



Environmental Management Plan

Petroleum Lease

PL 388

March 2011

The following document was prepared by RLMS



On behalf of Bow Blackwater CSG PL Pty Ltd



RLMS (Resource and Land Management Services) is an independent consultancy established in 1990, focusing on the energy, transport, communications and exploration sectors Australia wide. RLMS specialises in tenure management, land negotiation and acquisition, route corridor selection, environmental approvals, mapping, and gas market analysis.

Environmental Management Plan

Petroleum lease

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Bob Otjen, General Manager		

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1 INTRODUCTION

1.1 Objective

This document comprises an Environmental Management Plan (EM Plan) prepared to support an application for a Level 1 environmental authority (EA) for Petroleum Lease (PL) 388. The objective of the development of PL 388 is to provide commissioning gas to the Blackwater Gas-fired Power Station.

The purpose of this EM Plan is to propose environmental protection commitments to assist the administering authority to decide conditions of the EA. This EM Plan is prepared to comply with the revised guidelines for coal seam gas projects released by the Department of Environment and Resource Management (DERM) on 31 March 2010.

1.2 Proponent

The PL area is under application by Bow Blackwater CSG PL Pty Ltd, a wholly owned subsidiary of Bow Energy Limited. References throughout this document to Bow Energy include this subsidiary company.

Bow Energy Limited was formed on 17 September 2004, as a wholly owned subsidiary of Arrow Energy NL to focus on Arrow's conventional petroleum interests. Arrow Energy itself would focus on the coal seam gas interests held. On 30 March 2005 Bow Energy issued a prospectus for 30 million shares, which was fully subscribed on 29 April 2005. Bow Energy Limited was listed on the Australian Securities Exchange (ASX) on 20 May 2005. In the 2010 Annual Report, Bow Energy reported market capitalisation in excess of \$370 million. In November 2009, the company announced the development of a 30 megawatt gas-fired power station in Blackwater, to deliver low-emission electricity into the national grid for domestic and industrial users. The initial focus for market development is domestic power generation and domestic gas supply for industry.

The company has four directors including:

- Howard Stack, Independent Non-executive chairman;
- Ron Prefontaine, Managing Director;
- Steve Bizzell, Non-executive Director; and
- Nick Mather, Non-executive Director.

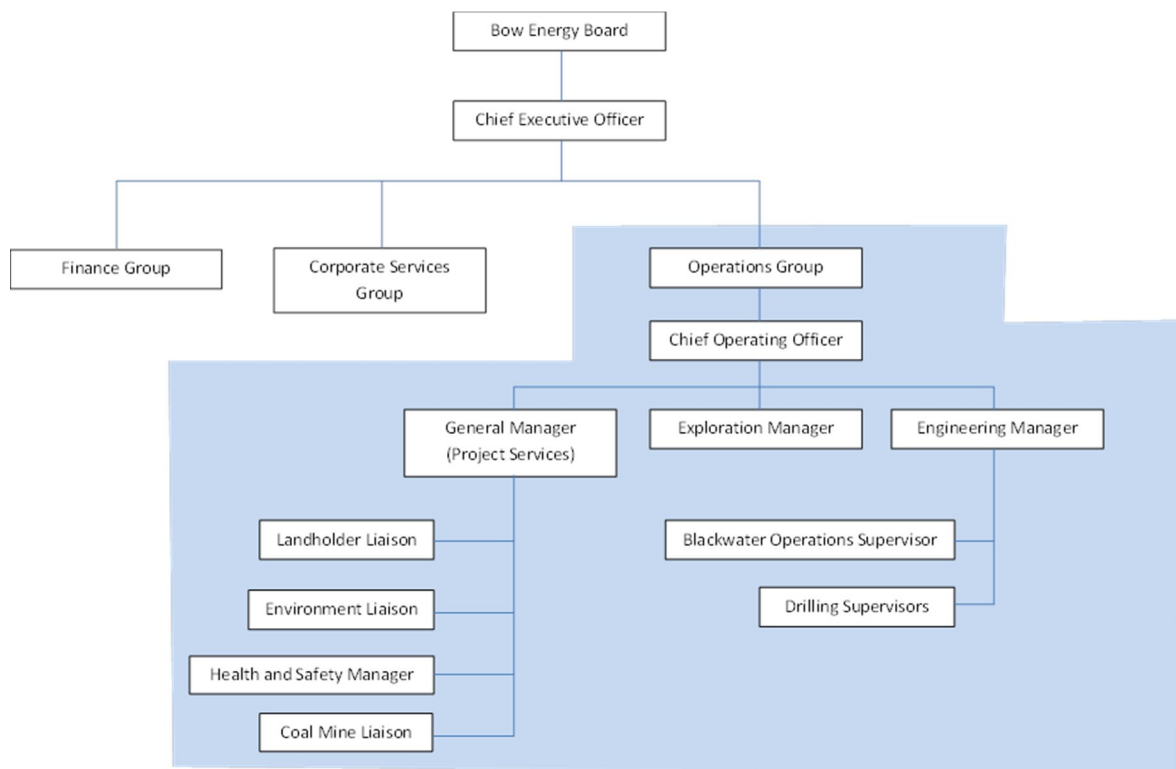
Bow Energy Ltd has a number of wholly owned subsidiaries including:

- Bow CSG Pty Ltd;
- Ocellaris Oil Pty Ltd;
- Roma CBM Pty Ltd;
- SEQOil Pty Ltd;
- Blackwater Power II Pty Ltd;
- Blackwater Power Pty Ltd;
- Blackwater Transmission Pty Ltd;
- Bow Land Holdings Pty Ltd;

- Bow Norwich Park CSG PL Pty Ltd;
- Bow Blackwater CSG PL Pty Ltd;
- Bow Don Juan CSG PL Pty Ltd;
- Bow Energy Gladstone Pipeline Pty Ltd; and
- Bow Energy Norwich Park Pipeline Pty Ltd.

