HANCOCK PROSPECTING PTY LTD

Alpha Coal Project Environmental Impact Statement

12 Groundwater

Section 12 Groundwater

12.1 Introduction

Hancock Prospecting Pty Ltd (HPPL) (the Proponent) proposes to establish an open cut coal mine within the Galilee Basin, Central Queensland, to service international export energy markets for thermal coal. The groundwater environment associated with the mine component of the proposed Project is discussed in this section. A detailed groundwater technical report is included in Volume 5, Appendix G of the Environmental Impact Statement (EIS).

12.2 Tenure

The Alpha Coal Project (Mine) (the Project) coal tenements are situated approximately 50 km north of Alpha and 420 km west of Rockhampton. The mine is located within mining lease application (MLA) 70426. The Proponent currently holds two mining development licences (MDLs), 333 and 285, in the Galilee Basin and has an exploration permit coal (EPC 1210) adjacent to these two MDLs.

The location of MLA 70246, relative regional geological basins, and major towns are shown in Figure 12-1.

12.3 Legislative Background

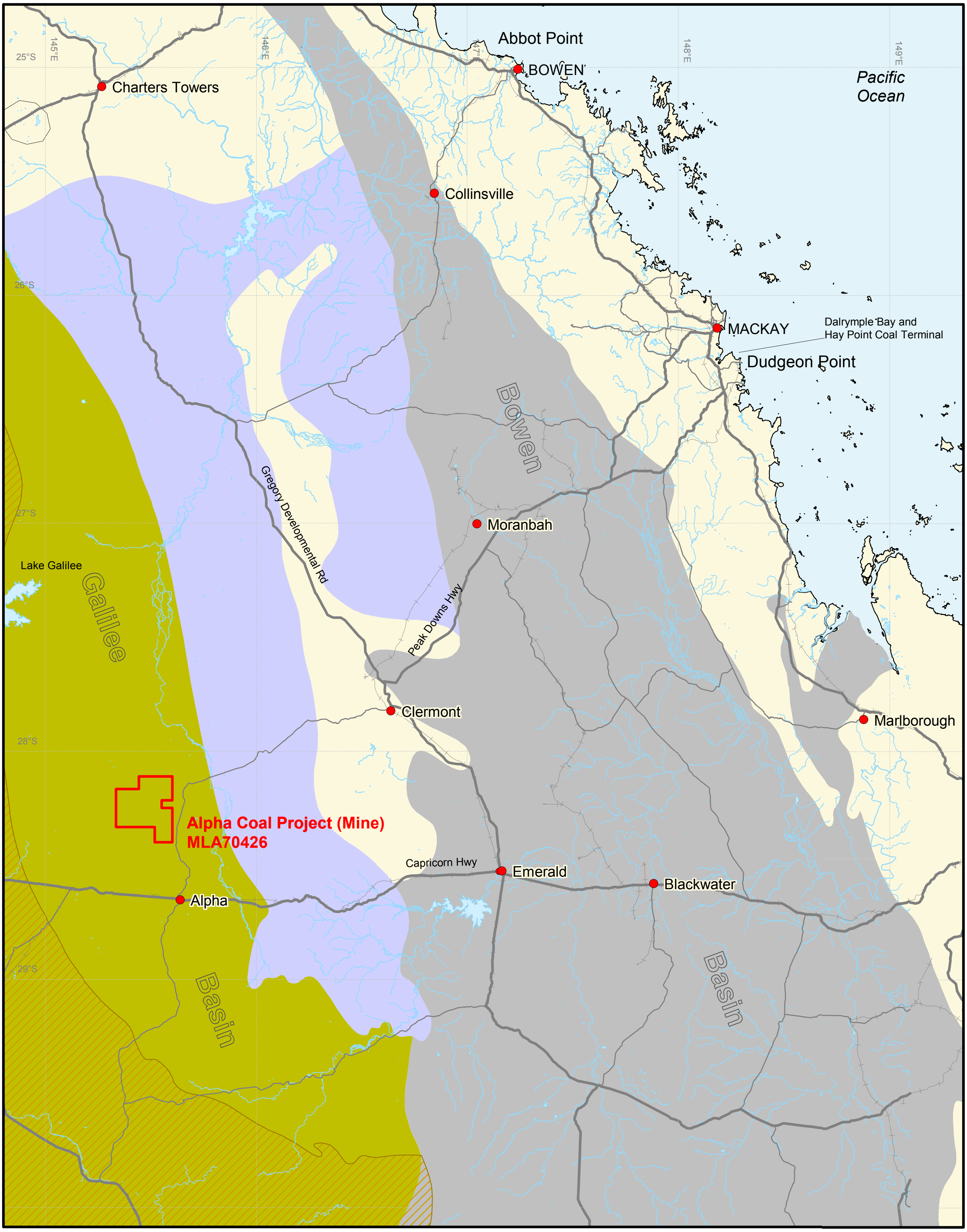
The *Water Act 2000* (Water Act) is the key piece of legislation that regulates the interference with, and extraction of, groundwater in Queensland.

The Project is located within the Highlands declared subartesian area, where authority is required to take or interfere with subartesian groundwater for any purpose other than stock or domestic use.

Other legislation which relate to groundwater resources include:

- The Environmental Protection (Water) Policy 2009 (EPP [Water[), which applies to all water in Queensland, and provides a framework for defining the environmental value of water and guidelines for water quality. The policy aims to protect water to designated environmental values;
- *Sustainable Planning Act 2009*, which promotes development based on the concept of ecological sustainability; and
- *Environmental Protection Act 1994* (EP Act), which promotes ecologically sustainable development, and has the stated objective “to protect Queensland’s environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends”.

The Project is also located within the area covered by the Water Resource (Burdekin Basin) Plan 2007 (WRP). The western boundary of the WRP in the Project area is the Great Dividing Range. The WRP has no direct bearing on groundwater resources in the Project area.



Mining Lease Application (MLA70426) Boundary

SEDIMENTARY BASINS
- Galilee
- Bowen
- Drummond
- Eromanga

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 25 50km
Scale 1:2 500 000 (A4)
Datum: GDA94, MGA Zone55

N W E S

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

GALILEE BASIN,
CENTRAL QUEENSLAND

Job Number 4262 6580
Revision A
Date 24-09-2010

Figure:12-1

File No: 42626580-g-2066.wor

12.4 Environmental Values

For the purpose of this EIS, groundwater and surface water resources were assessed to have the following Environmental Values (EV's):

- Agricultural purposes - groundwater in the Project area is used predominantly for stock watering supply, and based on current usage patterns, groundwater has an environmental value of agricultural purposes, specifically watering of beef cattle and horses;
- Cultural and spiritual values – permanent or semi-permanent surface water features that are maintained to some degree by groundwater flow may have cultural significance in an area where surface water is normally ephemeral. Specific surface water features are discussed in Volume 2, section 11 and in the groundwater technical report Volume 5, Appendix G (Section 8.0); and
- Surface water features (including those that may receive baseflow from groundwater) – surface water sources within and around the Project MLA 70426 are generally accessed by cattle for drinking water supply and in this respect the bed and banks of surface water features are degraded. Based on existing land use and interaction of cattle with waterways, it is interpreted that surface water features in the area would have an EV applicable to moderately disturbed waters.

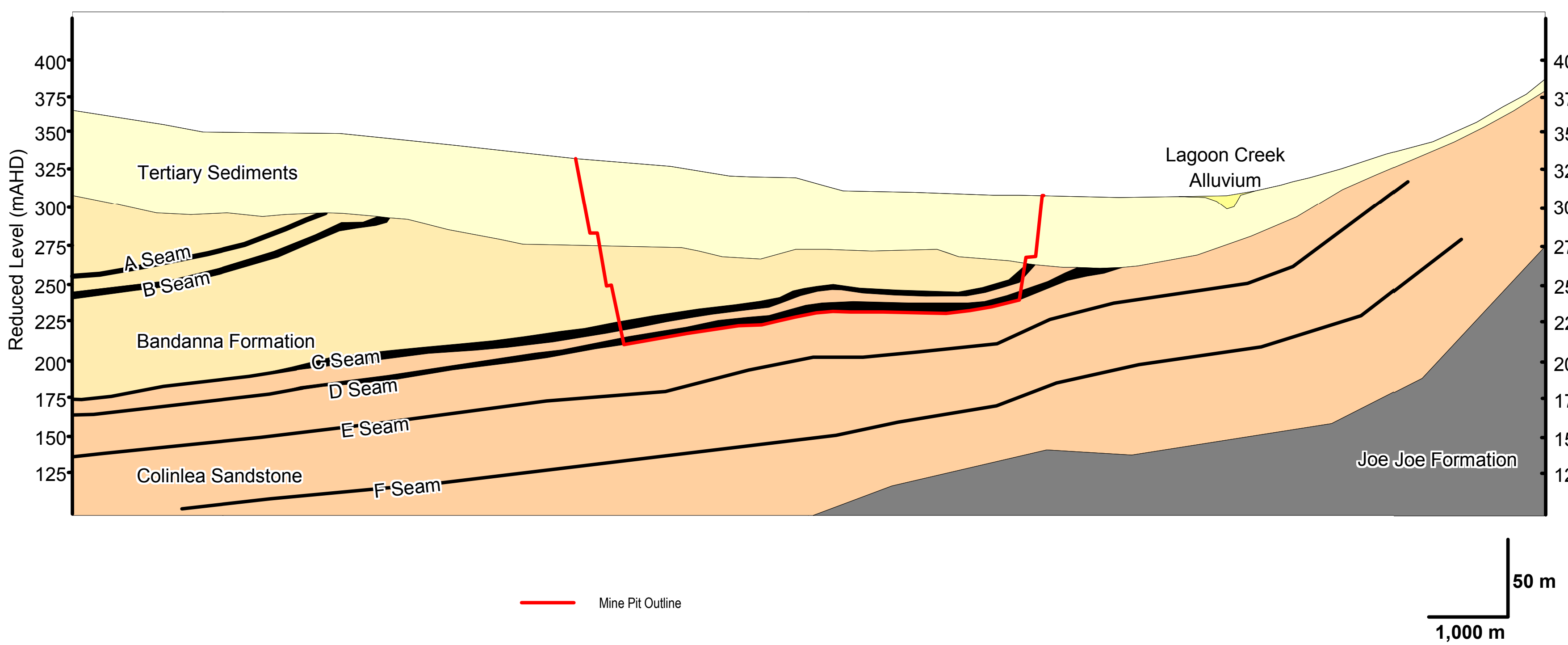
As discussed in Section 12.8.8, while groundwater in the area may be potable in some instances based solely on total dissolved solids (TDS) values, groundwater can be above drinking water guideline values for metals and metalloids, and generally is not suitable for drinking water consumption without complex treatment. For this reason groundwater in the area is not assessed to have an EV of drinking water.

12.5 Regional and Site Geology

The regional and site geology is presented in Volume 2, Section 4. The hydrostratigraphy of the Project site is discussed below.

12.6 Hydrostratigraphy

The Alpha Coal Project (Mine) deposit lies on the eastern side of the Galilee Basin. The geology consists of gently westerly dipping (generally <1º dip) sediments of Permian age, overlain by Tertiary and Quaternary sediments. Both historical and recent borehole data shows that the thickness of Tertiary and Quaternary sediments varies from greater than 60 metres (m) to less than 20 m in places. In addition to the Tertiary and Quaternary sediments, a variable thickness of weathered Permian material is also commonly present. Figure 12-2 presents a schematic cross-section through sediments and the coal seams mapped on site. The stratigraphy of the Project area, including a summary of the aquifer types encountered at site, is shown in Table 12-1.



Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

SCHEMATIC SECTION

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure:12-2

Datum: GDA94, MGA Zone55

File No: 42626580-g-2056.wor

Table 12-1: Site Stratigraphy and Aquifer Types

Era	Period	Lithology	Stratigraphic Unit	Thickness	Aquifer Type
Cainozoic	Quaternary	Alluvium		15-20 m	Unconfined
	Tertiary	Argillaceous sandstones and clays		40 m	Unconfined
	Unconformity				
	Triassic	Green brown-purple mudstone, siltstone and labile sandstone	Rewan Formation	18 m	Confining unit – base of hydrogeological Great Artesian Basin (GAB) – occurs to west of MLA
	Late Permian	Sandstone	Bandanna Formation	10–30 m	Unconfined to semi-confined
		Coal seam A. Seam contains thin dirt bands that thicken from south to north.		1–2.5 m	Unconfined to semi-confined
		A-B sandstone. Labile sandstone, siltstone and mudstone		10 m	Unconfined to semi-confined
		Coal seam B. Seam contains numerous dirt bands that constitute between 15 and 30% of seam. Variable in quality.		6–8 m	Unconfined to semi-confined
		B-C sandstone. Labile sandstone, siltstone and mudstone		70–90 m	Semi-confined to confined
		Coal seam C. Coal seam thins northward and splits apart	Colinlea Sandstone	2–3 m	Confined
		C-D sandstone. Labile sandstone, siltstone and mudstone		5–20 m	Confined aquifer
		Coal seam D. Stone bands present with seam thickening westward, upper section splits off main seam to north west		4.5–6 m	Confines underlying D-E sandstone
		D-E sandstone. Labile sandstone, siltstone and mudstone		15 m	Confined aquifer
		Coal seam E. Thin (0.2 m) clean coal bands, usually 2 bands E1 & E2		0.1 – 0.4 m	Leaky confining layer
		Sub-E sandstone. Labile sandstone, siltstone and mudstone		15 – 20 m	Confined aquifer
		Coal seam F. Localised thick geological section, no working section		0.5 – 5 m	Leaky confining layer
		Sub-F sandstone. Labile sandstone, siltstone and mudstone		Unknown	Confined aquifer
	Early Permian	Labile and quartz sandstone	Undefined	Transition to Joe Joe Formation	

12.6.1 Permian Deposits

Permian sedimentary deposits at site comprise the Bandanna Formation and the underlying Colinlea Sandstone. These units contain both economic and sub-economic coal seams. The coal seams are named alphabetically A through F, with the A seam being uppermost. There are two major coal seams that will be the target of mining within the deposit; the C seam and D seam, which vary in thickness from 2 to 6 m in the area to be mined. The overlying A and B coal seams will not be the target of mining by the Project, as the western limit of the proposed open cut does not extend to include these seams (refer Figure 12-2).

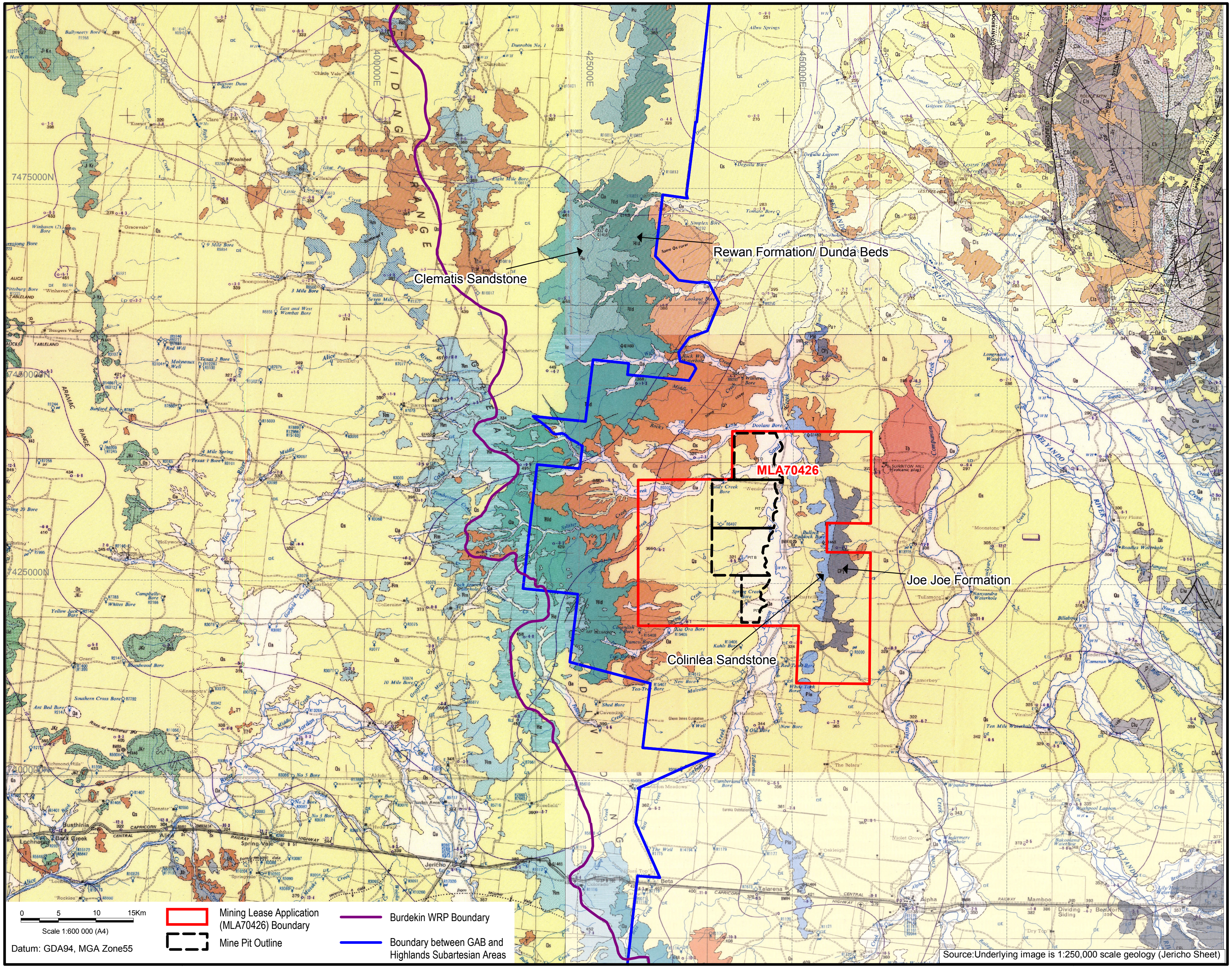
Geologically (for this EIS) the boundary between the Bandanna Formation and the underlying Colinlea Sandstone is taken to be an interval above the C coal seam at which sedimentation style changes from increasingly argillaceous (i.e. becoming more clayey with depth) to increasingly arenaceous (i.e. becoming more sandy with depth). Thus the Bandanna Formation hosts the A and B coal seams, while the Colinlea Sandstone hosts the target C and D coal seams (Figure 12-2).

From a groundwater perspective, major hydrostratigraphic boundaries occur within MLA 70426 at the base of weathering, beyond which groundwater is often encountered under confined conditions in the B-C sands, C-D sands, and B and C coal seams, and also at the base of the D coal seam. It has been observed during exploration drilling that groundwater inflows are relatively low until the D coal seam is drilled through, at which point higher rates of groundwater flow are often encountered. The sandstone unit directly below the D coal seam and above the E coal seam (D-E Sandstone) will be the major target of aquifer depressurisation, and the overlying sediments (B-C sandstone, C-D sandstone, and C and D coal seams) will need to be locally dewatered in order for mining to occur safely.

Below the D-E sandstone the Colinlea sandstone coarsens with increasing depth. The sub-E sandstone (between the E and F coal seams) and sub-F sandstone (below the F coal seam and to the base of the Colinlea Sandstone) are regarded as containing significant groundwater resources. Seepage modelling undertaken to date (refer Section 12.9.1) indicates that the sub-E and sub-F sandstones will not require active depressurisation.

The Colinlea Sandstone is in turn underlain by sediments of the Joe Joe Formation. The Jericho 1:250,000 scale geological map (Bureau of Mineral Resources, 1973) describes the Joe Joe Formation as “mudstone, labile sandstone, siltstone, shale” and on this basis the Joe Joe Formation is interpreted to be a confining unit below the Colinlea Sandstone aquifer.

The surface geology of the Project site and surroundings are shown in Figure 12-3. The figure shows the outcrop of the Rewan Formation (base of hydrogeological Great Artesian Basin [GAB]), Colinlea Sandstone, and Joe Joe Formation. The boundary of the WRP area (Figure 12-3) is defined as the surface water divide (the Great Dividing Range) where flow is to the west into the Coopers Creek catchment (GAB catchment and GAB intake beds), and flow occurs to the east into the Burdekin Basin catchment. Additional information is included in Volume 5, Appendix G of this EIS.



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HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

SURFACE GEOLOGY AND BOUNDARY OF GAB AND BURDEKIN WRP

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure:12-3

File No: 42626580-g-2057.wor

Relationship to the GAB

The boundary of the hydrogeological GAB (outcrop of Rewan Formation) occurs outside the MLA 70426 boundary and approximately 10 - 15 km west of the western limit of mining (refer Figure 12-3). The Rewan Formation is an aquitard and is the basal confining unit to the hydrogeological GAB.

The potential for the Project to impact the groundwater resources of the GAB is regarded as remote, as drawdown would be required to transfer through approximately 175 m of aquitard with a maximum vertical hydraulic conductivity of 10^{-4} to 10^{-3} m/day. However, the potential is to be investigated as a component of an ongoing regional groundwater modelling study.

12.7 Surface Water Environment

The major surface water drainage feature through the Project is Lagoon Creek, which drains from south to north through MLA 70426 (Figure 12-4). Major systems, which drain the site from west to east toward Lagoon Creek (i.e. from the eastern foothills of the Great Dividing Range) include Spring Creek and Sandy Creek. Drainage from the east of the MLA 70426 occurs from a low unnamed range that comprises the outcrop of the Colinlea Sandstone and underlying Joe Joe Formation (refer Figure 12-3 for site geology). Drainage from this range is to the west toward Lagoon Creek, and to the east (at the eastern margin of the MLA 70426) toward Native Companion Creek.

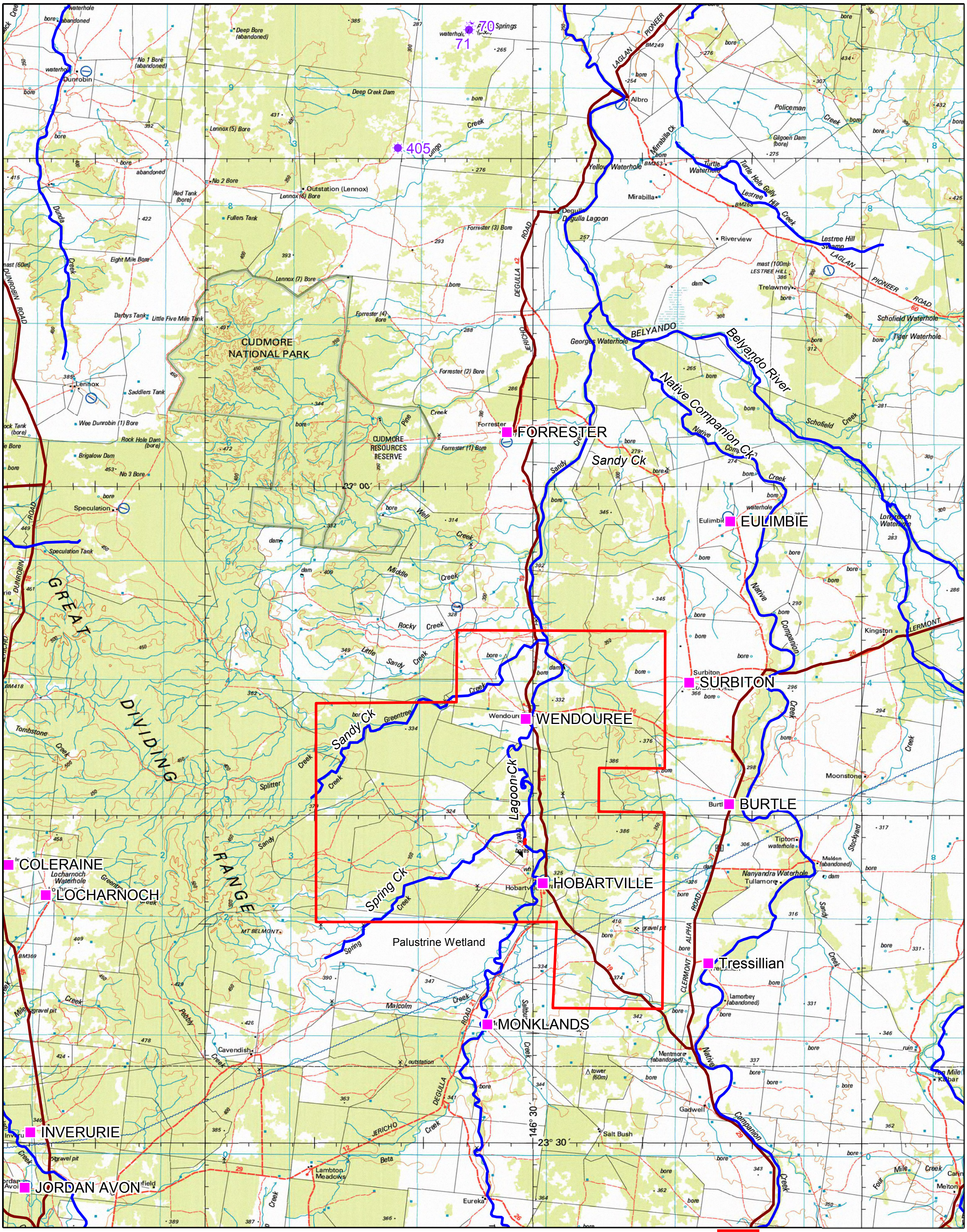
At the confluence of Lagoon Creek and Sandy Creek the drainage system continues north (as Sandy Creek) until joining the Belyando River, which in turn drains to the Suttor River, and ultimately to the Burdekin River.

