpments and minimal recharge at this location; and
- negligible vertical hydraulic head gradients exist within the Robertson Basalt. However, there is a large vertical hydraulic head gradient between the basalt and the underlying sedimentary units (note this large vertical head does not translate to large flow due to the very low hydraulic conductivity of the Wianamatta shales).

Some of the data presented in background reports (Coffey 2016a & 2016b) suggests there is a zone of saturation above the Berrima Colliery. The extent and location of this saturated zone is unknown. For a conservative approach, in this water assessment the Hawkesbury Sandstone is interpreted as being desaturated above the full extraction workings in the northern part of Berrima Colliery and as having a local zone of saturation above the first workings in the southern part of the mine. It is likely this local saturated zone is somewhat disconnected from the regional groundwater system, although some leakage from the local system to the regional system is likely to occur. Over time, this saturated zone is expected to increase in size and eventually reconnect with the regional groundwater system as the groundwater above the Berrima Colliery recovers.

The connectivity between the overlying Wianamatta Group shale and the Hawkesbury Sandstone is conceptualised as a stable low rate of leakage from the above low permeability system into the below high permeability regional sandstone system. This assessment conservatively assumes there is a direct hydraulic connection between the base of the Wianamatta Group shale, and the underlying upper Hawkesbury Sandstone. Although, it has also been interpreted from vertical head distributions that a desaturated zone in some areas could separate the two formations – in which case leakage from the shale into the underlying sandstone would be expected to already be occurring at a maximum flux rate. Figure 6.11 shows a schematic representation of the relationship between the local groundwater system in the Wianamatta Group and the regional groundwater system in the Hawkesbury Sandstone during pre-mining (A) and during mining (B) conditions.

An interpreted hydrogeological cross-section for the existing (pre-mining) situation, including the Berrima Colliery, is shown in Figure 6.12. This cross section is schematic and has an exaggerated vertical scale.



Schematic representation of Wianamatta Group - Hawkesbury Sandstone relatonship

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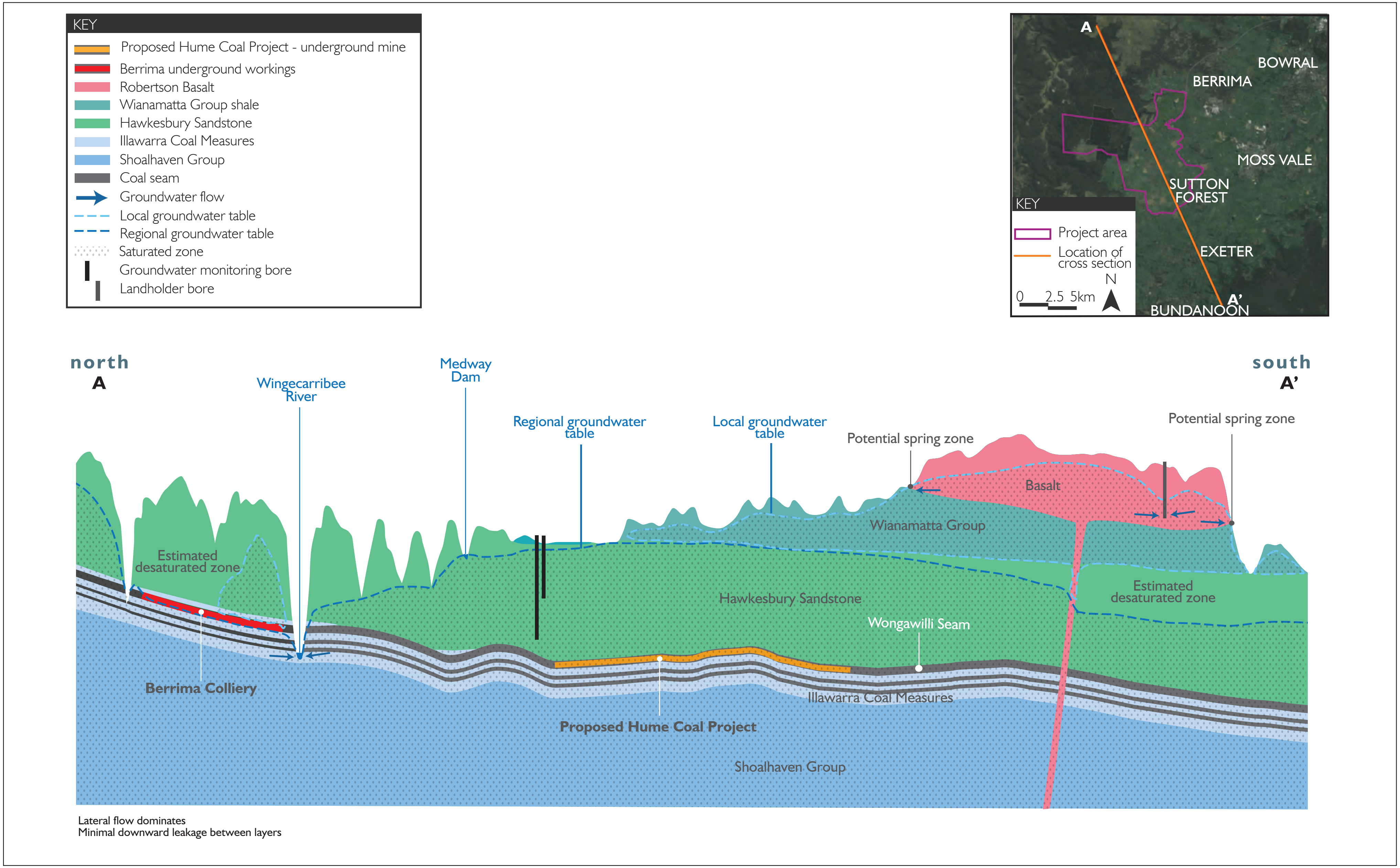
Figure 6.11



Schematic - not to scale
(vertical scale is exaggerated and this is a schematic representation only and does not accurately represent the size or locations of bores)

Interpreted hydrogeological cross-section - existing situation
Hume Coal Project
Revised Water Assessment

Figure 6.12

6.8 Groundwater quality

AR 52: An assessment of groundwater quality, its beneficial use classification and prediction of any impacts on groundwater quality.

Baseline water quality data collected between October 2011 and September 2015 from the Hume Coal groundwater monitoring program are included and details are presented in Appendix I. The baseline monitoring data has continued to be collected, and will continue up to the start of project construction and will be available for future analysis. The analysis presented here is based on the same data as the EIS (EMM 2017g). A summary analysis of the more recent data (ie post 2015 to 2018) has revealed no significant change in trends or results, and therefore additional analysis at this stage is deemed not required. Section 4.2.5 outlines the groundwater quality monitoring program. Table 6.2 summarises the baseline water quality data for each groundwater system used in this assessment. The sections below summarise the groundwater quality data.

Table 6.2 Summary of baseline water quality data per groundwater system

Groundwater system	Number of water quality monitoring bores	Total number of water quality samples collected	Data range
Robertson Basalt	2	9	December 2012–September 2015
Wianamatta Group	1	7	December 2013–September 2015
Hawkesbury Sandstone	23	131	October 2011–September 2015
Wongawilli Seam	15	93	October 2011–September 2015
Illawarra Coal Measures	3	14	March 2013–September 2015

6.8.1 Summary of groundwater quality

Graphical presentation of all the baseline groundwater geochemistry results has been provided to assist with the interpretation of the data:

- Piper diagram (Figure 6.13) including all of the baseline groundwater samples, rather than just the averages for each monitoring location (rainfall data have also been added to the plot for reference); and
- Box plots of pH, electrical conductivity, sulfate and total alkalinity (as $CaCO_3$) for each of the major formations (Figure 6.15, Figure 6.17, Figure 6.18, and Figure 6.19).