The company structure, as relevant for this EM Plan is shown below in Figure 1.

Figure 1 Organisational chart



Bow Energy operates a number of Queensland exploration tenures, shown in Table 1. The company now has both conventional petroleum and coal seam gas interests.

Table 1 Bow Energy Operated Queensland petroleum exploration tenures

Tenure	Status	Sub-status	Date lodged	Date granted	Expiry date	No. of sub-blocks
ATP 664P	Granted		1 Feb 1999	22 Aug 2003	31 Aug 2019	225
ATP 807P	Granted	Renewal lodged	19 Oct 2004	17 Dec 2004	31 Dec 2008	222
ATP 706P	Granted		14 May 2001	6 Oct 2003	30 Sept 2019	125
ATP 805P	Granted		1 Oct 2004	19 Aug 2005	31 Aug 2017	195
ATP 809P	Granted		26 Oct 2004	28 Mar 2006	31 Mar 2018	1050
ATP 1031P	Granted		4 Aug 2008	24 Feb 2009	28 Feb 2021	275
ATP 545P	Granted	Renewal lodged	11 Dec 1992	29 Jan 1993	31 Jan 2009	250
ATP 1025P	Granted		4 Aug 2008	24 Feb 2009	28 Feb 2021	309
ATP 948P	Application	Preferred tenderer	27 Aug 2007			650
ATP 944P	Application	Preferred tenderer	27 Aug 2007			1374
ATP 1053P	Application	Preferred tenderer	4 Aug 2008			124

1.3 Domestic gas project

The granting of this petroleum lease is being sought by Bow Energy as part of its domestic gas market focused Blackwater Power Station project. This power station is currently under construction, in accordance with a number of development approvals granted under the Sustainable Planning Act 2009 including:

- Development Approval 4012/10, Material Change of Use – Public Facility (Power Station) and Environmentally Relevant Activity 14 (Electricity Generation) (Development Permit); Lot 15 on RP861407; Approved by Central Highlands Regional Council (CHRC) on 25 November 2010;
- Department of Environment and Resource Management (DERM) Permit No. SPCE00323410; Permit Type “Concurrence Response for a MCU involving an ERA”;
- DERM Registration Certificate No. ENRE01859210; and
- Development Approval D4012/10/OW (Amendment 1) Operational Works, Public Facility (Power Station); Approved by CHRC on 1 December 2010.

Refer to Appendix 1 for copies of these approvals/permits.

Commissioning of the power station is scheduled for mid-2011. Bow intends to seek commissioning gas from two proposed petroleum leases (PL388 and PL391), and sometime in the future this power station will be able to take gas from a number of sources, including potentially incidental gas from regional coal mines. However, for this commissioning phase it is intended to use Bow Energy’s coal seam gas.

Bow is also constructing two gas pipelines linking PL 391 and PL 388 to the power station. Pipeline licence applications (PPL 158 and PPL 160) have been submitted to

the Department of Employment, Economic Development and Innovation (DEEDI) and supporting environmental authorities have recently been granted by DERM.

The electricity generated from the Blackwater Power Station will be supplied to the grid for domestic purposes. A 66KV transmission line will link the power station to the Ergon substation at Blackwater.

At present Bow CSG is developing selected pilot coal seam gas projects within the Blackwater region that it would like to place on extended production test. This will involve running the wells for some time whilst gas production builds. Bow believes that by directing this gas to the power station, it will achieve multiple purposes, allowing Bow to build and demonstrate Blackwater as a commercially viable coal seam gas field. Bow believes that by directing the test gas to the power station this will achieve a number of objectives and deliver better environmental outcomes by avoiding the need to flare/vent the gas.

Bow proposes to establish PLs 388 and 391 within the boundaries of its current exploration tenement ATP 1025P, as the required extended production test period is not authorised under the existing Authority to Prospect (ATP) approvals.

An initial development plan (IDP) has previously been submitted to DEEDI as part of Bow's overall petroleum lease application. This plan outlines general development activities for the entire Blackwater CSG field within ATP 1025P. However, for the purposes of this power station commissioning phase, Bow proposes to develop a domestic gas focussed project and establish the two petroleum leases.

1.4 Legislative framework

PL 388 will be administered under the Petroleum and Gas (Production and Safety) Act 2004 and the associated regulations. Environmental activities on PL 388 will be administered under the Environmental Protection Act 1994 (EP Act) through the granting of an EA. The administering authority for the EP Act is DERM.