Other surface water features shown on Figure 12-4 include:

- An area of palustrine wetland, which is interpreted to be a perennial water feature, and which will be monitored to establish whether the feature is groundwater dependent; and
- The location of registered springs as defined by Springs of Queensland[1]. The nearest of these springs to the boundary of the MLA 70426 is spring reference no. 405, which is located just over 40 km from the boundary of the MLA 70426.

Volume 2, Section 11 (surface water) provides a detailed description of the existing surface water environment on the Project site. Additional surface water information is also available in the EIS surface water technical reports, Volume 5 Appendix F.

[1] Springs of Queensland version 4.0, Aug 2005, http://www.epa.qld.gov.au/wetlandinfo/site/factsfigures/springs.html



Mining Lease Application (MLA70426) Boundary

Location of Homestead

Location and reference number of springs. Source: Springs of Queensland version 4.0, Aug 2005

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 5 10Km

Scale 1:400 000 (A4)

Datum: GDA94, MGA Zone55

N W E S

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

SURFACE WATER FEATURES

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure: 12-4

File No: 42626580-g-2058.wor

12.8 Existing Groundwater Environment

12.8.1 Groundwater Investigations

12.8.1.1 Previous Investigations

Prior to the current phase of groundwater investigations there have been at least three phases of groundwater investigation undertaken on the parcel of land now described as MLA 70426. These phases of investigation include:

Phase 1 – Surface water, groundwater, and geotechnical investigations by Australian Groundwater Consultants (AGC) for Bridge Oil Limited, during 1982-1983. In summary, these investigations provided:

- Information from the drilling of pumping test wells and monitoring bores at four sites (TPB-1 to TPB-4); and
- Information (observations and calculated hydraulic properties) from pumping tests undertaken at four sites (TPB-1 to TPB-4).

Phase 2 – Groundwater and geotechnical investigations undertaken by Longworth & McKenzie during 1984 for Bridge Oil Limited. In summary, these investigations provided:

- Information from the drilling of pumping test wells and monitoring bores at one site, with pumping wells developed in vertically separated aquifer systems. Pumping test bores included bore W1 which was constructed within “aquifer 1” (this covers an interval including the C and D coal seams and interburden); and bore W2 which was constructed within “aquifer 2” (the sandstone aquifer between the D and E coal seams); and
- Information (observations and calculated hydraulic properties) from pumping tests undertaken on bores W1 and W2.

Results from these pumping tests are summarised in Table 12-2 and Table 12-3. The location of groundwater investigation and monitoring bores is shown in Figure 12-5.

Table 12-2: Summary of Pumping Tests

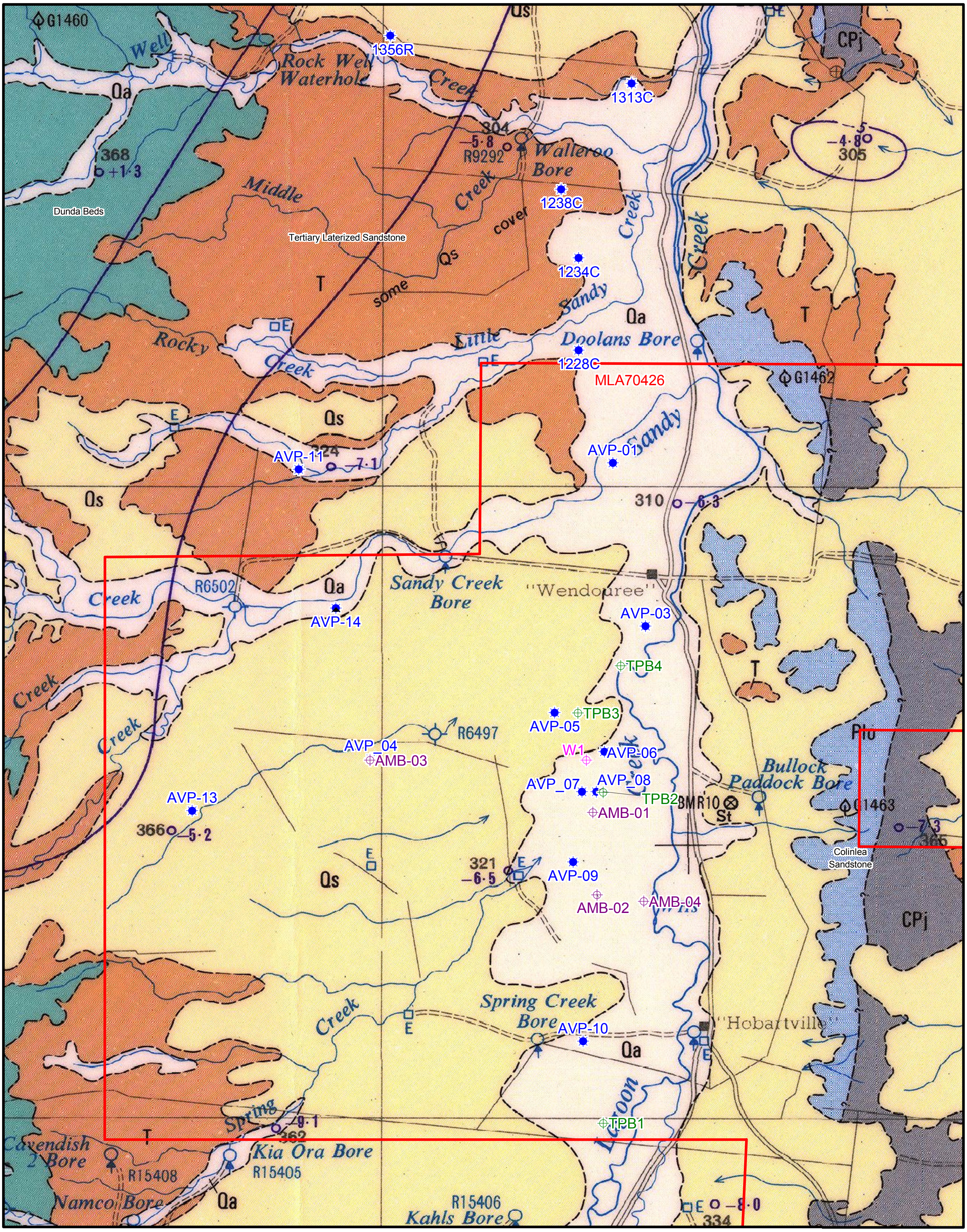
Bore	Test Duration	Interval Tested	Pumping Rate (L/s)	Comments
Testing undertaken by AGC 1982-83				
TPB-1	100 hr	D-E Sands	10	37 m of drawdown in pumping bore. Water level drawn down to base of top screens.
TPB-2	24 hr	D-E Sands	3.6	At a pumping rate of 10 L/s the water level dropped to the pump intake. Testing continued at 3.6 L/s. Drawdown during test was 55 m in the pumping bore.
TPB-3	100 hr	C-D Sands	10	19 m of drawdown in pumped bore. Water level almost down to top of aquifer.
TPB-4	100 hr	D-E Sands	6	44 m of drawdown in pumped bore. Water level drawn down within the aquifer.
Testing undertaken by Longworth & McKenzie 1984				
W-1	48 hr	C-D Sands	0.1	Bores W-1 and W-2 were constructed at the same location, but were screened within separate aquifers. W-1 was constructed within “Aquifer 1” (C-D Aquifer of AGC reports), while W-2 was constructed within “Aquifer 2” (E Aquifer of AGC Reports) 5.5 m of drawdown in pumped bore.
W-2	380 hr	D-E Sands	1.03	34.27 m of drawdown in pumping bore.

Table 12-3: Aquifer Hydraulic Properties from Pumping Tests

Pumping Test Bore	Bore Monitored	Distance from Pumped Bore (m)	Unit	Analysis Method	Transmissivity (T) (m^2/day)	Aquifer thickness (m)	Hydraulic Conductivity (K)		Storage Coefficient
							(m/d)	(m/s)	
AGC (1983)									
TPB1	TPB1	0	D-E Sandstone	Jacob	41.6	24	1.73	2.01E-05	-
				Jacob Late Stage	23.2	24	0.97	1.12E-05	-
				Recovery	29.1	24	1.21	1.40E-05	-
	B597	10.05	D-E Sandstone	Jacob	43.9	30	1.46	1.69E-05	4.80E-05
				Jacob Late Stage	30.4	30	1.01	1.17E-05	4.70E-04
				Recovery	29.8	30	0.99	1.15E-05	-
	B593	260	D-E Sandstone	Jacob	42.7	24	1.78	2.06E-05	3.60E-05
				Jacob Late Stage	28.4	24	1.18	1.37E-05	4.65E-05
				Recovery	28	24	1.17	1.35E-05	-
	B591	572.5	D-E Sandstone	Jacob	42	28	1.50	1.74E-05	1.26E-04
				Recovery	65.3	28	2.33	2.70E-05	-
				Average - Jacob			1.56	1.80E-05	7.00E-05
				Average - Jacob late stage			1.20	1.39E-05	2.58E-04
				Average - Recovery			1.43	1.66E-05	-
TPB2	TPB2	0	D-E Sandstone	Jacob	2.8	16	0.18	2.03E-06	-
				Recovery	4.7	16	0.29	3.40E-06	-
	B538	20.03	D-E Sandstone	Jacob	5.3	16	0.33	3.83E-06	6.60E-05
				Jacob	2.8	16	0.18	2.03E-06	-

Pumping Test Bore	Bore Monitored	Distance from Pumped Bore (m)	Unit	Analysis Method	Transmissivity (T) (m^2/day)	Aquifer thickness (m)	Hydraulic Conductivity (K)		Storage Coefficient
							(m/d)	(m/s)	
				Average - Jacob			0.25	2.93E-06	6.60E-05
				Average - Recovery			0.27	3.15E-06	
TPB3	TPB3	0	C-D Sandstone	Recovery	6.5	20	0.33	3.76E-06	
	B506	21.35	C-D Sandstone	Jacob	5.6	20	0.28	3.24E-06	1.10E-03
				Recovery	5.4	21	0.26	2.98E-06	
				Average			0.30	3.50E-06	1.10E-03
TPB4	TPB4	0	D-E Sandstone	Jacob	10.3	32	0.32	3.73E-06	
				Recovery	9.8	32	0.31	3.54E-06	
	B627	32.9	D-E Sandstone	Jacob	14.8	26	0.57	6.59E-06	1.00E-05
				Recovery	18.3	26	0.70	8.15E-06	
	B191	370	D-E Sandstone	Jacob	16.6	30	0.55	6.40E-06	1.90E-05
				Recovery	15.9	30	0.53	6.13E-06	
				Average - Jacob			0.48	5.57E-06	1.45E-05
				Average - Recovery			0.51	5.94E-06	