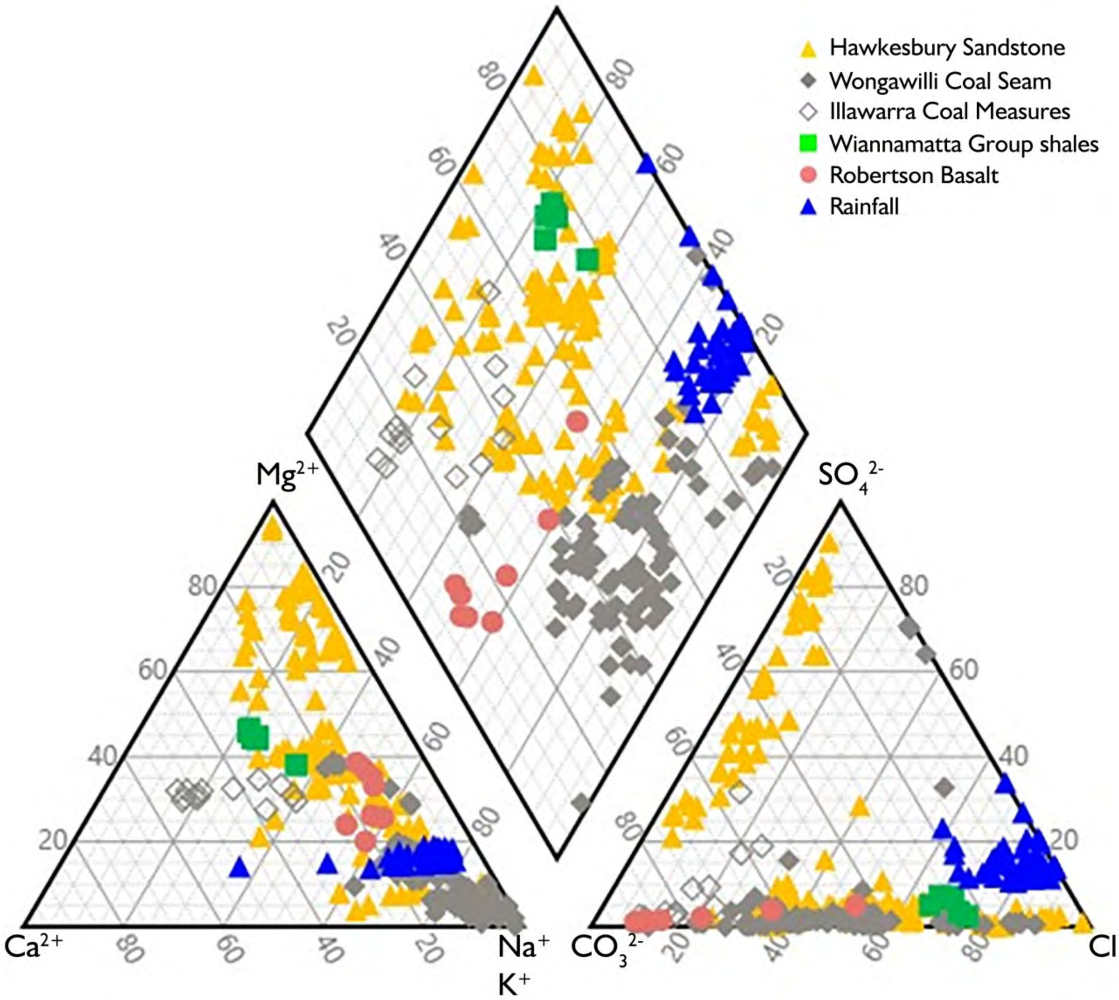


Figure 6.13 Piper diagram for all baseline groundwater samples

A histogram of pH for baseline samples is shown in Figure 6.14 for data collected from the groundwater monitoring bores in the Wianamatta Group, Hawkesbury Sandstone, and the Wongawilli Seam. pH conditions straddle neutral values for the Robertson Basalt and Wianamatta Group, while pH conditions are slightly more acidic in the Hawkesbury Sandstone and Wongawilli Seam. A box plot of all pH data (Figure 6.15) illustrates the data for all formation and also illustrates data for the Illawarra Coal measures as separate from just the Wongawilli Coal Seam.

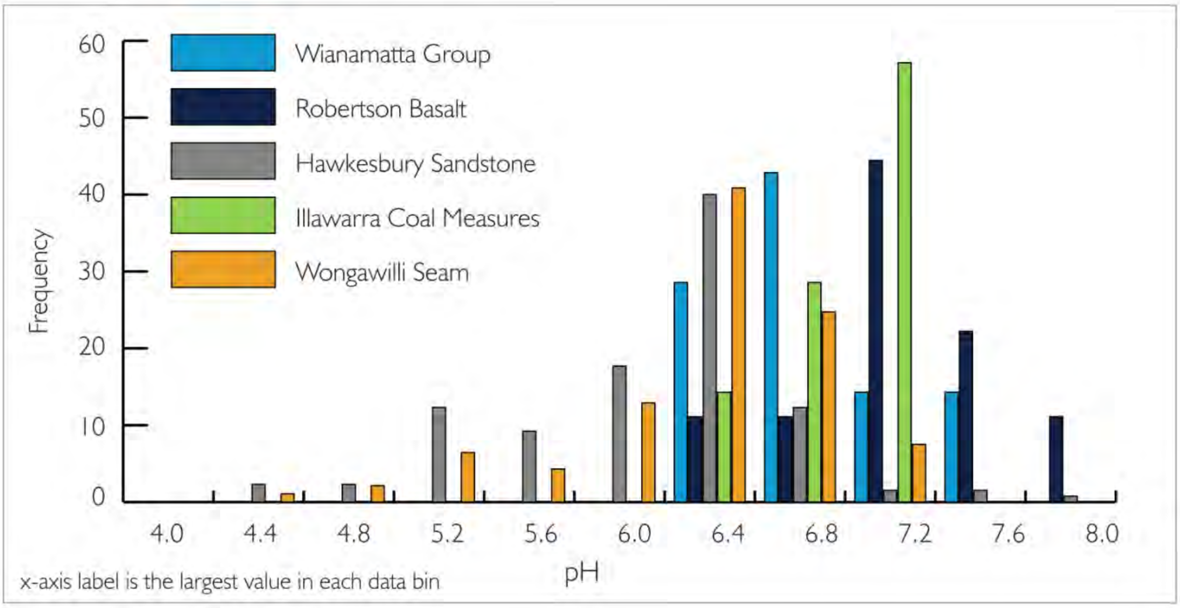


Figure 6.14 Histogram of groundwater pH

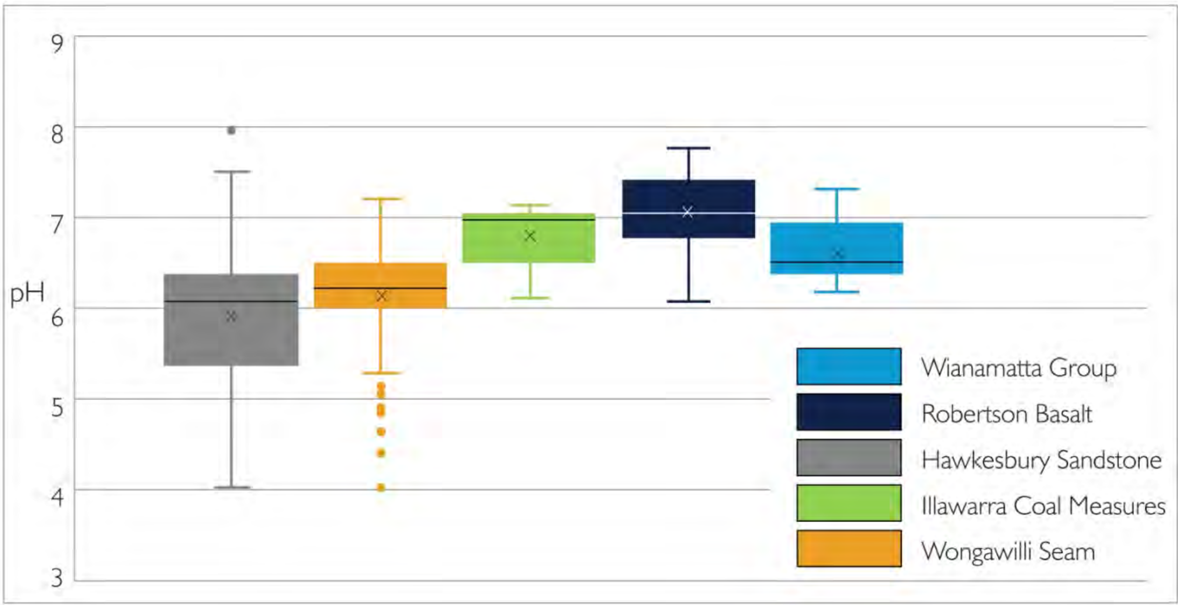


Figure 6.15 Box plot of pH of major groundwater formations

Figure 6.16 shows a histogram of total dissolved solids (TDS), a measure of salinity, for baseline samples collected from the groundwater monitoring bores in the Wianamatta Group, Hawkesbury Sandstone, and the Wongawilli Seam. Figure 6.17 shows a box plot for electrical conductivity (EC), an alternate measure of salinity, for all baseline samples collected from groundwater monitoring bores.

Groundwater is generally fresh in the Hawkesbury Sandstone and Illawarra Coal Measures and comparable to surface water (Section 5.3), indicating proximity to recharge areas. Groundwater quality is also fresh in the Robertson Basalt although the mean TDS is slightly higher compared to the sandstone and coal. The Wianamatta Group hosts brackish groundwater remnant from the marine depositional setting, long residence times, and coastal rainfall influence. It is noted by Russel et al (2009) that the salinity of groundwater in the Wianamatta Group shale in the Southern Highlands is typically <3,000 mg/L.

The similarity of TDS measurements between the Illawarra Coal Measures and Hawkesbury Sandstone indicates they are hydraulically connected between the units. Local elevations in the Hawkesbury Sandstone TDS measurements are attributed to higher salinity groundwater leaking from the overlying Wianamatta Group, where present. Figure 6.20 shows spatial variability of the average TDS for monitoring bores in each monitored zone. The lower salinity groundwater observed in the Hawkesbury Sandstone in the west and north-west is indicative of flushed recharge areas and absence of overlying shale. Two monitoring bores (HU0142PZB and HU0142PZC) showed anomalous TDS results after the bores were installed (up to 3,172 mg/L); these results have been interpreted as an influence of the bore installation and are not representative of natural groundwater.