DERM is responsible for:

- administration of environmental authorities;
- monitoring environmental performance of petroleum projects;
- conducting site inspections and environmental audits;
- managing environmental impact assessments;
- ensuring adequate rehabilitation; and
- enforcing compliance with environmental controls.

The Environmental Protection Regulation 2008 prescribes regulatory requirements with which DERM must comply when making environmental management decisions. It further describes conditions that DERM must consider imposing.

Impacts on groundwater by coal seam gas activities are now administered under the Water Act 2000, following legislative amendments passed 1 December 2010 which removed these aspects from the petroleum legislation. Requirements for Underground Water Impact Reports, baseline assessments and make good

obligations on water bores are now administered under the Water Act 2000 by the Queensland Water Commission.

Additionally changes have been made to the Water Supply (Safety and Reliability) Act 2008 to deal with coal seam gas water under the recycled water framework of that Act. These changes must be considered when the release of coal seam gas water may impact on water sources for public consumption (i.e. upstream releases from town water supplies).

Additionally, certain activities are also subject to a number of other legislative constraints including:

- Land Protection (Pest & Stock Route Management) Act 2002;
- Water Act 2000;
- Nature Conservation Act 1992;
- Aboriginal Cultural Heritage Act 2003;
- Native Title Act 1993 (Cwth); and
- Environment Protection and Biodiversity Conservation Act 1999 (Cwth).

These Acts are administered by various State Government Departments. The Commonwealth Department of Sustainability, Environment, Water, Population and Communities administers the Environment Protection and Biodiversity Conservation Act 1999.

1.5 Relevant policies and guidelines

Several operational policies and guidelines are applicable to the proposed activities for PL 388 including:

- Coal Seam Gas Water Management Policy (June 2010);
- Environmental Protection Policies (EPPs) that provide relevant environmental values and quality objectives; and
- Preparing an environmental management plan for coal seam gas activities (March 2010).

Additionally the State Government has an array of policy positions which impact upon development of energy resources. These include:

- The ClimateSmart 2050¹ policy, which increased the target of electricity sold in Queensland from gas-fired generators to 18%;
- Blueprint for the Bush², a 10 year partnership plan launched in June 2006, between the Queensland Government, AgForce and the Local Government Association of Queensland to foster and support sustainable, livable and prosperous rural communities in Queensland;
- Land Access Policy Framework and Land Access Code³ which provide guidance to landholders and companies about how to manage processes related to consultation and compensation and mandatory conduct conditions

¹ Queensland Government: June 2007: ClimateSmart 2050 Queensland climate change strategy 2007: a low-carbon future

² <http://www.regions.qld.gov.au/dsdweb/v4/apps/web/content.cfm?id=13343>

³ Department of Employment, Economic Development and Innovation: November 2010: Land Access Code

that companies must comply with when undertaking authorised activities on private land; and

- Strategic Cropping Land Policy Framework which was released on 23 August 2010 by the State Government with new legislation planned for introduction in early 2011. This is discussed more fully in Section 5.5.3.

2 DESCRIPTION OF PETROLEUM AUTHORITIES

On 25 March 2010 Bow Blackwater CSG PL Pty Ltd, a wholly owned subsidiary of Bow Energy Ltd, lodged an application for Petroleum Lease 388.

Bow Energy is currently constructing the Blackwater Power Station, a 30MW gas fired power station located approximately 15km north-east of Blackwater on Lot 15 RP 861407. The electricity generated from the Blackwater Power Station will be supplied to the grid for domestic purposes through a 66kV transmission line connected to the Ergon Energy substation at Blackwater.

Commissioning of the power station is scheduled for mid-2011. Initially gas will be supplied from coal seam gas wells on an extended production test located on PL 388 and PL 391. Utilising coal seam gas from extended production tests negates the need to flare or vent this gas and delivers a better environmental outcome. A gas pipeline, constructed and operated under Pipeline Licence (PPL) 158 will deliver CSG from PL 391 to the Blackwater Power Station. Similarly, a gas pipeline (PPL 160) will deliver CSG from PL 388 to the power station. Refer to Appendix 2 for a copy of the environmental authority for PPL 160.

2.1 Area description

Figure 2 shows the location of PL 388. It is wholly within the Central Highlands Regional Council area. The area of the PL is 16.48 km² (1648 hectares).

Blackwater Creek runs through the northern portion of the PL while the southern portion of the PL also intersects a number of smaller tributaries of Blackwater Creek.

The north eastern boundary of PL 388 follows the Bluff Jellinbah Road.

2.2 Graticular blocks

Blocks and sub-blocks which comprise PL 388 are listed in Table 2.

Table 2 Graticular block description PL 388

BIM	Blocks	Sub-blocks
CLER	2940	q, w
	3012	b, g, m, n

2.3 Real property descriptions

Details of the lots on plan that are intersected by the PL are provided in Table 3 and shown on Figure 3. Tenure is freehold across the PL area.