Pumping Test Bore	Bore Monitored	Distance from Pumped Bore (m)	Unit	Analysis Method	Transmissivity (T) (m^2/day)	Aquifer thickness (m)	Hydraulic Conductivity (K)		Storage Coefficient
							(m/d)	(m/s)	
Longworth & McKenzie (1984)									
W1	W1	0	C-D Interval	Jacob early time	2.8	24	0.12	1.35E-06	
	P1/1	30	C-D Interval	Jacob early time	4.3	24	0.18	2.07E-06	1.30E-03
	P3		C-D Interval	Jacob early time	2.8	21	0.13	1.54E-06	8.00E-03
				Average			0.14	1.66E-06	4.65E-03
W2	W2	0	D-E Sandstone	Leaky aquifer analysis	4.6	21	0.22	2.54E-06	
	P1/2	30	D-E Sandstone	Leaky aquifer analysis	4.3	15	0.29	3.32E-06	3.20E-05
	P2/2	50	D-E Sandstone	Leaky aquifer analysis	4.3	15	0.29	3.32E-06	3.70E-05
				Average			0.26	3.06E-06	3.45E-05



Source: 1:250,000 scale Geological Map sourced from Geoscience Australia

Mining Lease Application (MLA70426) Boundary	AVP-01 Vibrating Wire Piezometer (VWP) Bore Site with datalogger and rain gauge	1338DG Test Site (AGC 1983)	
	AMB-01 Standpipe Monitoring Bore	W1 Test Site (Longworth & McKenzie 1984)	

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 2 4km
Scale 1:150 000 (A4)

Datum: GDA94, MGA Zone55

N E S W

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

LOCATION OF GROUNDWATER MONITORING BORES

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure: 12-5

File No: 42626580-g-2059.wor

12.8.1.2 Current Investigations

Groundwater investigations and analysis for the current phase of groundwater studies include:

- Vibrating wire piezometer (VWP) monitoring bores have been installed at 17 sites, monitoring 46 vertical intervals within the sub-E sandstone, D-E sandstone, C-D sandstone, B-C sandstone (refer Figure 12- for bore locations);
- Standpipe monitoring bores have been installed at four sites monitoring the sub-E sandstone, D-E sandstone, C-D sandstone (refer Figure 12-);
- Test pumping bores have been installed at three sites. Two bores are constructed within the D-E sandstone, and one bore is constructed within the sub-E sandstone. Pumping test are ongoing;
- Seepage modelling, undertaken to predict inflow rates to the pit, extent of drawdown due to passive drainage, and geotechnical requirements for mine dewatering. Results of modelling are presented in this report;
- Regional numerical finite element (FEFLOW) groundwater modelling is being undertaken to provide prediction of the magnitude and extent of groundwater level impacts from Alpha and Kevin's Corner projects (cumulative impacts);
- Final void modelling, to provide predictions of water levels and long-term water quality (in terms of salinity); and
- Survey of existing groundwater facilities (bore survey) (refer Section 12.8.2.2 below).

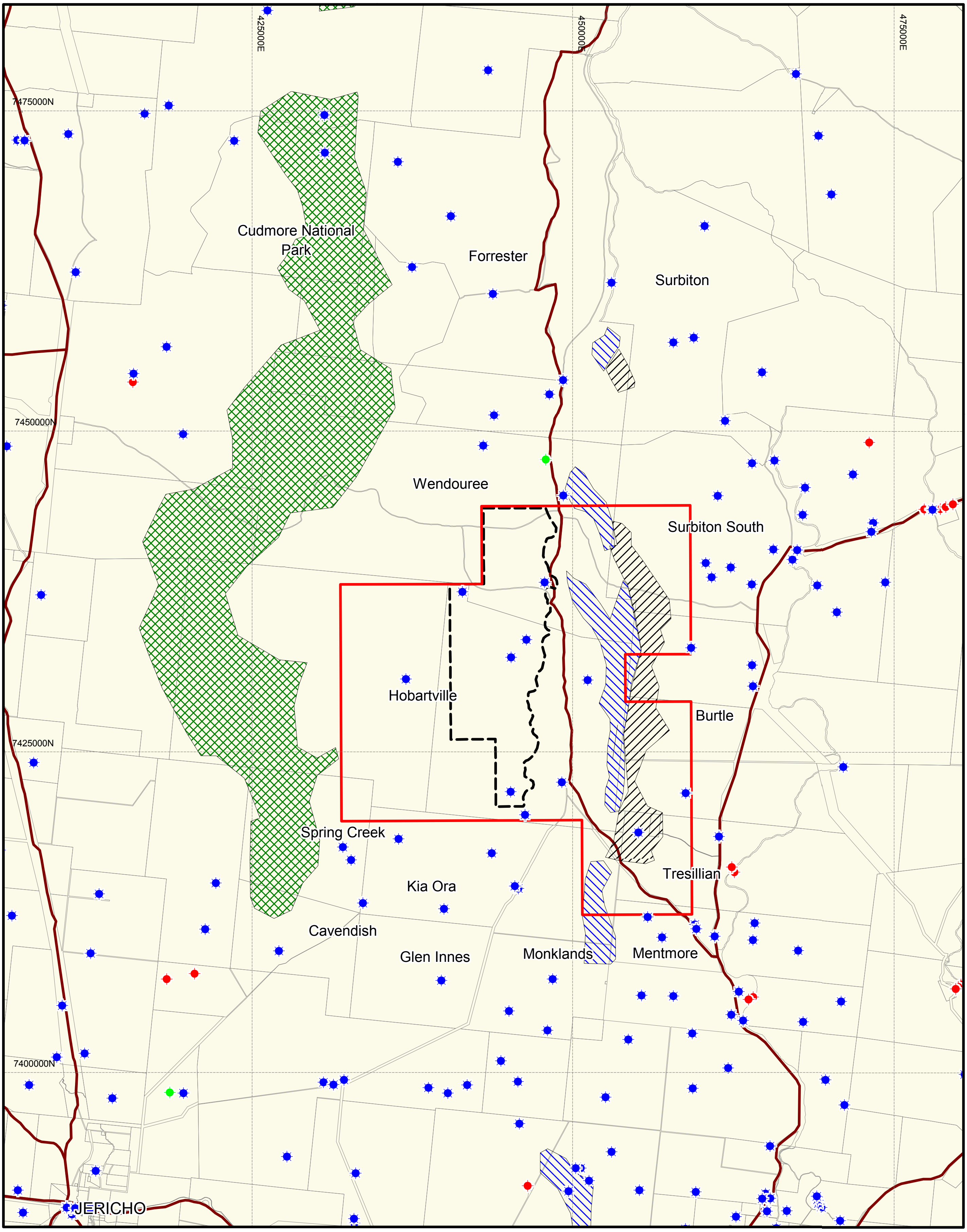
12.8.2 Existing Groundwater Users

12.8.2.1 DERM Groundwater Database

Registered bores from the DERM groundwater database within an area of just over 20 km from the boundary of MLA 70426 are shown in Figure 12-6. The DERM groundwater database has fields to indicate the status of the bores, which includes existing, proposed, abandoned and destroyed, or abandoned but still useable. The database has been filtered to exclude bores that are listed as being abandoned and destroyed, and the remaining bores are colour-coded based on whether they are listed as existing, proposed, or abandoned but still useable.

There are almost 150 registered groundwater bores within the area shown on Figure 12-6. The majority of bores are shown as existing, with approximately 10 listed as abandoned but useable, and 1 listed as proposed. Within 20 km of the edge of the mine pits there are 61 bores listed as existing, 2 listed as abandoned but useable, and 1 listed as proposed.

The number of groundwater bores within the vicinity of the project indicates that groundwater is a resource of some importance in the area.



Status of Groundwater Facility (DERM Database)

- Mining Lease Application (MLA70426) Boundary
- Mining Pit Outline
- Colinlea Sandstone Outcrop
- Joe Joe Formation Outcrop
- Rewan Formation Outcrop
- Existing Bore Hole
- Abandoned but Useable
- Proposed Bore Hole

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 5 10km
Scale 1:400 000 (A4)
Datum: GDA94, MGA Zone55

N W E S

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

PROPERTIES ON WHICH
BORE SURVEY WILL BE UNDERTAKEN

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure: 12-6

File No: 42626580-g-2060.wor

12.8.2.2 Bore Survey

A bore survey is being undertaken on properties adjoining MLA 70426, or within the envisaged impact area of mining. The basis on which properties were selected for the survey was:

- Properties that are wholly west of the Rewan Formation outcrop (aquitard) are excluded based on the interpretation that drawdown impacts will not extend through the aquitard;
- Properties that are wholly east of the Joe Joe Formation outcrop (aquitard) are excluded based on the interpretation that drawdown impacts will not extend through the aquitard; and
- A number of properties in the eastern portion of MLA 70426 are included on the basis that they may be east of the Joe Joe Formation outcrop, but they are still within the MLA, and could be impacted to some degree (i.e. monitoring is required for water quality as well as water level drawdown considerations).

The properties on which a bore survey is proposed to be conducted are shown in Figure 12-6.

Existing Groundwater Use

Based on interviews with landholders to date, it is apparent that the main use for groundwater in the region is for stock supply. Many properties also have a “house bore” and this water is used for domestic purposes. Drinking water supplies are obtained from rainwater tanks, and there is no known properties in the Project area where bore water is used as drinking water supply. Groundwater use will be further established as part of the bore survey. The bore census was scheduled to be undertaken in September and will take several months due to access issues and data collection requirements. The results will be included as an addendum to the hydrogeological technical study report (Volume 5, Appendix G). Information that will be sought during the bore survey includes:

- Bore construction details (diameter, materials, depth, screened interval, aquifer screened, etc.);
- Pump details (pump type, setting depth);
- Bore yield (operating pumping rate);
- Bore usage patterns (frequency and duration of use, purpose of taking water);
- Water level (static water level and operating water level); and
- Water quality.

12.8.3 Potentiometric Surface and Groundwater Flow Direction

A number of VWP bores have been installed at site (as discussed in 12.8.1.2 above), and these bores generally targeted the sandstone below the D seam (i.e. D-E sandstone interval, within the Colinlea Sandstone) as well as sediments above the D seam (typically C-D sands, within the Bandanna Formation) (refer Figure 12-2).

Figure 12-7 shows the potentiometric surface of the D-E sands aquifer (i.e. upper Colinlea Sandstone aquifer) for readings taken in April 2010. Piezometric pressures are higher in the west and southwest of the lease area and lower in the east toward Lagoon Creek, in other words, the potentiometric surface of the D-E sandstone (Colinlea Sandstone) indicates the potential for recharge to the groundwater system is to the south-west of the MLA 70426, and that there is potential for groundwater discharge into Lagoon Creek (refer Section 12.8.5 below).

12.8.4 Groundwater Recharge

12.8.4.1 Rainfall Data

Rainfall and temperature data is sourced from the Bureau of Meteorology (BOM) station at Barcaldine Post Office (Station 036007), located approximately 138 km west of the Project site. Recording of data at Barcaldine Post Office has been occurring from 1886 to present.