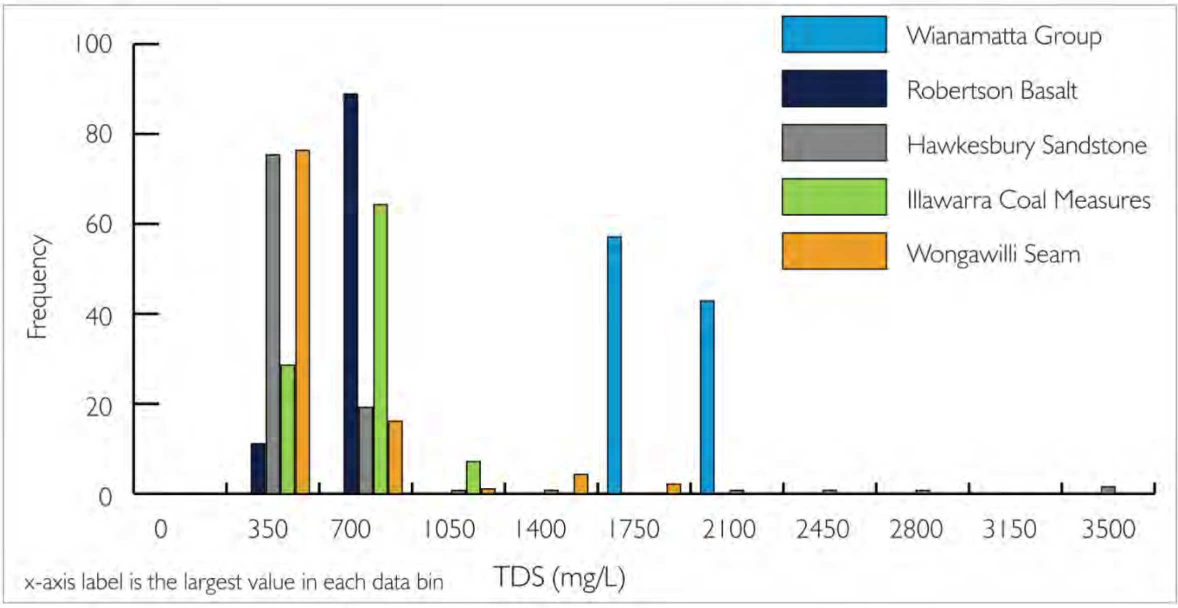


Figure 6.16 Histogram of groundwater TDS

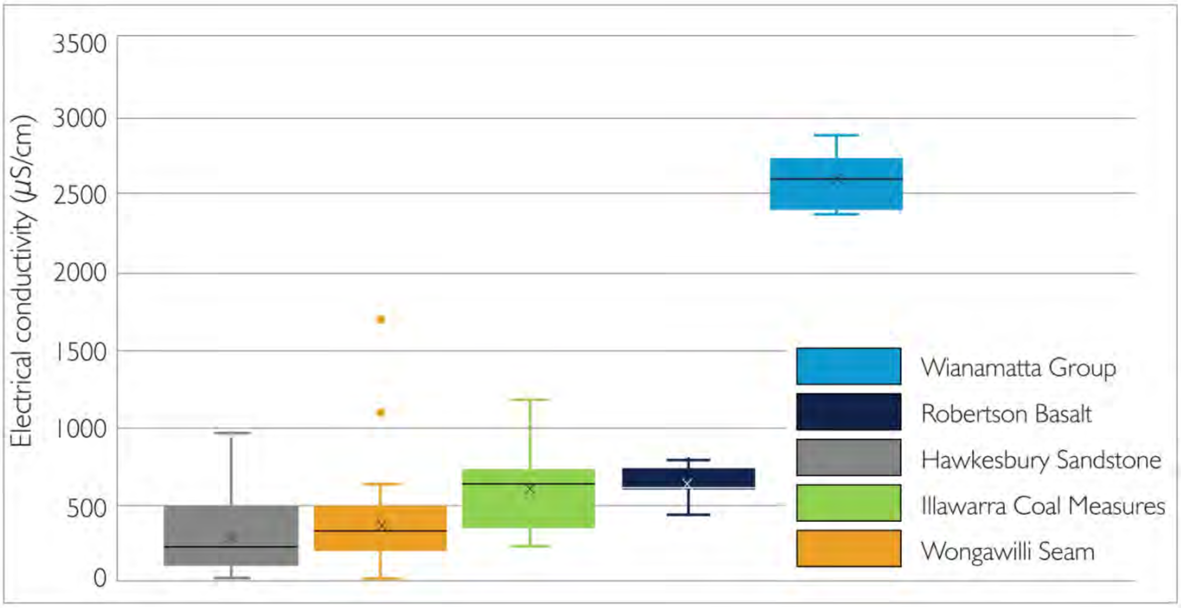


Figure 6.17 Box plot of electrical conductivity of major groundwater formations

Figure 6.18 shows a box plot of alkalinity for all baseline samples collected from the groundwater monitoring bores in the Wianamatta Group, Hawkesbury Sandstone, basalt, Wongawilli Seam and the Illawarra Coal Measures.

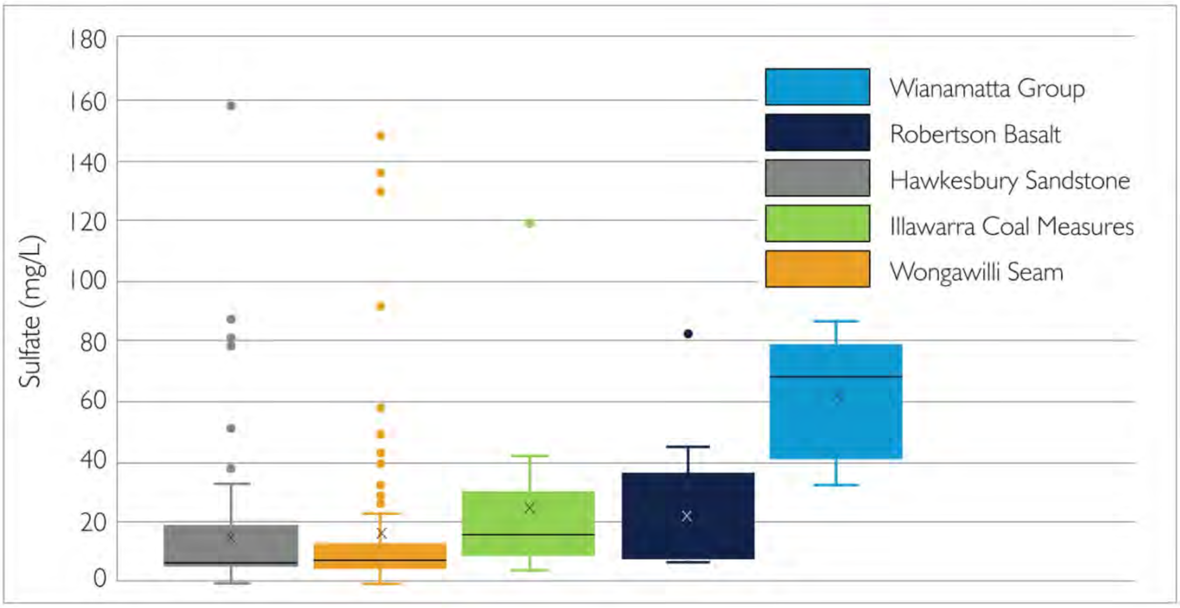


Figure 6.18 Box plot of alkalinity of major groundwater formations

Dominant water type for each monitored formation is shown in Table 6.3. The dominant hydrochemical water type in the basalt was Mg-Ca-HCO3-Cl, indicating the groundwater represents a mixture of rainfall recharge that has been influenced by mineral dissolution within the basalt rock.

The predominant hydrochemical water type in the Wianamatta Group shale formation is Mg-Ca-Na-Cl-HCO_3. The strong chloride component in the shale is likely to be associated with connate salts from its original marine deposition, and also longer residence time and coastal rainfall with weakly dissolved salts subject to evapotranspiration over time.

The Hawkesbury Sandstone varies in water type. There is a continuous range in cations from magnesium-rich to sodium-rich groundwater, but none that are rich in calcium. There are two distinct distributions of groundwater types for anions; one type consists of bicarbonate and chloride with very low sulfate and the other consists of sulfate and bicarbonate without chloride. The sulfate concentration within the Hawkesbury Sandstone is investigated in detail in Section 6.8.3.

Table 6.3 Dominant major ion chemistry for each groundwater system

Groundwater system	Water type
Robertson Basalt	Mg-Ca-HCO_3-Cl
Wianamatta Group	Mg-Ca-Na-Cl-HCO_3
Hawkesbury Sandstone	Na-Cl, Na-Mg-Cl-HCO_3, Mg-Na-SO_4-HCO_3
Wongawilli Seam	Na-Cl
Illawarra Coal Measures	Ca-Na-HCO_3

Concentrations of most dissolved metals are typically low for most samples collected from each groundwater system, with many measurements below detection limits. This is typical of groundwater with reasonably neutral pH.

No organic compounds were detected above the limit of detection in either the Wianamatta Group or the Illawarra Coal Measures groundwater. Minor detections of naturally occurring toluene and petroleum hydrocarbons were observed in the Hawkesbury Sandstone and Wongawilli Seam groundwater.