Table 3 Real property description

Lot Plan	Tenure	Landowner	Primary land use
10 SP224570	Freehold	Bruce Peter Goodwin & Arthur Henry Goodwin	Cattle breeding and fattening
100 SP230773	Freehold	Tremell Pty Ltd Sojitz Coal Resources Pty Limited Marubeni Coal Pty Ltd Jellinbah Group Pty Ltd	Extractive
11 SP147347	Freehold	Arthur Henry Goodwin & Anthony David Goodwin	Cattle breeding and fattening
15 RP861407	Freehold	Bow Land Holdings Pty Ltd	Electricity generation – power station (gas)
2 SP223677	Freehold	MCG Coal Pty Ltd	Cattle breeding and fattening

Figure 2 Location

Figure 3 Land tenure

3 DESCRIPTION OF PROJECT ACTIVITIES

3.1 Type of activity

The proposed activities associated with the production of coal seam gas under PL 388 comprise the following:

- drilling of exploration and appraisal wells;
- drilling and completion of pilot wells and production wells;
- construction of gas and water gathering and processing systems;
- construction of produced water storage facilities; and
- construction of power distribution, road networks and gas compression facilities.

Exploration and appraisal wells will be designed to test gas contents, permeability, stress regimes and will allow for a continuing improved understanding of the gas field.

Pilot testing will initially comprise a number of single vertical fracture stimulated or lateral (surface to in-seam) wells targeting the Rangal Coal Measures (Figure 12) with gas and water production being monitored. Pending early results the pilot will be expanded to total approximately 14 wells. Seams of the Burngrove Coal Measures will additionally be the target of stimulation and pilot testing at a future date.

Development is envisioned to trend parallel to geological strike and progress down-dip with time. Later development plans will be determined by test results. These continuing activities will fully develop economic gas resources within PL 388.

Produced gas will be metered and piped to the local power station. The gas gathering system may eventually be connected to a larger network that will require associated infrastructure, including nodal and main compression stations, to pressurise the gas to required levels.

Coal seam gas water production is expected to be minimal (<<100 barrels/well/day initially and then declining). Pending eventual estimates of coal seam gas water volumes, it will be gathered for processing and/or beneficial use.

Additional infrastructure comprising roads, power lines, transformers, pump drives, well measurement and control systems will be largely determined by field development, topography and environmental considerations.

The wells and related facilities will be abandoned and rehabilitated in full compliance with governmental regulations and best industry practice as determined during the life of the project.

3.2 Project life

The term of the PL associated with this EM Plan is 30 years.

Within the term of the Initial Development Plan (5 years) proposed work is outlined below.

Table 4 Summary of Initial Development Plan

Year	Activity	Number	Details
1	Drilling Dam design and construction Access tracks Flowlines	4 existing wells 1 water storage facility for coal seam gas water Not determined 3km	Production testing Design, construction, and operation Construction and maintenance Construction and maintenance
2	Drilling Access tracks Flowlines	3 wells Not determined 4km	Producing wells Construction and maintenance Construction and maintenance
3	Drilling Access tracks Flowlines	4 wells Not determined 2km	Producing wells Construction and maintenance Construction and maintenance
4	Drilling Access tracks Flowlines	6 wells Not determined 4km	Producing wells Construction and maintenance Construction and maintenance
5	Drilling Access tracks Flowlines	No additional wells No additional km No additional km	Production and maintenance of existing infrastructure

3.3 Exploration and production methods

3.3.1 Existing wells and infrastructure

Bow has drilled coal seam gas wells on the PL area under its precursor ATP tenure (ATP 1025P). These existing wells are summarised in Table 5 and shown on Figure 4. There are no wells that pre-date the grant of ATP 1025P.

There is no pre-existing seismic in the PL area.

Table 5 Existing petroleum activities on PL 388

Well	Date completed	Total depth (m)	Latitude	Longitude	Status
BWP 33	16 August 2010	512	23° 27' 42"	148° 57' 01"	Suspended
BWP 34	4 Sept 2010	455	23° 27' 45"	148° 56' 26"	Suspended
BWP 35	28 August 2010	503	23° 27' 16"	148° 56' 41"	Suspended
BWP 36	23 August 2010	475	23° 27' 34"	148° 56' 43"	Suspended

Figure 4 Existing petroleum activities

3.3.2 Principal Activities

The dominant activities will comprise well drilling and completion; low pressure gas production; gathering, compression and distribution; water gathering and treatment; road construction, electrical distribution and metering systems.

3.3.3 Initial Activities

Initial activities will comprise detailed ground reconnaissance, planning and landholder consultation. The area is semi-cleared open cattle country and particular emphasis will be directed towards maintaining adequate fencing, cattle grids and minimising disturbance to land owners and/or occupiers and identifying all existing bores.

3.3.4 Drilling

Initial drilling, in the shallower areas of the tenement will comprise vertical wells, under-reamed in the coal measures. Other vertical and surface to in-seam well configurations are also being investigated. Vertical options currently include water and proppant fracture stimulated wells. Surface to in-seam well options range from single to multi-seam laterals. Ultimately the reservoir characteristics will govern the actual drilling approach chosen over the tenement and it is probable that a combination of drilling methodologies will be implemented.

Appraisal of the development of the Burngrove Formation will continue, and if testing results are positive, then additional development activities may target these seams. However as their production potential is still uncertain, they are not included in the Initial Development Plan.