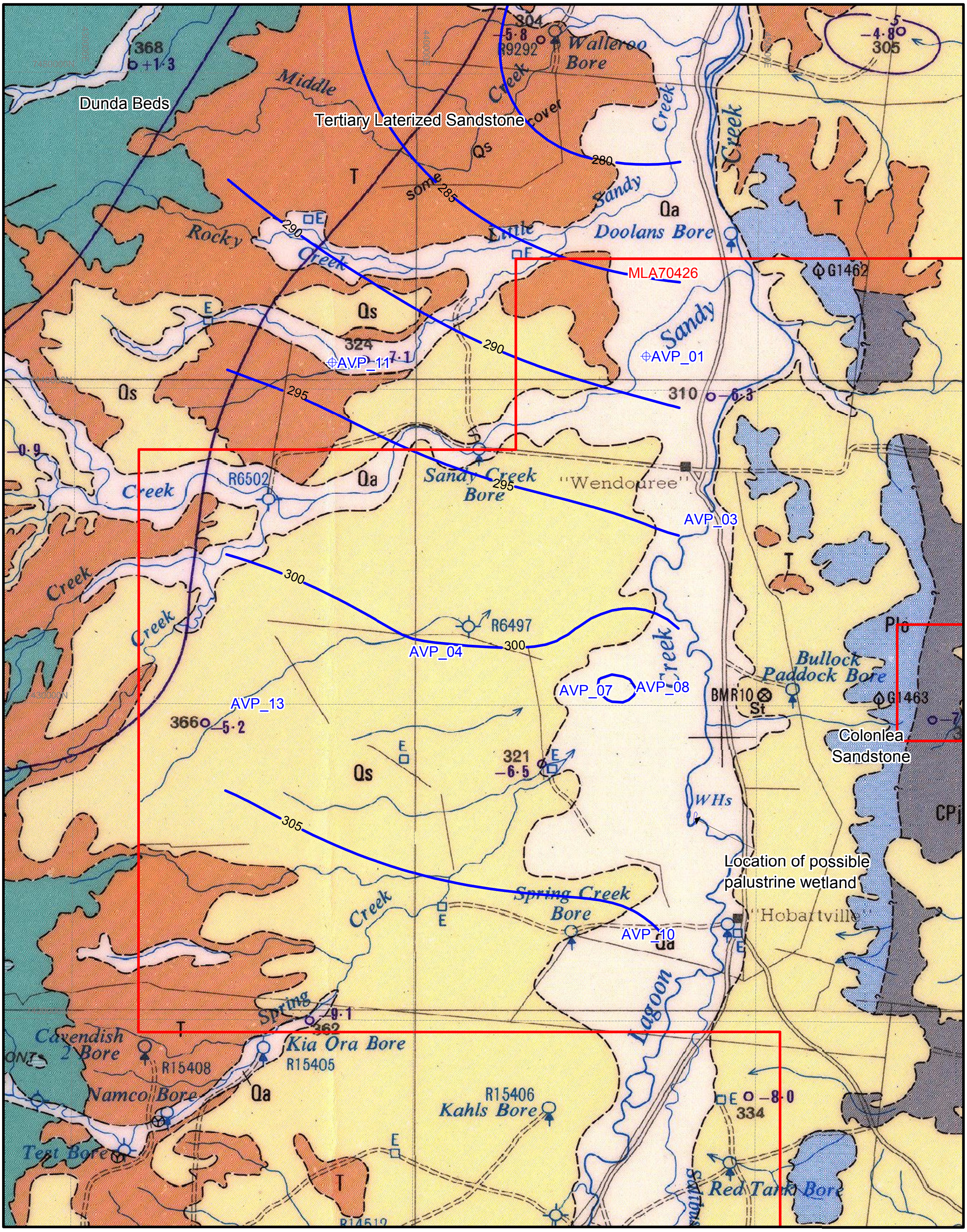
Data trends indicate that mean annual rainfall for the region is approximately 499 millimetres (mm), with the dry season peaking between August and September, and the wet season peaking from December through to February.

12.8.4.2 Rates of Groundwater Recharge

Groundwater recharge is a difficult area of study as recharge does not tend to occur as a percentage of rainfall, and it is recognised that rainfall events of a particular intensity are often required in order for recharge to occur. One reason for this is that the hydraulic conductivity of unsaturated material is low relative to the hydraulic conductivity of the same material when saturated. During rainfall events below a particular intensity water either runs off via the surface drainage system, or is lost through evapotranspiration (resulting in no deep drainage [recharge]).

A study of recharge rates to GAB intake beds was undertaken by Kellett et al, (2003). In line with the process described above, it was concluded that rainfall in excess of 200 mm per month in the area of the intake beds is required before significant recharge events will occur, and diffuse recharge (following “average” rainfall events, occurred at a rate of up to 3mm per year. Based on a rainfall depth at site of approximately 500 mm (refer Section 12.8.4.1 above) 3 mm of rainfall per annum would equate to a recharge rate of approximately 0.6% of annual rainfall.

Two potential recharge mechanisms are proposed, as discussed below.



Source: 1:250,000 scale Geological Map sourced from Geoscience Australia

Mining Lease Application (MLA70426) Boundary

Location of Vibrating Wire Piezometer with datalogger

Water Level Contour (April 2010)

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 2 4km

Scale 1:150 000 (A4)

Datum: GDA94, MGA Zone55

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Alpha Coal Project
Environmental Impact Statement

GROUNDWATER LEVEL CONTOURS
D-E SANDSTONE

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure:12-7

File No: 42626580-g-2061.wor

12.8.4.3 Recharge Mechanism 1 – Direct Recharge to Outcrop Areas

Figure 12-3 shows the geology of the Project area. From this figure it can be seen that the Colinlea Sandstone outcrops in the eastern area of the Project MLA 70426 and, as described above, weathered Colinlea Sandstone occurs at shallow depth between the area of outcrop and Lagoon Creek. Therefore, one possible recharge mechanism is via direct recharge to aquifer units in areas where they outcrop or subcrop (once sufficient rainfall has occurred to increase infiltration). This is the same mechanism by which recharge is assumed to occur within groundwater intake beds of the GAB. The main aquifer that underlies the Project area is the sandstone units of the Colinlea Sandstone. The base of the Colinlea Sandstone is, for the purpose of this groundwater study, the eastern-most extent of Colinlea Sandstone outcrop (Figure 12-3). The top of the Colinlea Sandstone for the purpose of groundwater studies is taken to be the base of D coal seam, and the D floor subcrop line is shown on Figure 12-10. Recharge may therefore occur in this zone from either rainfall recharge or from downward leakage from Lagoon Creek following flow events in the creek. In this recharge model, groundwater recharge enters the Colinlea Sandstone within this outcrop/subcrop area and migrates down-dip (i.e. generally westward).

12.8.4.4 Recharge Mechanism 2 – Diffuse recharge from the Great Dividing Range

Figure 12-3 shows the location of the Great Dividing Range relative to the MLA 70426 (highlighted by the location of the boundary of the Burdekin WRP boundary). The second recharge mechanism that has been considered is that recharge occurs in topographically elevated areas and flows down gradient (i.e. as a subdued reflection of topography) toward surface water drainage features in lower-lying areas. The major surface water drainage feature in the Project area is Lagoon Creek (Figure 12-4).

12.8.4.5 Proposed Recharge Mechanisms

The potentiometric surface contours presented as Figure 12-7 tend to support the second type of recharge mechanism, at least for the D-E sandstone and shallower aquifer system in the vicinity of the Project site.

If this is the case, a groundwater divide (i.e. representing a point at which some groundwater flow is to the west, and some flow is to the east) may exist for the Colinlea Sandstone to the west of the Project site. If this recharge mechanism is dominant, recharge from the area of Colinlea Sandstone outcrop and subcrop may not be as regionally significant as recharge that occurs to the west of the site, as the area to the west of the site represents a much greater surface area in which recharge could occur. However, it is possible that recharge as described by Mechanism 1 may be important for deeper units within the Colinlea Sandstone aquifer.

The above interpretation is complicated by the fact that the coal units and interburden aquifers crop out in the area of Lagoon Creek, and hydraulic testing data suggests that shallow units to the east are confined to semi-confined. Therefore, depending on surface water levels in Lagoon Creek, it is possible that the interburden aquifers are periodically recharged by Lagoon Creek (i.e. under flood conditions) and that the groundwater flow potential may be reversed under some conditions. However, under "average" dry conditions, it is considered most likely that groundwater recharge occurs to the west of the site, and that groundwater flow will be from elevated topographic areas toward Lagoon Creek.

12.8.5 Groundwater Discharge

Groundwater flow contours indicate a groundwater flow direction from topographically elevated areas to the west of site, to the north-north east and toward Lagoon Creek. While groundwater level data is not yet available for the area to the east of Lagoon Creek, it is judged as likely that the potentiometric surface observed to the west of Lagoon Creek will be mirrored on the eastern side of the creek, i.e. the potentiometric contours will vee up Lagoon Creek, indicating a potential for groundwater discharge to the Lagoon Creek system.

However, groundwater in the Permian Bandanna Formation and Colinlea Sandstone (the units in which groundwater is usually first intersected) is encountered under confined conditions, even adjacent to Lagoon Creek. Analysis of groundwater levels indicates that the confined water level (potentiometric surface) is approximately 8 to 10 m from surface in areas adjacent to Lagoon Creek, and the Lagoon Creek alluvium is interpreted to be in the order of 15 to 20 m deep in central area of the creek (AGC, 1983). Therefore there may be a potential for groundwater to discharge to the bed sands of Lagoon Creek, but it may be that actual discharge only occurs if structures are present (e.g. faults, sand lenses or joints) that allow the upward movement of groundwater to occur.

12.8.5.1 Areas of potential groundwater discharge

Within the region where the MLA 70426 is sited, potential for groundwater discharge has been identified in the following areas:

1. Discharge to the bed sands of Lagoon Creek, via the mechanisms described above.
2. Discharge to an area of palustrine wetland on Lagoon Creek. The area of palustrine wetland is shown on Figure 12-7, and has been identified in both the surface water ecology non-Indigenous cultural heritage EIS sections (Volume 2, Sections 10 and 19, respectively). The feature is understood to be ephemeral, but is known to have been deepened by dredging, possibly in the 1980s. It is not possible to prove or disprove that the feature is groundwater dependent with data available, so the feature will require further investigation (via construction of groundwater monitoring bores, monitoring of water levels in the surface water feature, and water quality analysis). This is described further in the groundwater sub-plan of the Environmental Management Plan (EM Plan) (Volume 5, Appendix P).
3. A number of groundwater springs have been identified on the Forrester property with the closest spring being approximately 40 km north of MLA 70426 boundary (refer Figure 12-4). These springs are outside the zone of predicted impact of the Project however the springs will be surveyed as part of the bores survey that will be undertaken.