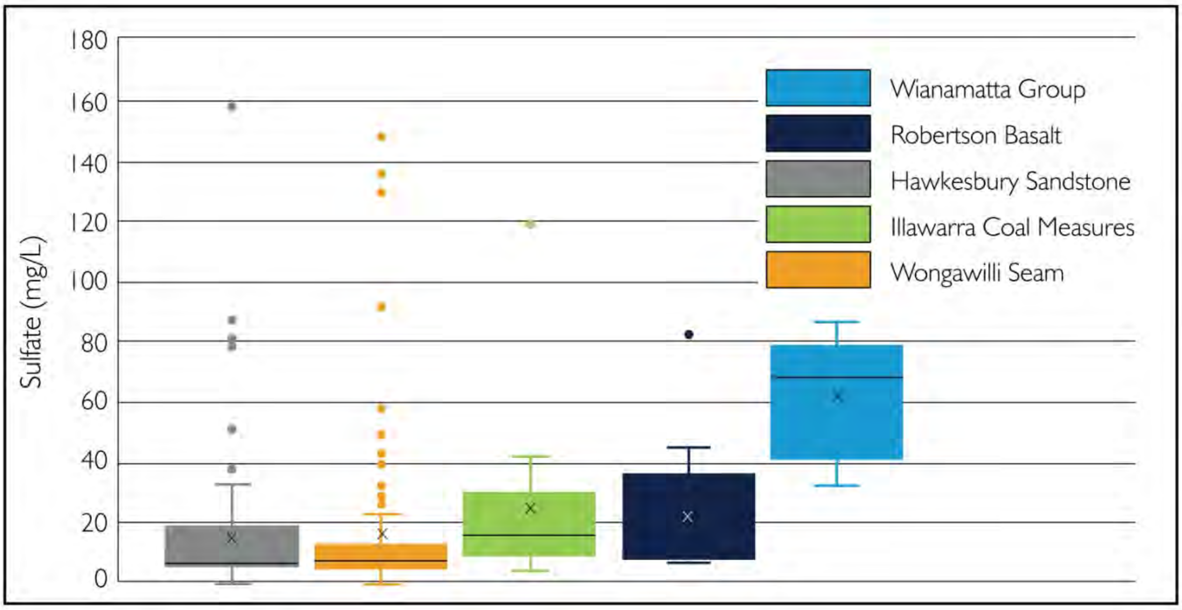
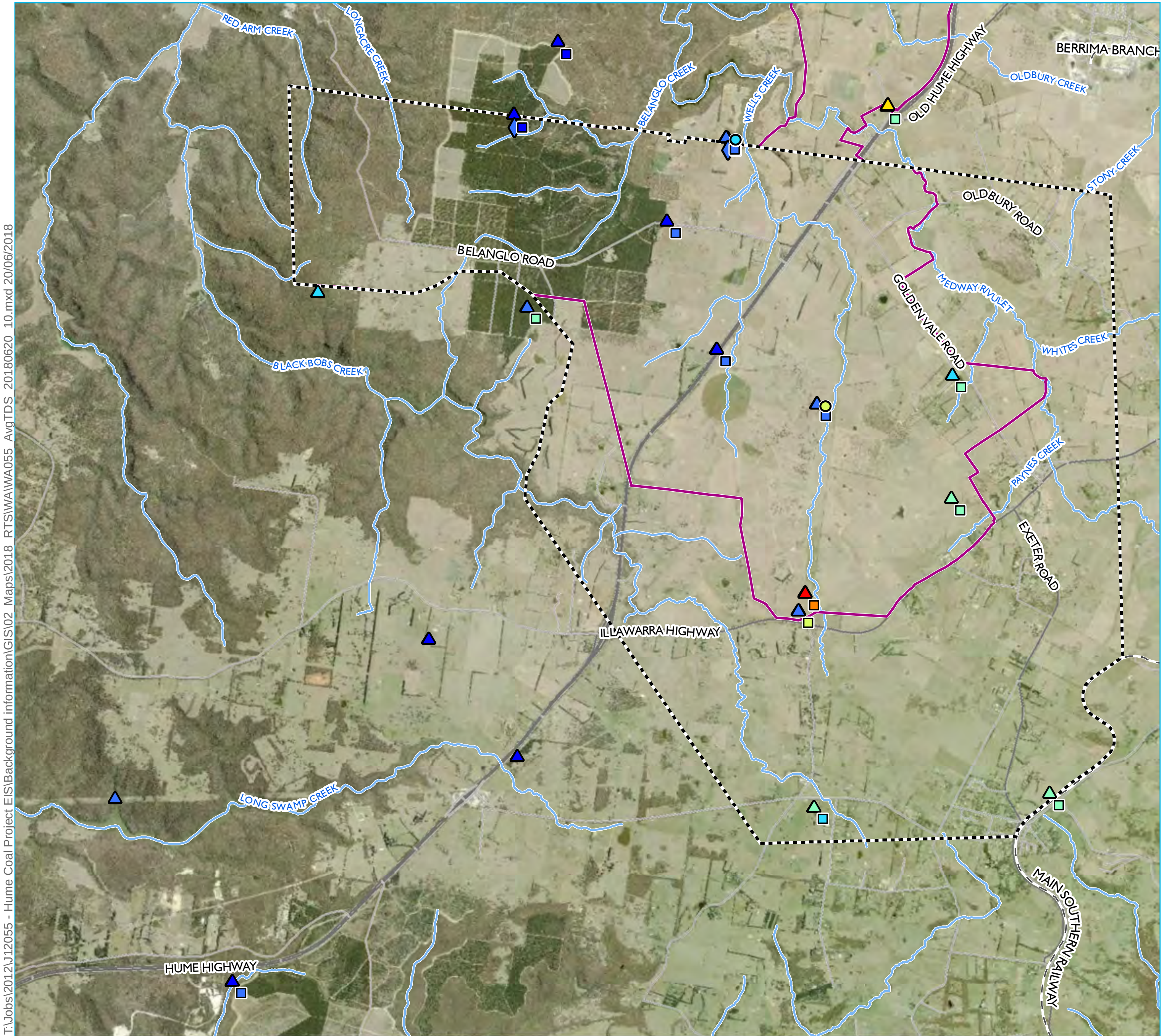


Figure 6.19 Box plot of sulfate concentration in major groundwater formations



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Source: EMM (2018); DFSI (2017); Hume Coal (2017); PB (2015)

Distribution of average TDS for monitoring bores within Hawkesbury Sandstone and Illawarra Coal measures

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Figure 6.20

6.8.2 Spatial and temporal variability in baseline monitoring data

Hawkesbury Sandstone groundwater sampled from the western part of the project area, where the sandstone outcrops, has a dominant Na-Cl signature, which is typical of rainfall recharge close to the coast. While, Hawkesbury Sandstone groundwater sampled from areas overlain by Wianamatta Group shale has a dominant Mg-CO_3 signature, which is characteristic of older groundwater that reflects a greater degree of water-rock interaction in the groundwater system (Appendix I).

Groundwater in the shale has a higher solute load than groundwater in the other formations, which is typical of the Wianamatta Group shales in the Sydney basin. However, the salinity of the groundwater in the one monitoring bore that intersects the shale is only moderately higher than groundwater sampled from other formations. It would not be unusual for groundwater in thicker occurrences of the Wianamatta Group shales to have salinity values (EC and TDS) an order of magnitude higher than that observed in the study area (Ross 2014).

Groundwater quality in the Hawkesbury Sandstone and the Wongawilli Seam are similar. Although it is common for groundwater in the Hawkesbury Sandstone to have a low solute load, coal seam groundwater would typically be expected to have greater salinity and greater variability in the geochemical signature. There was no significant distinction observed between groundwater in the Hawkesbury Sandstone, the Wongawilli Coal Seam, the ICM, and the basalt. This similarity in geochemical signature suggests a limited degree of soluble mineral phases in each of these formations.

The groundwater quality appears to have remained relatively unchanged across the monitoring period, showing very little seasonal variation or long-term trends. For example, Figure 6.21 and Figure 6.22 show major ion chemistry changes over time for two Hawkesbury Sandstone monitoring bores: HU0142PZB, in the south-eastern part of the project area, and HU0096PZC, in the north-western part of the project area. At each bore, the individual parameters maintain relatively consistent concentrations across the monitoring period.

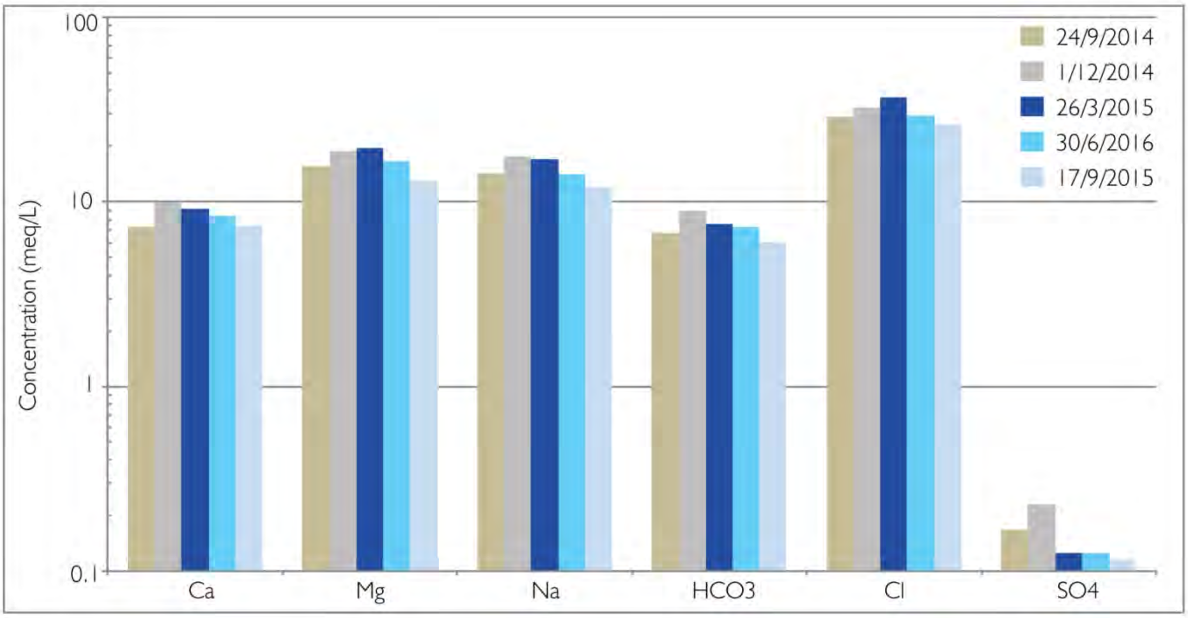


Figure 6.21 Major ion chemistry changes over time at Hawkesbury Sandstone bore HU0142PZB