3.3.5 Well Completion

Initial completion will involve fracture stimulation or surface to in-seam drilling of the coal measures. A down-hole progressive cavity pump will be run and operated to reduce hydrostatic pressure in the target coal seams. The reduced hydrostatic pressure will enable methane desorption into the wellbore.

3.3.6 Water Gathering System

Coal seam gas water will be gathered and pumped into temporary water storage infrastructure. Water pumping and metering systems will also be installed.

Options are being evaluated to establish 'beneficial use' of the minor amounts of expected produced water which may include:

- Use for authorised activities on tenure such as water for drilling;
- Utilisation of coal seam gas water by local coal mines; and
- Dust suppression, subject to water quality criteria being met.

There are currently no plans for augmenting town drinking water supplies due to insufficient volumes being produced.

3.3.7 Gas Gathering and Compression

Produced gas will be gathered via a low pressure HDPE pipeline network and initially piped into low pressure power station infrastructure.

Depending on volumes of gas accessible on the lease and the final location of centralised compression facilities, the gas may be further compressed on the lease or piped to the nearest centralised compression facility to be compressed to pipeline pressure.

The layout of the nodal compression and centralised compression will be determined at a later date taking into account the coordinated development of the petroleum leases and pipelines forming part of a broader Bow project.

3.3.8 Road Construction

Road construction will enable access for drilling and completion rigs, and maintenance of the production and distribution systems.

3.3.9 Ongoing Activities

Ongoing activities will be largely managed by Blackwater based employees of the Operator and local contractor support. Activities will predominantly comprise the management and maintenance of existing infrastructure, continued land owner and occupier consultations; and the monitoring and metering of produced gas and coal seam gas water.

3.3.10 Water Monitoring

All drilled production wells will include a coal seam gas water production monitoring schedule which will comprise the continuous collection of real time data of produced associated water volumes and routine conductivity and pH measurements. The collected information will be incorporated into a regional underground water management program.

Figure 5 Initial development plan

3.4 Environmentally relevant activities

The Environmentally Relevant Activities (ERAs) that will be undertaken within PL 388 are consistent with those activities detailed in Schedule 5 of the Environmental Protection Regulation 2008:

Item 8 A petroleum activity, other than a petroleum activity mentioned in items 1 to 7, that includes a chapter 4 activity for which an aggregate environmental score is stated.

The relevant chapter 4 activities (as listed in Schedule 2 of the Environmental Protection Regulation 2008) include:

- ERA 8 Chemical storage;
- ERA 15 Fuel burning;
- ERA 56 Regulated waste storage;
- ERA 60 Waste disposal; and
- ERA 63 Sewage treatment.

All chapter 4 activities (Environmental Protection Regulation 2008) for which an aggregate environmental score is stated, have an aggregate environmental score of 126 when carried out as a petroleum activity. The relevant chapter 4 activities are discussed in more detail below.

3.4.1 ERA 8 Chemical storage

Chemical storage under ERA 8 consists of storing:

- a) 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 in containers or at least 10m³; or
- b) 50t or more of chemicals of dangerous goods class 6, division 6.1 in containers capable of holding at least 900kg of the chemicals; or
- c) 10m³ or more of chemicals of class C1 or C2 combustible liquids under AS 1940 or dangerous goods class 3; or
- d) the following quantities of other chemicals in containers of least 10m³ –
 - I. 200t or more, if they are solids or gases;
 - II. 200m³ or more if they are liquids.

The thresholds for ERA 8 are shown in Table 6.

Table 6 ERA 8 Threshold table (Environmental Protection Regulation 2008)

Threshold	Aggregate environmental score
1. storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3	51
2. storing 50t or more of chemicals of dangerous goods class 6, division 6.1	51
3. storing the following total quantity of chemicals of class C1 or C2 combustible liquids under AS1940 or dangerous goods class 3	
a) 10m ³ to 500m ³	No score
b) more than 500m ³	85
4. storing 200t or more of chemicals that are solids or gases	31

Threshold	Aggregate environmental score
5. storing 200m ³ or more of chemicals that are liquids, other than chemicals mentioned in items 1 to 3	31

3.4.2 ERA 15 Fuel burning

Fuel burning consists of the use of fuel burning equipment that is capable of burning at least 500kg of fuel in an hour. The aggregate environmental score is 35.

3.4.3 ERA 56 Regulated waste storage

Regulated waste storage consists of operating a facility for receiving and storing regulated waste for more than 24 hours. The aggregate environmental score for storing regulated waste other than tyres is 21.

3.4.4 ERA 60 Waste disposal

Waste disposal consists of:

- Operating a facility for disposing of any, or any combination of, the following:
 - Regulated waste
 - General waste
 - Limited regulated waste
 - If the facility is in a scheduled area, no more than 5t of untreated clinical waste in a year;
- Operating a facility for disposing of, in a year, 50t or more of waste consisting of any, or any combination, of the following
 - General waste
 - A quantity of limited regulated waste that is no more than 10% of the total amount of waste received at the facility in a year
 - If the facility is in a scheduled area, no more than 5t of untreated clinical waste.

The thresholds for ERA 60 are shown in Table 7.