12.8.6 Groundwater Yield

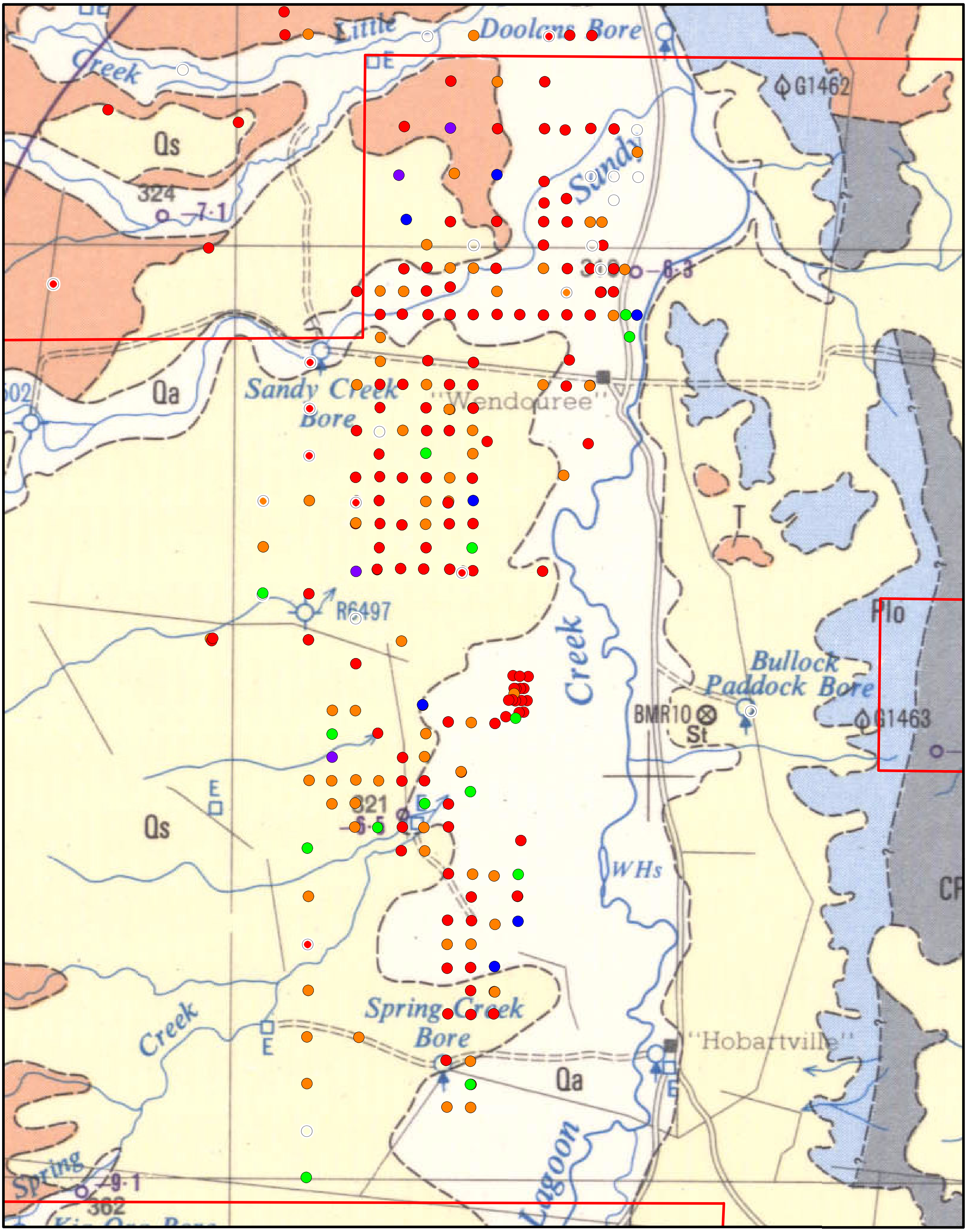
12.8.6.1 Review of Air-Lift Yield Data

Information on groundwater yield is available from site exploration drilling, where air lift yields are routinely measured at the end of the hole using a 90° v-notch weir. Most exploration bores extend below the D coal seam into the D-E sandstone. Therefore the air-lift yield figures presented below can be assumed to be based on inflows from the entire Permian sequence down to the top 5 – 10 metres of the D-E sandstone (where drilling is generally discontinued). The weathered overburden material, comprising the Tertiary sediments and weathered Permian sandstones, is generally cased off at the start of drilling, so it assumed that no water is reporting to the bore from the weathered Permian and overlying Tertiary sediments.

Figure 12-8 shows bore yield classes for data obtained from air-lift testing of site exploration boreholes. The data shows that of the 457 bores for which data was available (in the area covered by Figure 12-8):

- 263 (57%) recorded a yield less than 1 L/s;
- 141 (31%) recorded a yield between 1 and < 2 L/s;
- 45 (10%) recorded a yield between 2 and < 5 L/s; and
- 8 (2%) recorded a yield between greater than 5 L/s.

The data suggests that the majority of the bores in the area will yield < 2 L/s. However, high yielding bores (10 L/s or more) are known from the area, as discussed below. It should be noted that the data set does not include information on holes that were dry, so the data may be skewed towards an assumption of relatively high yields.



Air Lift Yield from Exploration Drilling
Yield Class (No. of Samples)

Mining Lease Application (MLA70426) Boundary

- <1 L/s (263)
- 1 to <2 L/s (141)
- 2 to <3 L/s (30)
- 3 to <5 L/s (15)
- > 5 L/s (8)
- ND (57)

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 1.25 2.5km
Scale 1:110 000 (A4)
Datum: GDA94, MGA Zone55

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Environmental Impact Statement

AIR LIFT YIELD
FROM EXPLORATION BORES

Job Number 4262 6580
Revision A
Date 24-09-2010

Figure:12-8

File No: 42626580-g-2062.wor

12.8.6.2 Pumping Test Data

Data is available on groundwater yield from a number of pumping tests undertaken at site, as discussed in Section 12.8.1.1. Testing was undertaken at a number of bores at a rate of 10 L/s; however, analysis of the data indicates that yields of that magnitude were short lived, as water levels were being drawn down close to the pump intake level after 100 hours of pumping. These results suggest that areas may exist where short-term bore yields are relatively high (~10 L/s) but in general, yields of less than 2 L/s or less could be expected over a wider area, and in the longer term.

12.8.7 Sustainable Yield

The concept of sustainable yield is much debated, and the definition may change to reflect the requirements or circumstances of a particular area. Sustainable yield is defined by the Department of Environment, Heritage, Water and the Arts[2] as “the groundwater extraction regime, measured over a specified planning timeframe that allows acceptable levels of stress and protects dependent economic, social, and environmental values”.

Kellett et al (2003) provides an equation for the sustainable yield of aquifer management zones of the GAB, and it is useful to introduce this concept as this type of calculation, or something similar, is likely to form the basis of DERM’s decision-making in relation to water allocation. The equation for sustainable yield is given as (Kellett et al 2003):

Sustainable Yield = Recharge Flux – Outflow – Environmental Flow ± Vertical Leakage.

The terms on the right-hand side of the equation are described briefly in Table 12-4 below.

[2] http://www.environment.gov.au/water/publications/environmental/groundwater/annex-a.html

Table 12-4: Description of Terms in Sustainable Yield Calculation

Term	Comment
Recharge Flux	Recharge entering the groundwater system, as discussed above in Section 12.8.4.3.
Outflow	Refers to the volume of water that must be allowed to leave the recharge areas in order to maintain water levels in down-gradient areas. This term is of significance in the GAB as it accounts for the volume of water that must be allowed to flow from recharge areas to meet pressure recovery targets for down-gradient areas (from which groundwater extraction may also be occurring). For the Alpha Coal Project (Mine) area, it is assumed that this term would be interpreted to represent a volume that must be in excess of the volume of water currently used by landholders, as well as the volume of any water allocation (i.e. water licence) sought by the Project for long-term water supply. In other words, there must be water left to flow out of the system after taking account of water extraction from bores, environmental flows, and vertical leakage (these last two terms are discussed below).
Environmental Flows	Groundwater flows that are required to maintain the health of groundwater dependent ecosystems (GDE's). One area of potential GDE has been identified to date in the Project area (an area of palustrine wetland located on Lagoon Creek). This area of potential GDE is shown in Figure 12-.
Vertical Leakage	Refers to the volume of water leaking into the aquifer from units above or below, as well as water leaking out of the aquifer to units above or below. Leakage into the aquifer is a positive value; leakage from the aquifer to neighbouring units is a negative value.

- Based on recharge of between 3 and 5 mm/year, and applied over the area of the Alpha MLA (648 km^2), groundwater recharge is calculated to be in the order of 1.9 to 3.2 GL/year. Based on the lack of response of monitoring bores to significant wet season recharge, it is concluded that recharge rates are likely to be at the lower end of the range proposed above.
- Requirements for mine dewatering will be greater than recharge, therefore the mine will impact groundwater levels (Section 12.9.1).
- As mine dewatering requirements will be in excess of recharge, the operation will not be applying for a water licence for groundwater supply. However, the Project will require a mine dewatering licence to allow mining to proceed safely to depth.

12.8.8 Water Quality

12.8.8.1 Summary Data from DERM Groundwater Database

The location of registered bores in the vicinity of the Project (from the DERM groundwater database) is shown in Figure 12-6. Within an area of just over 20 km from the boundary of MLA 70426 there are 176 registered groundwater bores. Of these, 90 bores have some recorded water chemistry data, and a number of bores have multiple samples. A summary of water quality data from the DERM groundwater database (minimum and maximum values recorded, as well as mean and median values) are shown below in Table 12-5.

The data indicates that the Total Dissolved Solids (TDS) of groundwater in the region is dominated by sodium and chloride. Other main parameters that contribute to the TDS include (in order of decreasing concentration) bicarbonate, silica, sulphate, magnesium, potassium, and calcium.

Table 12-5: Summary Water Quality Data from DERM Groundwater Database

Parameter	Unit	No. of Samples	Min	Max	Mean	Median
pH	pH units	312	4.8	8.5	7.27	7.20
EC	µS/cm	312	180	22 700	2 034	1 480
TDS	mg/L	313	88	14 211	1 204	829
Sodium	mg/L	313	23	4 860	328	215
Potassium	mg/L	289	0.2	52	11	10
Calcium	mg/L	305	0.1	380	40	30
Magnesium	mg/L	305	0.5	496	42	30
Chloride	mg/L	312	10	7 700	544	333
Sulphate	mg/L	304	0	980	60.3	37
Carbonate	mg/L	278	0	14	0.7	0.2
Bicarbonate	mg/L	299	12	964	174	171
Fluoride	mg/L	294	0	11	0.4	0.22
Aluminium	mg/L	101	0	0.11	0.025	0.01
Copper	mg/L	100	0	0.1	0.02	0.01
Zinc	mg/L	125	0	4	0.24	0.03
Silica	mg/L	254	1	7 575	81	61

12.8.8.2 Laboratory Analysis - Site Data

Water quality analyses from previous and current groundwater testing programs have been reviewed against drinking water[3] and stock watering standards[4], and summary tables are presented in the groundwater technical report (Volume 5, Appendix G).

In summary the analyses indicate that groundwater is, in some cases above drinking water guideline levels for:

- TDS (aesthetic based standard);
- Sodium and Chloride (aesthetic based standard);
- Sulphate;
- Fluoride;
- Aluminium;
- Arsenic;
- Lead;

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[3] Australian Drinking Water Guidelines (ADWG 2004)

[4] ANZECC water quality guidelines (Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000, National Water Quality Management Strategy. Volume 4 – Primary Industries.

- Manganese;
- Nickel; and,
- Selenium.

Groundwater is, in some cases, above guideline levels (for beef cattle) for:

- TDS;
- Fluoride;
- Aluminium; and,
- Selenium.

Groundwater chemistry is discussed in further detail in the groundwater technical report (Volume 5, Appendix G).

12.8.9 Groundwater Beneficial Use

The primary beneficial use for groundwater is judged to be stock watering (specifically, watering of beef cattle and horses). It is judged that groundwater is generally not suitable for potable supply without complex treatment, and on this basis it is assessed that a beneficial use for drinking water does not apply.

12.8.10 Conceptual Groundwater Model – Pre-Mining

A pre-mining conceptual groundwater model is presented as Figure 12-9. Based on the information presented in previous sections, the pre-mining conceptual groundwater model is summarised as:

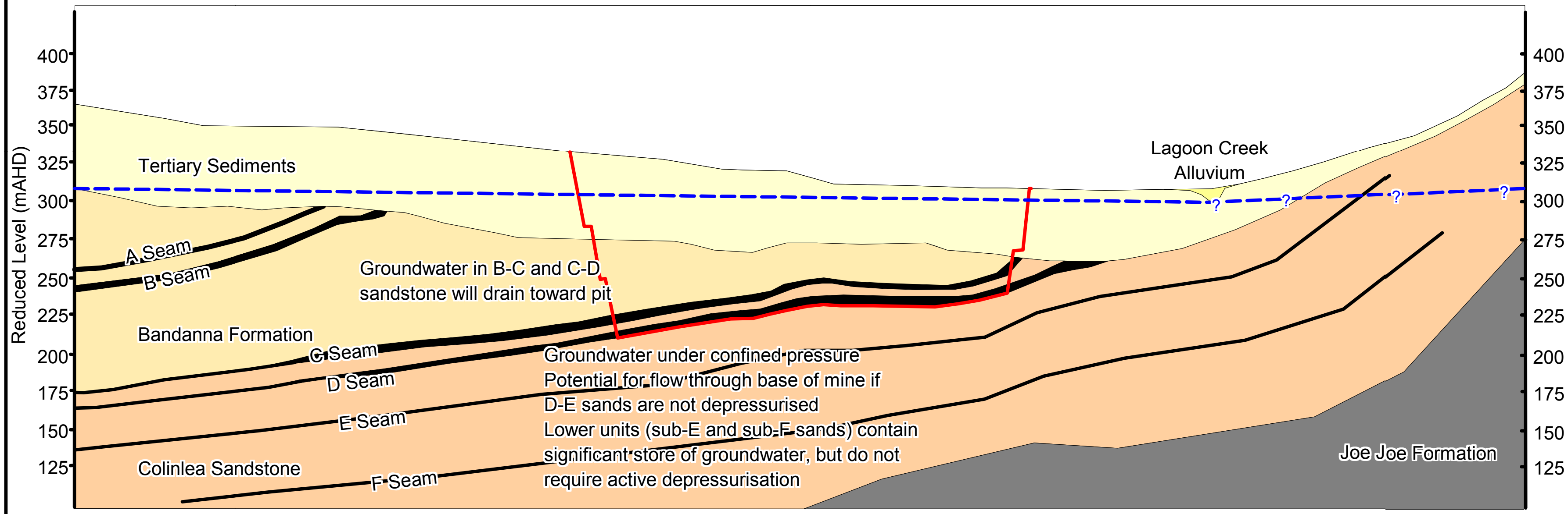
- Groundwater occurs beneath the MLA in coal seam and sandstone (interburden and floor) aquifers. The sandstone aquifers, which occur between and below the coal seams, are the major groundwater sources;
- The sandstone aquifers become cleaner (greater quartz content) and coarser with increasing depth;
- The coal seams confine the underlying sandstone aquifers. This is of greatest significance where the D coal seam confines the underlying D-E sandstone. Seepage modelling predicts that, if the D-E sandstone is not depressurised, the upward pressure from groundwater will exceed the weight of overlying material (i.e. weight balance would be exceeded), causing the floor of the mine to heave (plus groundwater ingress through floor). Therefore, depressurisation of the D-E sands will be required to allow mining to proceed safely to depth;
- Groundwater occurrence in the units overlying the Permian deposits (Tertiary sediments and Quaternary alluvium) is sporadic, and the units are not regarded as significant regional aquifers;
- Recharge occurs in topographically elevated areas and flows down gradient (i.e. as a subdued reflection of topography) toward Lagoon Creek. In the area to be mined the groundwater flow direction (on the western side of Lagoon Creek) is to the north-north-east, and the gradient is shallow (approximately 1:1,000); and

- Groundwater in the Permian Bandanna Formation and Colinlea Sandstone is encountered under confined conditions, even adjacent to Lagoon Creek. This suggests that groundwater does not necessarily discharge to Lagoon Creek under average conditions, but may reach surface e.g. if structures such as joints or faults exist that allow upward movement of water.