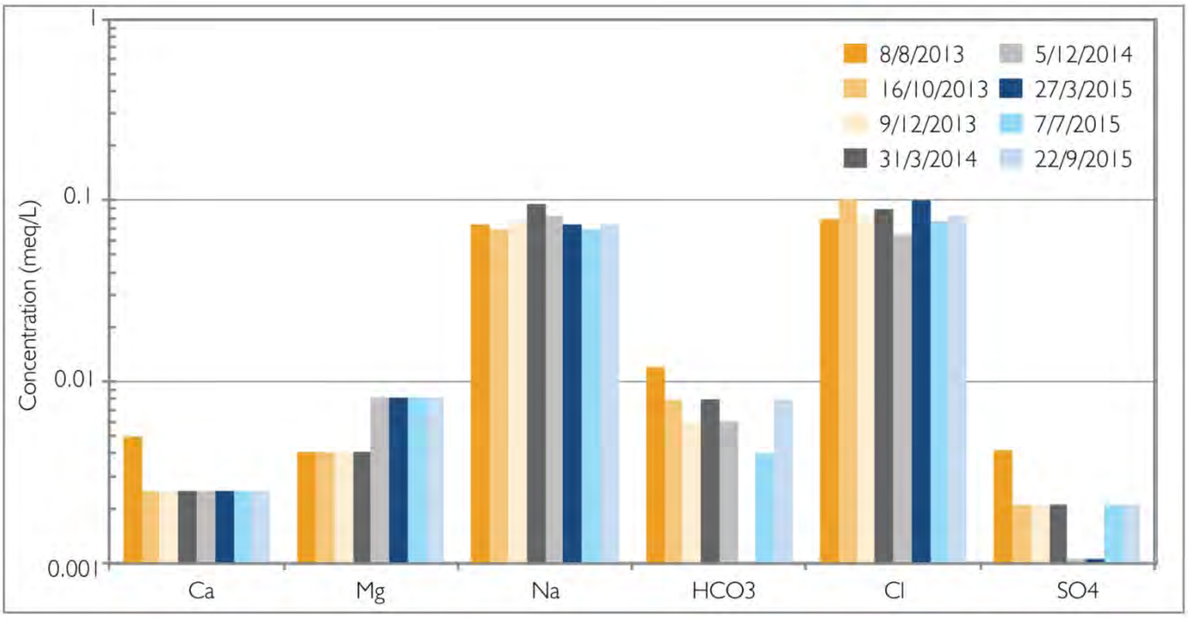


Figure 6.22 Major ion chemistry changes over time at Hawkesbury Sandstone bore HU0096PZC

6.8.3 Groundwater with elevated sulfate

The baseline groundwater monitoring program indicated several monitoring locations that were either sulfate-dominant geochemical water types or contained sufficient sulfate to be recognised for classification purposes. The majority of these were collected from monitoring wells screened in the Hawkesbury Sandstone, a formation in which elevated sulfate in groundwater is not commonly encountered.

The sulfate water types can broadly be characterised as follows, based on the relative proportion of sulfate to other anions:

- Sulfate dominant – sulfate comprises 50-90% of total anions, on a milliequivalents per litre (meq/L) basis. Sulfate dominant water was present at H37B, H43B and H44B.

- Sulfate-bicarbonate waters – sulfate comprises 40-50% of total anions, on a meq/L basis, and is present in approximately equal proportions to bicarbonate. Sulfate-bicarbonate water was present at H38C, H42C and H56B.

- Bicarbonate-sulfate waters – There is sufficient sulfate to be recognised for water classification purposes (~ 30% on a meq/L basis), however bicarbonate is the dominant anion. Bicarbonate-sulfate water was present at H23C and H32LDB.

The sulfate groundwater types also shared the following geochemical traits:

- Slightly lower pH values relative to other monitoring locations (<pH 5 in sulfate dominant water types), which increased with increasing bicarbonate alkalinity.

- Lower TDS values relative to other monitoring locations (~50-120 mg/L, versus ~250 mg/L in other locations).

- Lower proportions of sodium and chloride relative to other monitoring locations (generally <10% each on a meq/L basis, compared to 50-60% each in other locations). The sulfate-dominant water types were classified as Mg-SO_4.

In the original hydrogeochemical groundwater report, it was speculated that higher sulfate groundwaters may have been associated with zones of enhanced or rapid recharge, based on the lower TDS values, the presence of sulfate-dominant groundwater in wells in sandstone outcrop areas (the primary recharge zone for the sandstone), and a general pattern of higher sulfate concentrations in the shallowest wells in nested well installations. However, with further investigation this original assumption is not the only reason for the elevated sulfate for the following reasons:

- many of the elevated sulfate wells are installed in the sandstone outcrop areas to the west of the project area, and others are in the basalt and shale outcrop areas. There are also other wells installed in the upgradient sandstone outcrop areas with negligible sulfate content, in proximity to the elevated sulfate wells; and

- the geochemical signature of rainfall close to the coast is typically Na-Cl dominant (refer to the Piper diagram (Figure 9.1) whereas there is a clear trend of these constituents being negligible in the wells where elevated sulfate is present.

The source(s) of the sulfate in these locations is therefore uncertain, and potentially due to a number of reasons, explained below. Traditional sources of sulfate in groundwater include: oxidation of pyrite minerals (which would be consistent with the correlation with lower pH values); seawater intrusion (or connate salts in formations deposited in a marine environment); and dissolution of sulfate-bearing mineral phases in the aquifer.

i Possible sources of sulfate

a. Pyrite oxidation

Pyrite oxidation is likely a contributing process to the elevated sulfate, but potentially not the only or dominant process, as the Hawkesbury Sandstone is not particularly known for its pyrite content. However, it is possible that there pyrite associated with increasing organic shale interbeds, particularly towards the base of the sandstone in the transition to the underlying coal measures. Pyrite oxidation is commonly associated with coal seams, and some of the sulfate-dominant wells (such as H43B and H44B) are located close to the edge of the escarpment where the coal measures daylight and diffusion of atmospheric oxygen may promote pyrite oxidation.

The spatial distribution of this process is inconsistent, and there is little correlation between sulfate and iron concentrations in the groundwater samples. This is likely due to iron precipitating as an oxyhydroxide in the presence of oxygen. Also, the vertical hydraulic gradient in the sandstone was interpreted to be flat or downward across the project area and surrounds, with no interpreted upward flow from the coal seams, so this seems less plausible as a broad source of sulfate in the sandstone aquifer (and again, why would this process manifest in certain specific wells and not in others nearby).

b. Seawater source

The project area is too far from the coast for seawater intrusion to be relevant, but the Wianamatta Group Shales are interpreted to have been deposited in brackish or marine settings and therefore could conceivably contain salts with a seawater signature. However, the groundwater quality data from H35B, screened within the shale formation, indicates negligible sulfate, and most of the wells installed beneath the shale also have negligible sulfate. Accordingly, the shale formation is unlikely to be a significant contributor to the elevated sulfate wells.

c. Dissolution of sulfate minerals

It is possible that sulfate mineral phases are present within the Hawkesbury Sandstone, although there is no mineralogical data to support this, and the mineral 'cement' in the sandstone matrix is typically reported to comprise carbonate mineral phases such as calcite, dolomite and siderite. As with the other processes, this process would be difficult to reconcile with the spatial inconsistency of the sulfate wells.

d. Summary

The presence of elevated sulfate in groundwater in certain wells in and around the project area is recognised, and the source of the sulfate is likely to be trace pyrite, but may include other processes. The available data suggests that oxidation of trace pyrite that may be present in interbeds in the sandstone is a potential contributor, especially with the correlation with lower pH values. It is unclear why sulfate is selectively present in certain wells and absent in others nearby, but that is potentially just a function of subsurface heterogeneity.

6.9 Beneficial uses

AR 68 (part): The EIS must describe background conditions for any water resource likely to be affected by the development, including:
c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters
d. Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government

The groundwater quality of the basalt is characterised by relatively low TDS and around neutral pH, with very few exceedances of the water quality assessment criteria. Where exceedances occurred, they are generally associated with metals concentrations that are marginally above the ANZECC and ARMCANZ (2000) ecological criteria. Accordingly, groundwater associated with the basalt intrusions in the study area is likely to be suitable for a broad range of beneficial uses, from a water quality perspective.

Groundwater associated with the Wianamatta Group shales is typically too saline, and the yield is too low, to support a broad range of beneficial uses. Although the TDS is relatively moderate with respect to shale groundwater in other parts of the Sydney Basin, it is still above the aesthetic guideline value for drinking water (NHMRC 2016), and is generally considered to have limited potential as a groundwater resource.

Groundwater in the Hawkesbury Sandstone is an important local water supply resource, and is developed to support domestic and stock supply, and irrigation. It is characterised by a low salinity and, in combination with good bore yields, makes it suitable to support most beneficial uses. Environmental values associated with the Hawkesbury Sandstone are likely to include: primary industries (irrigation and general water uses, stock drinking water, aquaculture and human consumption of aquatic foods), drinking water, and, in places of discharge to streams, aquatic ecosystems.

6.10 Groundwater use

AR 51: The existing groundwater users within the area (including the environment), any potential impacts on these users and safeguard measures to mitigate impacts.