Table 7 ERA 60 Threshold table (Environmental Protection Regulation 2008)

Threshold	Aggregate environmental score
1. operating a facility for disposing of, in a year, the following quantity of waste:	
a) less than 50,000t	50
b) 50,000t to 100,000t	82
c) more than 100,000y to 200,000t	100
d) more than 200,000t	110
2. operating a facility for disposing of, in a year, the following quantity of waste:	
a) 50t to 2000t	13
b) more than 2000t to 5000t	20
c) more than 5000t to 10,000t	29

Threshold	Aggregate environmental score
d) more than 10,000t to 20,000t	41
e) more than 20,000t to 50,000t	53
f) more than 50,000t to 100,000t	58
g) more than 100,000t to 200,000t	73
h) more than 200,000t	96

Regulated waste is defined as waste that is commercial or industrial waste, whether or not it has been immobilised or treated, and is of a type or contains a constituent of a type mentioned in Schedule 7 of the Environmental Protection Regulation 2008. This includes, for an element, any chemical compound containing the element; and anything that contains residues of the waste⁴.

Schedule 7 of the Environmental Protection Regulation 2008 contains a number of items, including the following of particular relevance to the petroleum upstream industry:

- 19 encapsulated, chemically fixed, solidified or polymerized wastes
- 36 non-toxic salts, including for example saline effluent;
- 37 hydrocarbons and water mixtures, or emulsions, including oil and water mixtures or emulsions; and
- 53 sewage sludge and residues, including nightsoil and septic tank sludge.

3.4.5 ERA 63 Sewage treatment

Sewage treatment consists of operating one or more sewage treatment works at a site that have a total daily peak design capacity of at least 21 equivalent persons (EP); or operating a sewage pumping station with a total design capacity of more than 40KL in an hour, if the operation of the pumping station is not an essential part of the operation of the sewage treatment works already mentioned. The relevant activity does not include carrying out works involving only infrastructure for the collection of sewage, such as pipes, carrying out works involving either operating or maintaining composting toilets, or treating or recycling greywater. The thresholds for ERA 63 are shown in Table 8.

Table 8 ERA 63 Threshold table (Environmental Protection Regulation 2008)

Threshold	Aggregate environmental score
1. operating no-release works with a total daily peak design peak design capacity of at least 21 EP	No score
2. operating sewage treatment works, other than no-release works, with a total daily peak design capacity of:	
a) 21 to 100 EP	27
b) more than 100 to 1500 EP	53

⁴ Section 65 Environmental Protection Regulation 2008

Threshold	Aggregate environmental score
c) more than 1500 to 4000 EP	76
d) more than 4000 to 10,000 EP	89
e) more than 10,000 to 50,000 EP	114
f) more than 50,000 to 100,000 EP	125
g) more than 100,000 EP	145
3. operating at sewage pumping station	No score

3.5 Notifiable activities

The notifiable activity (as listed in Schedule 3 of the Environmental Protection Act 1994) expected to be carried out on the PL is:

37. Waste storage, treatment or disposal—storing, treating, reprocessing or disposing of waste prescribed under a regulation to be regulated waste for this item (other than at the place it is generated), including operating a nightsoil disposal site or sewage treatment plant where the site or plant has a design capacity that is more than the equivalent of 50,000 persons having sludge drying beds or on-site disposal facilities.

The location information, such as lot on plan, necessary to notify DERM of the carrying out of a notifiable activity, is unknown at this stage of the project. Bow will submit the Notification of Land form to DERM once the potential location is confirmed.

4 FINANCIAL ASSURANCE

A Schedule of Disturbance, calculated in accordance with the latest version of DERM's Guideline: Financial assurance for petroleum activities, is attached to the application that this EM Plan supports.

The financial assurance calculation is based upon the Initial Development Plan period and will be reviewed periodically. These reviews will be undertaken at least every 5 years when a Later Development Plan is required under the Petroleum & Gas (Production & Safety) Act 2004; but may be more frequent depending upon the Operational Plan period. Bow will prepare an operational plan in accordance with the model level 1 conditions prior to commencement of petroleum activities related to this EM Plan.

5 DESCRIPTION OF ENVIRONMENT

This section of the EM Plan provides a description of the existing environment as required by the Guideline: Preparing an EM Plan for CSG activities.

5.1 Matters of National Environmental Significance

Matters of National Environmental Significance include:

- listed threatened ecological communities;
- listed threatened species;
- World Heritage properties;
- National Heritage places;
- wetlands of international importance;
- migratory species protected under international agreements;
- Commonwealth marine areas; and
- nuclear actions (including uranium mines).

Database⁵ searches of the study area and extended study area (shown on Figure 2) were made. The following results were obtained:

- 11 threatened species were identified as possibly occurring or having habitat across the search area;
- 13 migratory species were identified as possibly occurring or having habitat across the search area;
- 12 listed marine species were identified as possibly occurring or having habitat across the search area;
- Three (3) threatened communities are known from or likely to occur within the search area;
- there are no world heritage properties within the search area;
- there are no national heritage places identified across the search area;
- there are no nationally important wetlands identified across the search area; and
- the area is within the same catchment as one wetland of international importance (Ramsar Wetland).

The Commonwealth's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides the regulatory regime for the protection of Matters of National Environmental Significance.