Recharge (west)
Diffuse downward recharge, predominantly in west (Great Dividing Range) where soil cover is thinnest
Vibrating wire piezometers within MLA show that the potentiometric surface of all aquifers converges in east, near Lagoon Creek. Potentiometric surface of C-D sandstone higher than potentiometric surface for D-E sandstone in west - indicates downward flow potential

Discharge
Potential for discharge to base of Lagoon Creek alluvium, but would require structural control (faults, joints) to allow groundwater discharge to base of alluvium. Groundwater occurs under confined conditions adjacent to creek

Recharge (east)
Downward recharge potential, but only under conditions where consistent rainfall saturates the rock profile. Otherwise, rainfall will runoff, or shallow infiltration will flow across weathered rock interface at shallow depth (1 to 5 m) toward Lagoon Creek alluvium



Conceptual Groundwater Model - Pre-Mining

Location of Proposed Open Cut Mine

Potentiometric Surface - D-E Sandstone
Groundwater flow direction to NNE on west side of Lagoon Creek, interpreted to be NNW on eastern side of Lagoon Creek

Source: See Copyright Details below and for full disclosure Please Refer to the EIS

Volume 4 - References

Datum: GDA94, MGA Zone55

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CONCEPTUAL GROUNDWATER MODEL
- PRE-MINING

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure:12-9

File No: 42626580-g-2063.wor

12.9 Impact of the Proposed Operation on Groundwater

12.9.1 Mine Dewatering Requirements

Mining will occur below the regional water table and it will be necessary to dewater the mine (i.e. remove groundwater) in advance of operations to allow mining to occur safely to the intended depth. Mine dewatering will be required for geotechnical reasons (i.e. to depressurise behind the pit walls and below the floor of the mine, to prevent slope failure and floor heave) and for operational reasons (to prevent uncontrolled inflows to the mine, which would result in wet digging, equipment wear, and potential safety issues). Mine dewatering has the potential to impact on:

- Groundwater levels;
- Groundwater flow direction;
- Groundwater chemistry; and,
- Recharge and discharge mechanisms.

The following sections discuss the studies undertaken to predict the dewatering requirements of the operation, in order that impacts resulting from mine dewatering may be assessed.

Studies to date have included:

- Pit seepage modelling, which investigated the water level impacts from passive drainage to the pit (i.e. for a scenario with no advance dewatering bores) and the geotechnical stability implications of not undertaking advance dewatering via bores. A conclusion of the modelling study was that depressurisation of the D-E sandstone would be required to prevent floor heave and instability at the toe of the batters;
- Analytical modelling to assess pumping requirements to reduce groundwater pressures in the D-E sandstone to below the base of the D coal seam over a 12-month period prior to commencement of mining; and,
- Numerical regional groundwater modelling to assess the long-term groundwater impacts of the operation, including final void modelling studies. This modelling is ongoing, and will be finalised once additional information regarding adjacent mining activities have been included, to allow for an assessment of cumulative impacts. The results of the modelling will be made available as an addendum to the hydrogeological technical report (Volume 5, Appendix G).

12.9.1.1 Management of Water from Mine Dewatering Operations

Water supply requirements of the mining operation during full production will be up to 11 GL/year. The majority of this water will be provided via a pipeline supply, with water from mine dewatering to provide a relatively minor component of the Project water supply.

Modelling undertaken to date predicts that mine dewatering requirements will never exceed 11 GL/year, therefore:

- It is anticipated that all groundwater obtained from mine dewatering will be utilised as a component of the mine water supply; and

- Generally there will be no requirement to discharge groundwater obtained via mine dewatering to the surface water environment. Any requirement for release would be managed via the mine water management system.

Out-of-pit dewatering water will be considered clean (ambient quality) water, and can therefore be stored in the raw water dam.

Dewatering water obtained from pumping of pit sumps will be considered “dirty” mine affected water, and will be stored in the mine water dams. Sizing of dams will, therefore, need to consider wet season storage requirements against average and short-term water consumption requirements of the Project.

12.9.2 Impacts from Mine Infrastructure

12.9.2.1 Tailings Storage Facility

12.9.2.1.1 Geology/Hydrogeology

The proposed out-of-pit tailings storage facility (TSF) is located to the east of Lagoon Creek (Figure 12-10). The site is located immediately west of an outcrop area of Colinlea sandstone, and to the east of the subcrop line of the D coal seam, which is taken for the purpose of this report to be the upper boundary of the Colinlea Sandstone.

Geotechnical drilling data (Douglas Partners, 2010) indicates that the site is underlain by weathered sandstone and siltstone with a relatively thin veneer (several metres) of sand and clayey silt. The majority of these sediments are derived from in situ weathering of the underlying sandstone and siltstone, which is interpreted to be Colinlea Sandstone.

Potential Groundwater Impacts

The current location of the TSF is within the outcrop area of the Colinlea Sandstone. If the TSF were unlined, the postulated scenario for migration of leachate from the facility would include:

- Downward leakage through surficial sediments (silty sands derived from weathering of the underlying Colinlea Sandstone) until reaching lower permeability weathered sandstones and siltstones;
- Lateral migration through the surficial sediments, particularly weathered conglomerates and sands/gravels;
- Movement of leachate down gradient at shallow depth toward Lagoon Creek where it could potentially discharge to the Lagoon Creek alluvium;
- Over time, the weathered rock profile would become saturated, and downward drainage would be induced;
- Therefore, movement of leachate away from the facility would be preferentially via shallow subsurface flow toward Lagoon Creek, in addition to deeper downward infiltration through the saturated rock underlying the TSF; and
- Deeper leakage would be expected to be drawn toward the pit, as dewatering activities will create a cone of depression, and it is interpreted that groundwater flow lines will be from the area of the TSF toward the pits.

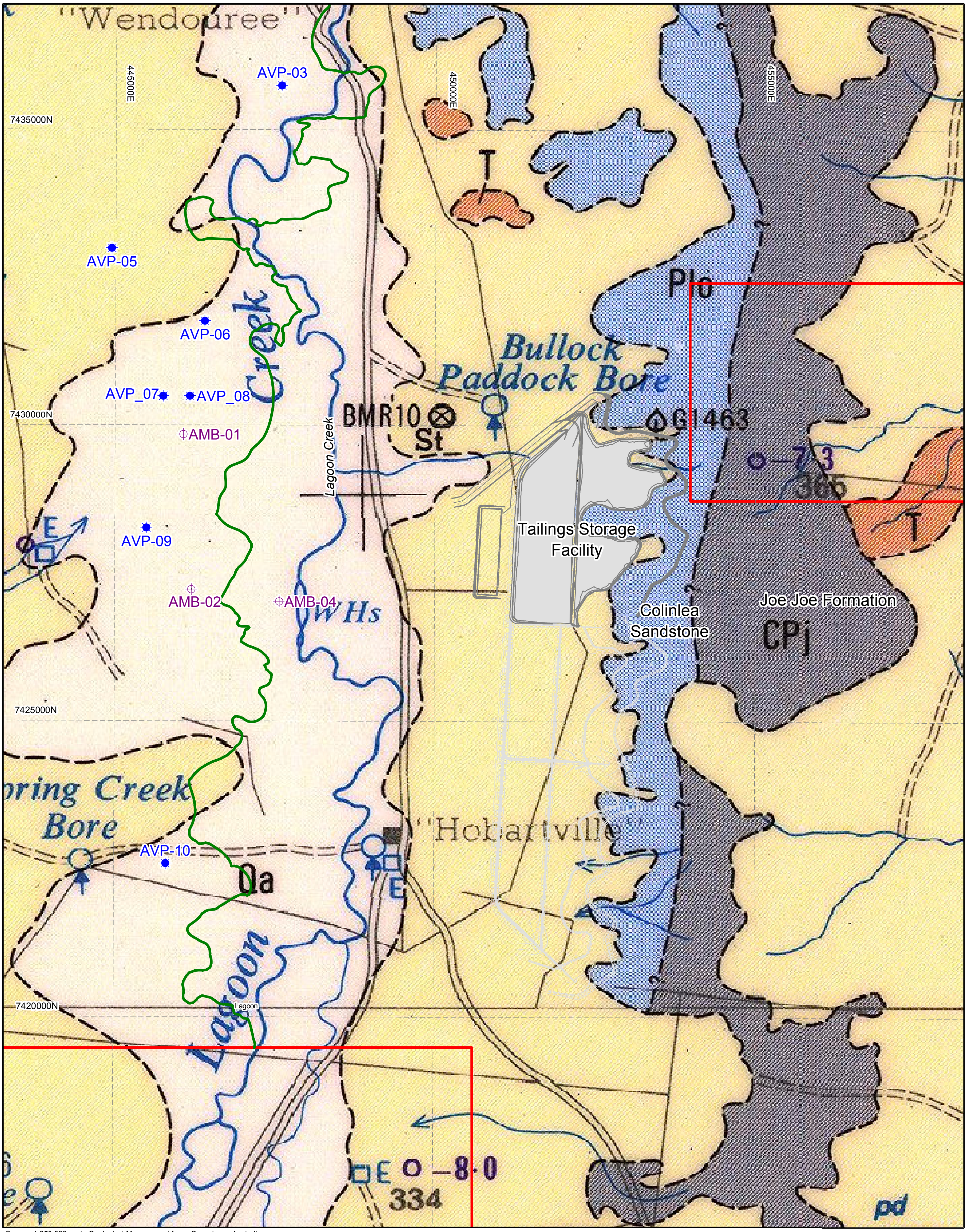
The scenario described above is considered unacceptable (EP Act) as the Colinlea Sandstone is an important regional aquifer. In addition, the proposed location of the TSF is in the lower part of the Colinlea Sandstone (sub-E, sub-F sandstone), which is likely to be the target for drilling of make-good water supply bores. Therefore any contamination of the aquifer would be deemed counter-productive and thus unacceptable.

12.9.2.1.2 Tailings Storage Facility (TSF) Design and Monitoring Requirements

Design of the TSF would need to be undertaken to limit the potential for leakage from the facility, with a means of intercepting any leakage prior to leachate reaching the Lagoon Creek alluvium. The current proposed design of the TSF (Alpha Coal Tailings Storage Facility – Concept Design Report) includes:

- A fully lined footprint;
- An under drainage systems atop of the liner; and
- Drainage transported directly to a decant system (which will reduce the head above the liner).

Investigation and monitoring requirements and commitments are outlined in the EM Plan (Volume 2, Section 26).