6.10.1 Landholder and DI Water monitoring bores

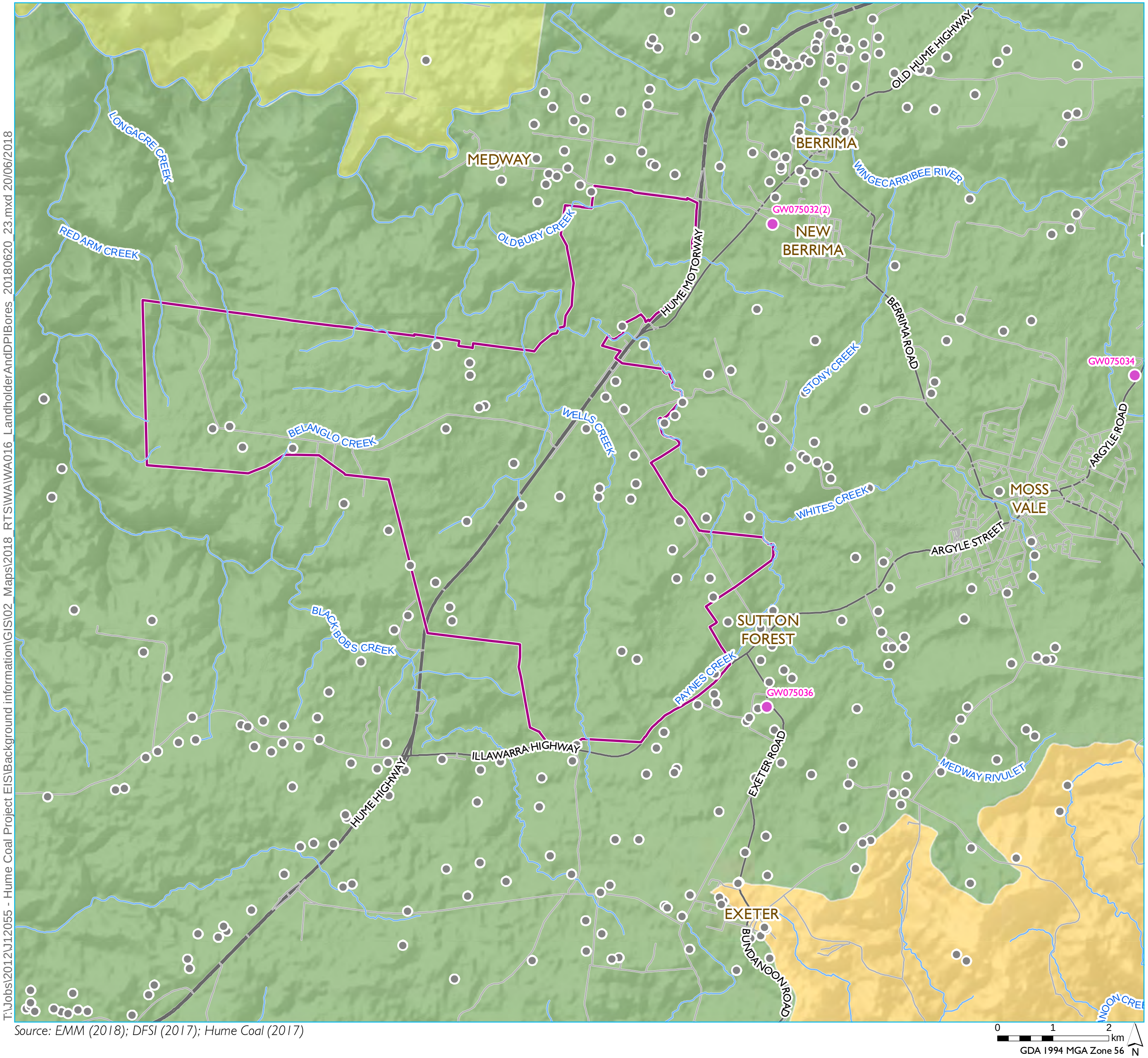
According to DI Water's groundwater bore database (DPI Water 2015b) and WaterNSW's licence and approvals database, there are approximately 360 registered landholder bores with active work and use approvals (not including bores located on Hume Coal property), and three DI Water monitoring sites within a 9 km radius from the middle of the project area. These bores are shown in Figure 6.23. WaterNSW provided an up-to-date extraction from their water licence and approvals database to Hume Coal on 27 April 2018.

DI Water monitoring bores are used to monitor groundwater levels and water quality at locations across the state. Often the monitoring bores are constructed as 'nested sites' with multiple bores screening different formations. One of the three DI Water monitoring sites is a nested site with two bores installed to different depths (GW075032), the remaining monitoring sites are single bore sites (GW075034 and GW075036) (Figure 6.23).

The median bore depth of the private landholder bores is approximately 85 m, with most bores extracting groundwater from the Hawkesbury Sandstone. Landholder groundwater pumping from the basalt is concentrated around Exeter, south of the major sub-vertical feature. Landholder bores are mainly associated with the farmed areas, with very few bores observed in the Belanglo State Forest. Landholder licensed bores are mainly for domestic and stock use.

Coffey (2016a) identified 83 private water bore access licences within the 9 km radius of the project area with a combined level of entitlement of 5,300 ML/year. It is possible a number of unregistered bores also exist, but these are likely to be stock and domestic bores, and unlikely to be used for irrigation. As regulatory agencies for the area do not meter usage, the actual usage from registered bores is unknown.

A number of basic rights bores (registered for stock and domestic use) also exist; there is no volumetric entitlement associated with these bores. The total usage of basic rights bores within 9 km from the middle of the project area is estimated to be 950 ML/year.



KEY

- Project area

Type

- DPI monitoring bore
- Registered landholder bore

Water Sharing Plan for the Greater Metropolitan Region Groundwater Source (2014)

- Sydney Basin Nepean Groundwater Source (Nepean Zone 2)
- Sydney Basin Nepean Groundwater Source (Nepean Zone 1)
- Sydney Basin South Groundwater Source

Existing features

- Main road
- Local road
- Drainage line

Source: EMM (2018); DFSI (2017); Hume Coal (2017)

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Landholder bores and DPI Water monitoring bores

Hume Coal Project
Revised Water Assessment
Figure 6.23

HUMECOAL PROJECT
EMM

6.10.2 Ecosystems that rely or potentially rely on groundwater

AR 41: Detailed description of dependent ecosystems and existing surface water users within the area, including basic landholder rights to water and adjacent/downstream licensed water users

Ecosystems that could rely on either the surface or subsurface expression of groundwater within or surrounding the project area are those associated with:

- creeks where groundwater is interconnected and provides baseflow after runoff. This includes Medway Rivulet and some drainage channels in the northern and western areas of the project;
- shallow groundwater systems;
- springs associated with basalt hills south of the project area and springs at the shale/sandstone boundary near creeks;
- upland swamps in the wider locality, namely Stingray Swamp and Long Swamp; and
- terrestrial vegetation overlying shallow groundwater (within the vegetation's root zone).

These ecosystems have been classified into three categories according to their dependence on groundwater: non-dependent, facultative, and entirely/obligate (Figure 3.7).

Assessment of ecosystems reliant and potentially reliant on groundwater is described in the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c). A summary is provided below.

Ecosystems that rely on groundwater are important environmental assets and typically occur where groundwater is at or near the land surface. NSW water sharing plans (WSPs) include schedules with lists of high priority groundwater dependent ecosystems (GDEs), which are required to be assessed using the minimal impact criteria outlined in the Aquifer Interference Policy.

There are no high priority GDEs identified within the project area in the Metropolitan Groundwater WSP. However, Paddys River Swamps (comprising Long, Hanging Rock, Mundego, and Stingray Swamps) and Wingecarribee Swamp (Figure 1.4) are listed in the WSP as high priority GDEs but are some distance from the project area. Paddys River Swamps are about 9 km to the south-west of the project area and the Wingecarribee Swamps are 13 km to the east (EMM 2017c). Peat swamps rely on both groundwater baseflow to the drainage channels in which these swamps occur and surface water runoff.

Long Swamp and Stingray Swamp have a facultative (proportional) dependence on groundwater as they would take a portion of their water requirements from the groundwater near ground surface and a portion from rainfall infiltration and stream surface flows.

Paddys River Swamps contain the Temperate Highland Peat Swamps on Sandstone listed in the NSW *Threatened Species Conservation Act 1995*. These swamps are also listed in the *Directory of Important Wetlands in Australia* (Environment Australia 2001).

One spring was recorded in cleared land on a basalt hill in the south of the project; however, given its location in a cleared area, there are no surrounding drainage lines that would rely on spring flow. Several springs were also recorded in cleared areas during surveys north and south of Oldbury Creek and Medway Rivulet. These springs would make a minor contribution to surface flows in the area to Oldbury Creek and Medway Rivulet, and therefore these systems are considered to be non-dependent.