5.1.1 Threatened Species

The following table provides a summary of threatened species that may occur or have habitat that may occur in the study area.

⁵ EPBC Protected Matters Search; Environmental Reporting Tool

Table 9 Threatened species

Common name	Scientific name	Status	Comments
Birds			
Red Goshawk	<i>Erythrotriorchis radiatus</i>	Vulnerable	Species or species habitat likely to occur within area
Squatter pigeon	<i>Geophaps scripta scripta</i>	Vulnerable	Species or species habitat likely to occur within area
Star Finch (eastern), Star Finch (southern)	<i>Neochima ruficauda ruficauda</i>	Endangered	Species or species habitat likely to occur within area
Australian Painted Snipe	<i>Rostratula australis</i>	Vulnerable	Species or species habitat may occur within area
Mammals			
Northern quoll	<i>Dasyurus hallucatus</i>	Endangered	Species or species habitat may occur within area
Greater long-eared bat, South-eastern long-eared bat	<i>Nyctophilus timoriensis</i> (south-eastern form)	Vulnerable	Species or species habitat may occur within area
Reptiles			
Ornamental snake	<i>Denisonia maculata</i>	Vulnerable	Species or species habitat likely to occur within area
Yakka skink	<i>Egernia rugosa</i>	Vulnerable	Species or species habitat likely to occur within area
Dunmall's snake	<i>Furina dunmali</i>	Vulnerable	Species or species habitat may occur within area
Brigalow scaly-foot	<i>Paradelma orientalis</i>	Vulnerable	Species or species habitat likely to occur within area
Fitzroy river turtle, Fitzroy tortoise, Fitzroy turtle	<i>Rheodytes leukops</i>	Vulnerable	Species or species habitat may occur within area

5.1.2 Migratory Species

Australia is party to international conventions and agreements to protect many migratory species. These conventions include:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA);
- Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention); and
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Many migratory species listed under the international conventions and agreements that Australia is party to, are now protected under the Environment Protection and Biodiversity Conservation Act 1999.

Migratory species which are known, likely or may occur within the study area are shown in Table 10.

Table 10 Migratory species

Common name	Scientific name	Status	Comments
Migratory terrestrial species			
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	Migratory CAMBA	Species or species habitat likely to occur within area
White-throated Needletail	<i>Hirundapus caudacutus</i>	Migratory CAMBA JAMBA ROKAMBA	Species or species habitat may occur within area
Rainbow bee-eater	<i>Merops ornatus</i>	Migratory JAMBA	Species or species habitat may occur within area
Black-faced monarch	<i>Monarcha melanopsis</i>	Migratory Bonn	Species or species habitat may occur within area
Satin fly-catcher	<i>Myiagra cyanoleuca</i>	Migratory Bonn	Species or species habitat likely to occur within area
Migratory wetland species			
Great egret, White egret	<i>Ardea alba</i>	Migratory CAMBA JAMBA	Species or species habitat may occur within area
Cattle egret	<i>Ardea ibis</i>	Migratory CAMBA JAMBA	Species or species habitat may occur within area
Latham's snipe, Japanese snipe	<i>Gallinago hardwickii</i>	Migratory Bonn CAMBA JAMBA ROKAMBA	Species or species habitat may occur within area
Australian cotton pygmy-goose	<i>Nettapus coromandelianus albigennis</i>	Migratory	Species or species habitat may occur within area
Painted snipe	<i>Rostratula benghalensis</i> s. lat.	Migratory CAMBA	Species or species habitat may occur within area
Migratory marine birds			
Fork tailed swift	<i>Apus pacificus</i>	Migratory CAMBA JAMBA ROKAMBA	Species or species habitat may occur within area
Great egret, White egret	<i>Ardea alba</i>	Migratory CAMBA JAMBA	Species or species habitat may occur within area
Cattle egret	<i>Ardea ibis</i>	Migratory CAMBA JAMBA	Species or species habitat may occur within area

5.1.3 Listed marine species

Under the United Nations Convention on the Law of the Sea, Australia has rights and responsibilities over 16 million square kilometers of oceans. Within this area, the Australian Government uses the EPBC Act to protect and manage threatened, migratory and marine species.

Listed marine species which are known, likely or may occur within the study area are shown in Table 11.

Table 11 Marine species

Common name	Scientific name	Status	Comments
Birds			
Magpie goose	Anseranus semipalmata	Listed – overfly marine area	Species or species habitat may occur within area
Fork tailed swift	Apus pacificus	Listed – overfly marine area	Species or species habitat may occur within area
Great egret, White egret	Ardea alba	Listed – overfly marine area	Species or species habitat may occur within area
Cattle egret	Ardea ibis	Listed – overfly marine area	Species or species habitat may occur within area
Latham’s snipe, Japanese snipe	Gallinago hardwickii	Listed – overfly marine area	Species or species habitat may occur within area
White-bellied Sea-eagle	Haliaeetus leucogaster	Listed	Species or species habitat likely to occur within area
White-throated Needletail	Hirundapus caudacutus	Listed – overfly marine area	Species or species habitat may occur within area
Rainbow bee-eater	Merops ornatus	Listed – overfly marine area	Species or species habitat may occur within area
Black-faced monarch	Monarcha melanopsis	Listed – overfly marine area	Species or species habitat may occur within area
Satin fly-catcher	Myiagra cyanoleuca	Listed – overfly marine area	Species or species habitat likely to occur within area
Australian cotton pygmy-goose	Nettapus coromandelianus albipennis	Listed – overfly marine area	Species or species habitat may occur within area
Painted snipe	Rostratula benghalensis s. lat.	Listed – overfly marine area	Species or species habitat may occur within area

5.1.4 Threatened Communities

Three threatened communities are identified within the PL application area. These are listed in Table 12, and described further below.