Source; 1:250,000 scale Geological Map sourced from Geoscience Australia

Mining Lease Application (MLA70426) Boundary

Subcrop of D Seam Floor

AVP-03 Vibrating Wire Piezometer (VWP) Bore Site

AMB-01 Standpipe Monitoring Bore

Source: See Copyright Details below and for full disclosure Please Refer to the EIS *Volume 4 - References*

0 1 2km

Scale 1:80 000 (A4)

Datum: GDA94, MGA Zone55

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Alpha Coal Project
Environmental Impact Statement

TAILINGS STORAGE FACILITY
AND UNDERLYING GEOLOGY

Job Number	4262 6580
Revision	B
Date	24-09-2010

Figure:12-10

File No: 42626580-g-2064b.wor

12.9.3 Other Facilities

The majority of mine infrastructure will be located to the east of Lagoon Creek, where geotechnical investigations (Douglas Partners, 2010) have shown that, in general, weathered rock (Colinlea Sandstone) occurs at shallow depths of 1 to 5 m. Therefore the potential contamination issues for all infrastructure areas (artificial recharge) are similar to those identified above for the TSF.

The areas that will be the subject of further investigation, including installation of groundwater monitoring bores, include:

- General landfill;
- Coal Handling and Preparation Plant (CHPP);
- Waste rock dump;
- Train load-out facility;
- Environmental dams; and
- Sewage treatment plant.

Groundwater investigation, monitoring, and reporting commitments are presented in the EM Plan (Volume 5, Appendix P).

12.9.4 Impact on Recharge

Assuming a diffuse rate of recharge of between 3 and 5 mm/year (0.6 to 1% of average annual rainfall), recharge over the MLA area (648 km^2) is calculated at between 1.9 and 3.2 GL/year. Assuming recharge potential was lost over the entire disturbance area, this would equate to a loss of recharge of between 0.62 and 1.1 GL/year (approximately a third of the recharge over the entire MLA). The loss to recharge from the proposed TSF (assuming surface are of 17 km^2, and assuming recharge rates between 3 and 5 mm/year) is between 50 and 85 ML/year.

In the context of overall recharge to the Colinlea Sandstone in the area, the loss of recharge area attributable to the Project is not considered significant.

12.9.5 Impact on Existing Groundwater Users

Based on results of seepage modelling and analytical modelling undertaken to date, it is concluded that groundwater level impacts of 5 m or greater may be experienced at distances up to 20 km from the open pit. The effects will not be concentric, for example drawdown will be limited to the east of the MLA 70426 as the Colinlea Sandstone aquifer terminates against the Joe Joe Formation, which is a regional confining layer, and also to the west if drawdown extends as far as the Rewan Formation, which is another regional confining layer. The drawdown cone is therefore predicted to be elongated along strike (i.e. in a north-south direction).

12.9.6 Surface Water Impacts

It is interpreted that regional groundwater flow is from topographically elevated areas toward Lagoon Creek, where it is possible that groundwater discharges to Lagoon Creek under some conditions (within the MLA 70426).

The presence of the open-cut mine will result in a cone of depression that will alter groundwater flow directions to be toward the pit (Figure 12-11) and will reduce the groundwater level in the vicinity of

Lagoon Creek, effectively removing the potential for groundwater discharge to Lagoon Creek in the vicinity of the operation (refer conceptual groundwater model – post mining, (Figure 12-11). The magnitude and extent of drawdown beneath Lagoon Creek will be considered as part of regional groundwater modelling.

12.9.7 Groundwater Quality Impacts

The Project has the potential, due to mining activities, to alter the groundwater quality within the open cut pits and below and adjacent to mine infrastructure (possible poor quality artificial recharge). The impacts are, however, limited as:

- During mining and after closure (final void), groundwater flow will be toward the pits, and the potential for contaminants to move out via the groundwater system is judged to be low; and
- Geochemical testing indicates that the materials disturbed and exposed during mining are non-acid forming or have low potential for acid-forming (Tests completed indicate that materials are non-acid forming (NAF) or have low potential for acid-forming (low PAF).

12.9.8 Final Void

Current mine plan includes a final void which will remain at the western limit of mining at life of mine (LOM). Modelling of the final void will be undertaken to make prediction of:

- Average final void water level and maximum water level under a range of climatic conditions;
- Long-term water quality (in terms of salinity) within the final void;
- Decant potential / risk;
- Final groundwater drawdown cone / zone of influence; and
- Long term impacts on surface water systems.

12.9.9 Cumulative Impacts

In addition to the Alpha Coal Project, which is the subject of this EIS, there are additional projects that have the potential to impact groundwater, and the cumulative impact of these projects must be assessed. The projects include:

- Kevin's Corner Project, which is a proposed 30 Mtpa open cut and underground coal mine, being developed by Hancock Galilee Pty Ltd (HGPL). The Kevin's Corner project is located on MLA 70425, immediately north and adjoining the Alpha MLA; and,
- Waratah Galilee Coal Mine, which is a proposed 25 Mtpa open cut coal mine being developed by Waratah Coal Inc. The proposed mine is located 13 km west and 35 km north of the township of Alpha.

The Kevin's Corner project is to be simulated within the regional groundwater model that will be developed and reported as an addendum to the hydrogeological technical report (Volume 5, Appendix G).

The regional groundwater model will consider the cumulative impacts (i.e. drawdown in groundwater levels) of the Alpha and Kevin's Corner projects with respect to:

- Drawdown in the area between the mining operations (i.e. where the cones of depression from each operation overlap);
- The extent of drawdown along geological strike (i.e. to the north and south of the Alpha and Kevin's Corner mines) as well as to the east and west of the operations (where the extent of drawdown is anticipated to be limited by hydrogeological boundaries);
- Cumulative impacts on defined springs to the north of the Kevin's Corner MLA 70425;
- Impacts on existing groundwater users; and
- Definition of a final zone of influence (i.e. at completion of both projects, following rebound of groundwater levels to a pseudo steady-state for the aquifers that are dewatered or depressurised by the mine, and for deeper aquifers that are expected to the be the target of bores drilled under make-good water supply agreements).

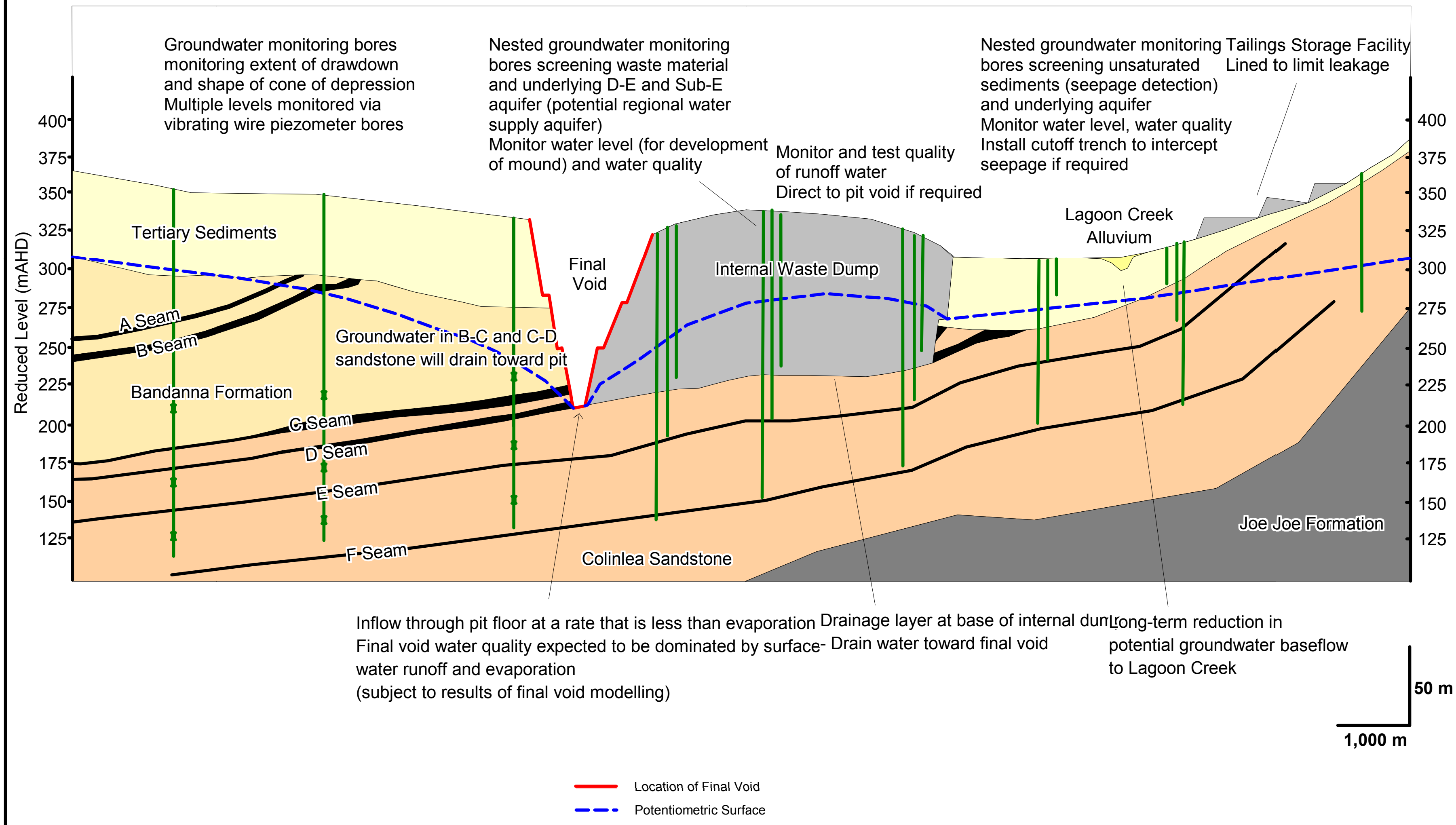
No details are known of the dewatering requirements of the Waratah Galilee Coal Mine or other potential mining activities within the immediate area (i.e. along strike), therefore the regional groundwater model will present drawdown contours for the area of the proposed mine.

12.10Conceptual Groundwater Model – Post Mining

Elements of the conceptual groundwater model (post mining) are shown in Figure 12-11.

Predictions relating to the post-mining groundwater regime may need to be revised once regional groundwater modelling has been undertaken (supplemental to this report), but based on modelling undertaken to date, and professional judgement, the following post-mining conceptual groundwater model is proposed:

- A drawdown cone will develop around the open pit that will extend preferentially north and south (along the line of strike) and to the west, but will be of limited extent in the east as the aquifers outcrop to the east and in this area the aquifers will be locally dewatered (Figure 12-11);
- Groundwater will flow into the pit through the pit wall, from the Tertiary sediments (where water occurs), the sediments of the B-C and C-D sands and C and D coal seams;
- Groundwater will flow through the pit floor from the underlying D-E sandstone aquifer. Seepage modelling predicts that the majority of groundwater reporting to the floor of the pit will be derived from the D-E sandstone, and not from underlying sandstone units (sub-E sands, sub-F sands);
- A water table will be developed over time in the in-pit waste dump. Sources of water will include direct rainfall infiltration, and inflow from the D-E sandstone that will underlie the in-pit dump;



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HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Environmental Impact Statement

CONCEPTUAL MODEL
- POST-MINING

Job Number	4262 6580
Revision	A
Date	24-09-2010

Figure:12-11

Datum: GDA94, MGA Zone55

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- Rehabilitation (and maintenance to counter settlement) of the surface of the in-pit dump will be required to limit the potential for rainfall infiltration (via capping, revegetation, and/or grading of the surface to encourage runoff and limit surface ponding);
- Design of the in-pit dump will include a basal drainage layer, to prevent build-up of groundwater pressure within the dump (which may lead to geotechnical instability) and also to encourage drainage toward the current and final pit void; and
- The cone of depression will extend to the west, but it is predicted that drawdown will not influence water levels in the GAB. The outcrop of the Rewan Formation, like the Joe-Joe Formation, is expected to provide a physical limit to the extent of groundwater level drawdown.

12.11 Groundwater Monitoring and Mitigation Measures

Commitments to groundwater monitoring and mitigation of impacts are presented in the Environmental Management Plan (EM Plan) in Volume 5, Appendix P.