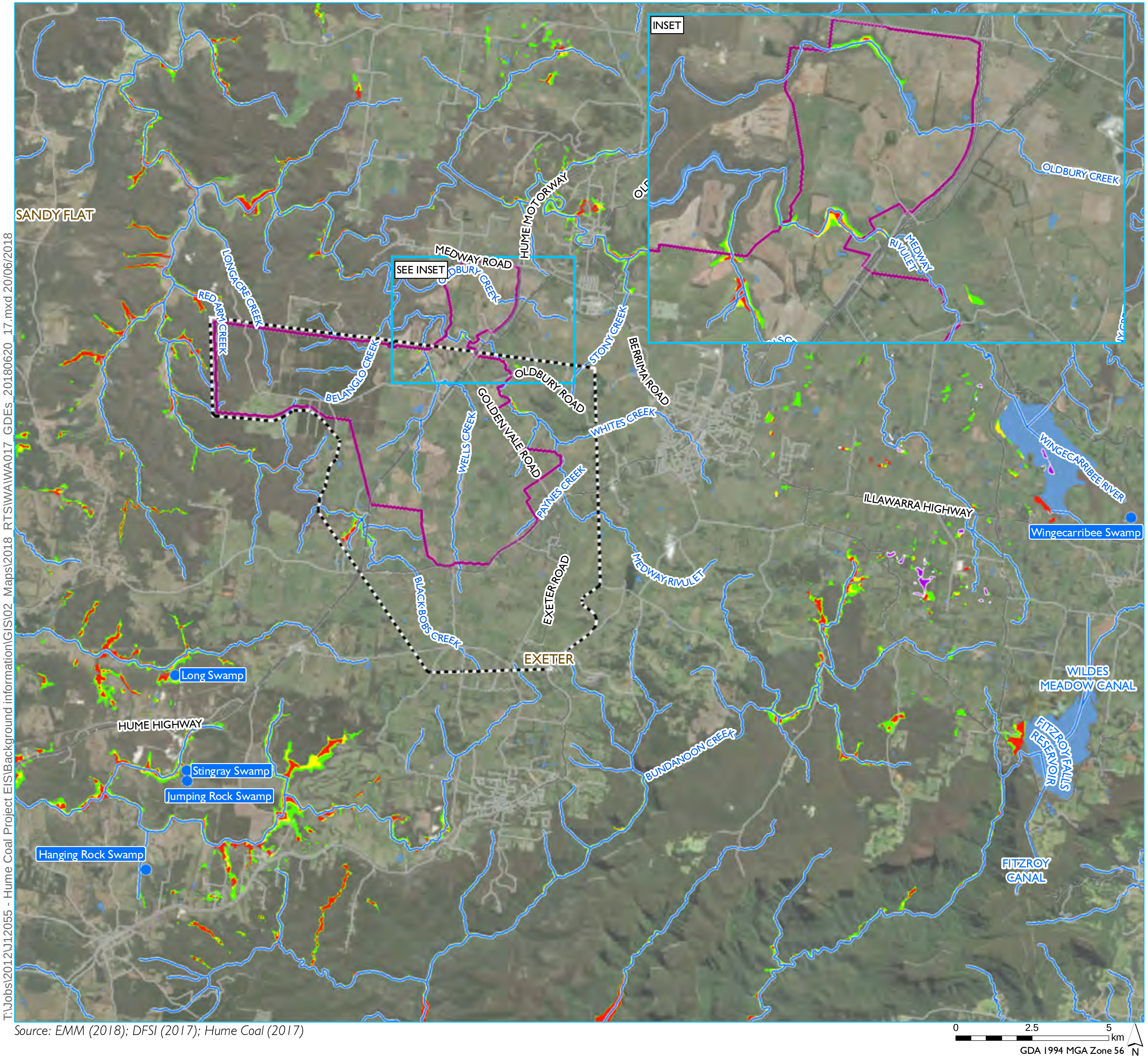
Terrestrial vegetation potentially overlies shallow groundwater (0– 10 mbgl) in some places in and around the project area, mainly along rivers and creeks. These include Medway Rivulet, Wells Creek, Belanglo Creek, Longacre Creek and Red Arm Creek. Six of the native vegetation types in the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c) study area occur where groundwater is less than 10 m deep and, therefore, have potential to access groundwater sporadically at these locations. One of these, namely Broad-leaved Peppermint Argyle Apple grassy woodland, contains the endangered Paddys River Box. Terrestrial vegetation also overlies shallow groundwater to the south of the project area, along Bundanoon Creek, and to the north along the Wingecarribee River (Figure 6.24).

None of these ecosystems described above have a facultative (highly dependent) dependence or are entirely dependent on groundwater.

An assessment of the aquatic fauna dependency on baseflow is provided in the *Hume Coal Project Biodiversity Assessment Report* (EMM 2017c). Groundwater systems are also discussed in the Aquatic Ecology Assessment; stygofauna living in groundwater systems are entirely/obligate dependence on groundwater.

The groundwater within the project area may support stygofauna endemic to groundwater discharge or groundwater itself (EMM 2017c). Generally, stygofauna biodiversity is highest near the water table and declines with depth from the ground surface, and is also highest in recharge areas (EMM 2017c).

Stygofauna studies undertaken for the project in 2013 and 2014 collected a total of one specimen of aquatic fauna (a crustacean) and three of terrestrial (commonly, an ant, a springtail, and a water strider) from 19 groundwater bores (8 within the project area and 11 outside of the project area) (EMM 2017c). The crustacean was collected from a shallow groundwater monitoring bore (5 mbgl), while the remainder were from three deeper bores (between 78 and 87 mbgl); all four bores intersect the Hawkesbury Sandstone. No stygofauna was found in any of the seven sampled bores that intersect the Illawarra Coal Measures in the project area. No rare or significant stygofauna was identified.



KEY
- Project area
- A349
- Vegetation potentially accessing shallow groundwater (Wingecarribee Shire Council mapping)
  - 0 - 3 mgbl
  - 3 - 5 mgbl
  - 5 - 10 mgbl
- Wingecarribee Shire Council vegetation communities
  - Temperate Highland Peat Swamps (EPBC Act)
- Swamps and important wetlands
- Watercourse
- Waterbody

Source: EMM (2018); DFSI (2017); Hume Coal (2017)

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Ecosystems that potentially rely on groundwater

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Revised Water Assessment
Figure 6.24

7 Site conceptual model

This chapter discusses the conceptual surface water and groundwater model for the project area. The conceptual model brings together the monitoring results and background information to develop an understanding of how the water systems interact with each other and the project.

7.1 Introduction

The hydrological conceptual model provides a schematic illustration of the various interacting components of the hydrological cycle. It includes the groundwater systems, surface water systems, flow paths, recharge and discharge mechanisms, and the interaction between these various hydrological components and geological units. It forms the basis for developing the numerical groundwater flow model.

The conceptual model is based on the information presented in Chapters 5 and 6 and is shown in Figure 7.1.

7.2 Conceptual model components

- Rainfall evaporation and evapotranspiration:
  - high average annual rainfall (approximately 960 mm/yr);
  - evaporation exceeds rainfall, on average, from September to March (pan evaporation 1,264 mm/yr); and
  - evapotranspiration from vegetation.
- Drainage lines:
  - most drainage lines in the project area are confined valley settings with occasional floodplains; and
  - upper reaches have low flow energy.
- Surface water use:
  - town water supply via storages (including Medway Reservoir, although not being used);
  - landholder diversion pumps and storages for licensed water supply, mostly for irrigation;
  - basic landholder rights (harvestable rights dams/riparian access for stock and domestic supply); and
  - harvestable rights dams for irrigation.

- Geological setting:
    - negligible alluvium in the project area, minor alluvium present along the upstream Wingecarribee River;
    - surface geology is dominated by Triassic sedimentary units: Hawkesbury Sandstone (west) and Wianamatta Group (Ashfield Shale) (east);
    - Hawkesbury Sandstone is a regionally continuous, porous and fractured flat-lying sandstone between 50–120 m thick in the project area;
    - the older Triassic Narrabeen Group disconformably underlies the Hawkesbury Sandstone and was eroded over the project area, but is present to the north of the project area;
    - Permian Illawarra Coal Measures (ICM) contains the mining target, Wongawilli Coal Seam;
    - outcrop of ICM occurs where watercourses have incised through the Hawkesbury Sandstone in the west;
    - the older Permian Shoalhaven Group is about 100 m thick and overlies Palaeozoic basement;
    - stratigraphy regionally dips to the east and has few structural features;
    - faults that have been inferred have small displacement (5–10m), with the exception of the Cement Works Fault north of the project area;
    - there are numerous igneous intrusions, including dykes and diatremes, assumed to be Jurassic; and
    - Tertiary Robertson Basalt overlies the Wianamatta Group (Ashfield Shale) in the south.
- Groundwater systems
    - localised, low permeability, unconfined groundwater systems are present in Robertson Basalt and Wianamatta Group (Ashfield Shale) (insert D in Figure 7.1);
    - the Wianamatta Group (Ashfield Shale) acts as a regional aquitard (retarding downward flow into the Hawkesbury Sandstone);
    - groundwater in the basalt is typically low yielding (unless localised fractures are intercepted), and quality is fresh;
    - groundwater in the shale is typically poor quality and low yielding;
    - the Hawkesbury Sandstone contains the major groundwater system in the region; groundwater is typically fresh and bore yields range from low to high; and
    - low permeability water bearing zones in the ICM and Shoalhaven Group generally restrict groundwater flow.

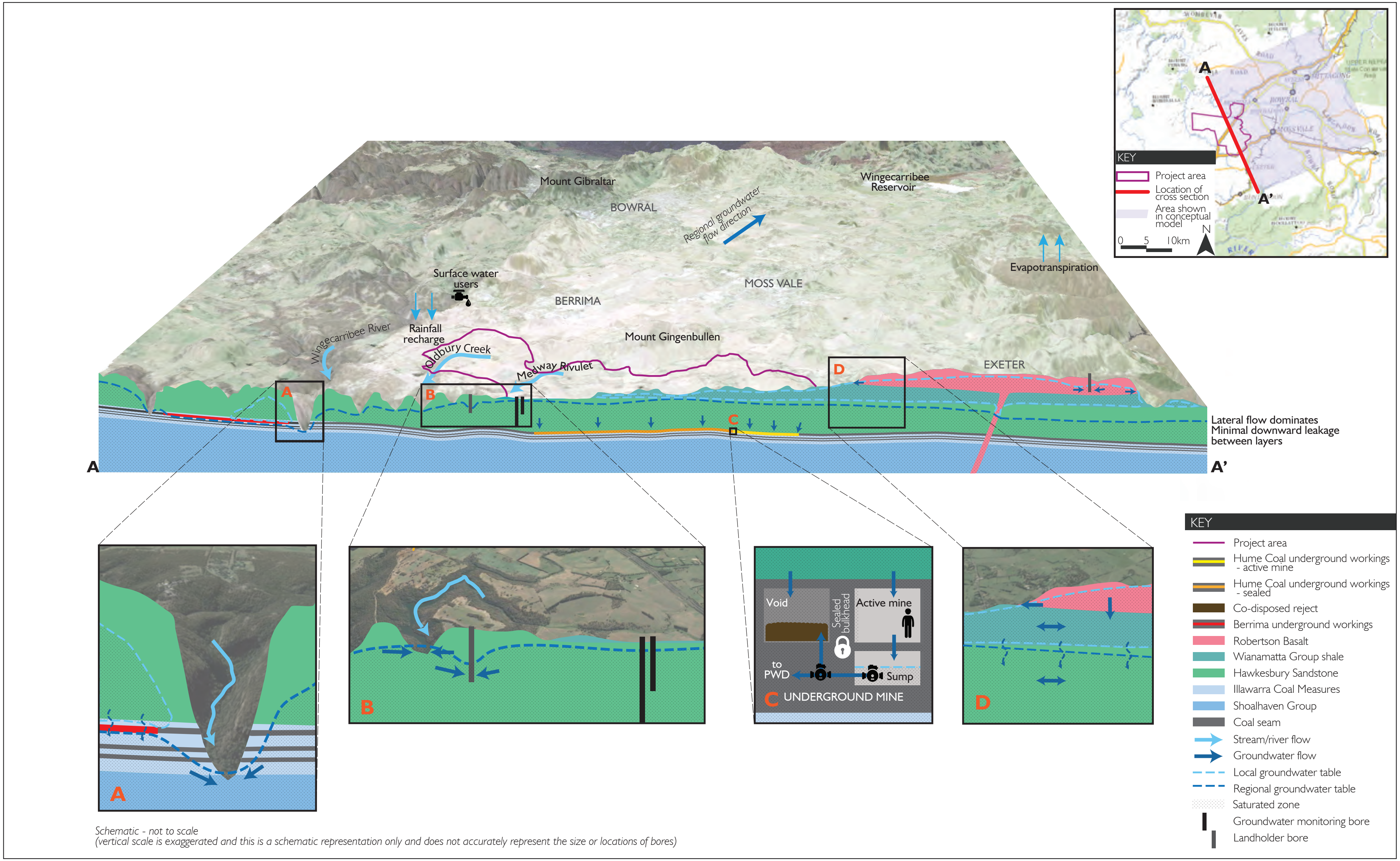
- Recharge:
  - average rainfall recharge is modelled as about 2% of annual rainfall;
  - rainfall recharge occurs mostly where Hawkesbury Sandstone and Robertson Basalt are exposed at the ground surface;
  - minor recharge occurs where Ashfield Shale outcrops; minor recharge to Ashfield Shale also occurs from overlying basalt, where present; and
  - recharge to Hawkesbury Sandstone is mostly from direct rainfall on outcrop and only very minor volumes are from overlying shale, where present.
- Groundwater discharge:
  - drainage to surface water (baseflow) – the largest discharge component;
  - extraction from landholder bores (insert B in Figure 7.1);
  - evaporation from water table, where shallow, and from surface water features;
  - evapotranspiration;
  - seepage/springs and evaporation along escarpments (insert A in Figure 7.1). Spring discharge between basalt and underlying Wianamatta Group (Ashfield Shale) (insert D in Figure 7.1);
  - deep drainage into old Berrima Colliery, and subsequently into Wingecarribee River (insert A in Figure 7.1); and
  - regional groundwater through flow in the Hawkesbury Sandstone and ICM is to the south-east.
- Groundwater flow:
  - lateral flow dominates, with minimal downward flow between layers (insert D in Figure 7.1);
  - groundwater flow in Hawkesbury Sandstone is via dual porosity: pores and minor structural features (fractures, joints, bedding planes);
  - regional flow influenced by stratigraphic dip and topography, generally towards the east;
  - minor localised flow to the north and west associated with local topographic gradients; and
  - faults typically do not appear to influence groundwater flow on a regional scale within the project area as demonstrated by long-term pumping tests.

- Groundwater levels:
  - stable hydraulic head regionally;
  - variable influence close to pumping landholder bores; and
  - around Berrima Colliery, significant depressurisation and desaturation as a result of full extraction mining, and continual discharge to the Wingecarribee River.
- Vertical gradients and connectivity:
  - downward trending gradients in the north-western part of project area;
  - steep vertical gradients along escarpments and seepage faces, where discharge occurs;
  - the top of the Hawkesbury Sandstone is often unsaturated, both where exposed and where it underlies the Wianamatta Group (Ashfield Shale) (insert D in Figure 7.1);
  - downward vertical gradients between the Wianamatta Group (Ashfield Shale) and the underlying Hawkesbury Sandstone– results in a low consistent groundwater flow from the shale to the sandstone (limited by the low hydraulic conductivity of the shale); and
  - hydraulic connection between Hawkesbury Sandstone and ICM occurs where there is minimal interburden between these units (ie in the west).
- Groundwater use:
  - numerous landholder bores associated with farmland, extract groundwater from the Hawkesbury Sandstone and a smaller number source groundwater from the Robertson Basalt to the south. Most of the bores yields are for stock and domestic use.
- Surface water/groundwater interaction:
  - most streams in the project area are classified as gaining streams with groundwater providing baseflow to streams;
  - some are gaining from the regional groundwater systems and some gaining from shallow groundwater systems (ie in shale and basalt areas) which may be perched and/or disconnected from the underlying regional groundwater system;
  - in some (isolated) locations, streams may provide groundwater to the underlying Hawkesbury Sandstone; and
  - regionally, the volume flux from surface water into groundwater is minor.
- Ecosystems that potentially rely on surface and/or groundwater:
  - there are no high priority GDEs identified within the project area, the closest one is Long Swamp, a temperate highland peat swamp, 7 km to the south;
  - minimal habitat for dense native fauna;

- drainage lines and creeks may provide surface water for in-stream ecosystems during times of flow;
- ecosystems may rely on surface expressions of groundwater at: creeks, where baseflow contribution is significant; springs, along the basalt hills in the south; upland swamps, in the south;
- vegetation root zones may rely on shallow groundwater (<10 mbgl) near some creeks; and
- stygofauna is unlikely to be significant in the area.

• Hume Coal mine / water interaction:

- groundwater inflows to the sump during active mining will be removed to allow mining to continue, and then recycled and reused for mining operations (inflow into sump) (insert C in Figure 7.1);
- groundwater inflow into void areas (inflow into void) (insert C in Figure 7.1). This water is part of the recovery process and remains part of the groundwater source;
- rainfall onto the infrastructure area (disturbed area) is harvested and stored in a series of mine water dams and stormwater basins for use in mining operations; and
- water excess to mining operations is pumped from the primary water dam (PWD) into the void underground (this mitigates depressurisation and drawdown and allows faster recovery of the groundwater system).



Schematic - not to scale
(vertical scale is exaggerated and this is a schematic representation only and does not accurately represent the size or locations of bores)

EMM HUMECOAL PROJECT

Conceptual hydrological model

Hume Coal Project
Revised Water Assessment
Figure 7.1

7.3 Surface and groundwater connectivity

AR 79: A full description of the development including those aspects which have the potential to impact on the quality and quantity of surface and groundwaters at and adjacent to the site, including:

- *the mining proposal and mine layout*
- *the location, mapping and geomorphology of all creeks and water resources overlying and adjacent to the proposed mining area*
- *the hydrogeological fluxes between surface and groundwaters, including the filling of pine feather voids*
- *the location, management and storage of all hazardous materials- the disposal of wastes from the treatment of mine waters in the mine water treatment plant*
- *the management of dirty water from the washing and preparation of coal for transport*
- *the location, sizing and description of all water quality management measures*
- *the location and description of all water monitoring points (surface and ground waters)*
- *on-site domestic (sewage) wastewater management*

7.3.1 Existing situation

The water assessment for both groundwater and surface water has specifically considered and focused on understanding groundwater and surface water interconnectivity, and changes to this relationship as a result of the project.

The majority of the streams in the area are (in time and location) gaining systems. That is, the water table is at a higher elevation than the stream stage, and therefore groundwater supplies baseflow to streams. Some are gaining as a result of shallow groundwater which may also be perched and/or disconnected to the underlying regional groundwater system. In systems that are gaining from a perched or disconnected shallow groundwater system, a reduction in the deeper regional groundwater systems will not impact on the baseflow contribution to the overlying stream.

Streams gaining from the regional groundwater systems are noted in the western part of the project area, where surface spring flows directly from the sandstone escarpments to the nearby surface water creeks can be observed.

7.3.2 Situation during mining

During the project’s operation, the gaining streams mostly remain as gaining streams. A small percentage of gaining streams will experience slightly decreased levels of baseflow contribution compared to the pre-mining conditions (this may occur in those streams gaining from the regional groundwater system). Streams gaining from perched or shallow systems are unlikely to be impacted.

The overall reduction of baseflow is considered insignificant and the volumes and timeframe for this interception is presented in Sections 10 and 11. Therefore, shallow groundwater baseflow continues to be provided to streams, even at the maximum water table drawdown due to mining in year 17.