Table 12 Threatened communities

	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Weeping Myall Woodlands
	Endangered	Endangered	Endangered
PLA 388	Community known to occur within area	Community may occur within area	Community may occur within area

5.1.4.1 Brigalow (*Acacia harpophylla* dominant and co-dominant)

In Queensland this ecological community is defined to include sixteen Regional Ecosystems (RE): RE 6.4.2; RE 11.3.1; RE 11.4.3; RE 11.4.7; RE 11.4.8; RE 11.4.9; RE 11.4.10; RE 11.5.16; RE 11.9.1; RE 11.9.5; RE 11.9.6; RE 11.11.14; RE 11.12.21; RE 12.8.23; RE 12.9-10.6 and RE 12.12.26. Of these, RE 11.3.1 is mapped by DERM within the study area.

All of these are “endangered” regional ecosystems (biodiversity status and Vegetation Management Act 1999 status) and therefore Category B environmentally sensitive areas, subject to the relevant environmental authority conditions. Not all vegetation in which Brigalow is a prominent component is included within the listed ecological community and 11 regional ecosystems within Queensland which contain Brigalow are excluded from the listed ecological community⁶.

In Queensland, 85% of the listed Brigalow ecological community remnants occur on flat to gently undulating Cainozoic clay plains that are not associated with current alluvium, and on gently undulating landscapes on generally horizontally bedded fine-grained sedimentary rocks. About 10% of remnants are associated with river and creek flats, and the remainder with old loamy and sandy plains, basalt plains and hills, or hills and lowlands on metamorphic or granitic rocks.

Brigalow regrowth is part of the listed ecological community only if it retains the species composition and structural elements typical of that found in undisturbed areas of the listed Brigalow ecological community. Where regrowth Brigalow is located in a declared area of high conservation or is more than 15 years old; clearing will require a permit under Queensland legislation and a referral under the EPBC Act. In general, areas that have been cleared within the last 15 years will not have regained the structure and species composition typical of remnant Brigalow and will therefore not require a referral under the EPBC Act⁷.

⁶ Listing advice Brigalow (*Acacia harpophylla* dominant and co-dominant) www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=28&status=Endangered

⁷ www.environment.gov.au/biodiversity/threatened/publications/brigalow-regrowth.html

5.1.4.2 Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

This community is typically composed of a mixture of forbs and native grasses and there are a number of key diagnostic characteristics and condition thresholds. Patches of good quality and best quality are included in the listing. It includes seven regional ecosystems, including RE 11.3.21, RE 11.4.4, RE 11.4.11, RE 11.8.11, RE 11.9.3, RE 11.9.12 and RE 11.11.17. None of these regional ecosystems are mapped by DERM within the study area.

5.1.4.3 Weeping Myall Woodlands

This listing is effective from 7 January 2009. The Weeping Myall Woodlands occur in a range from open woodlands to woodlands, generally 4-12 m high, in which Weeping Myall (*Acacia pendula*) is the sole or dominant overstorey species. Other common names include boree and myall. It generally occurs on flat areas, shallow depressions or gilgais on raised (relict) alluvial plains, not associated with active drainage channels. A number of criteria must be met for a patch of Weeping Myall woodland to be included in the listed community, including being at least 0.5 hectares in size and comprising at least 50% Weeping Myall in the canopy: the details are contained in the listing advice⁸. In Queensland, the Weeping Myall Woodlands ecological community is restricted to small patches that occur within two regional ecosystems; RE 11.3.2 and RE 11.3.28. Both of these ecosystems have an 'of concern' status with respect to both Vegetation Management Act 1999 and biodiversity. Although small patches of Weeping Myall may also occur in RE 11.9.3a and RE 4.9.6, these occurrences are on different landscape and soil types and are not considered to be part of the listed ecological community. None of these regional ecosystems are mapped by DERM within the study area.

5.1.5 National Heritage Places

The Australian Heritage Database contains information on over 20,000 places and includes places on the World Heritage List, the National Heritage List, the Commonwealth Heritage List, the Register of the National Estate, List of Overseas Places of Historic Significance to Australia and places under consideration or that may have been under consideration for any one of these lists.

The Register of the National Estate (RNE) has been frozen since 2006 following amendments to the EPBC Act. There is no provision in that Act to transfer listings from the RNE to the National Heritage List or the Commonwealth Heritage List. Under an agreement between the Commonwealth and the States and Territories, Registered places will be considered for inclusion in appropriate Commonwealth, State/Territory heritage listings. The National Heritage List has been established to list places of outstanding heritage significance to Australia and includes natural, historic and Indigenous places. It is compiled and maintained by the Department of the Sustainability, Environment, Water, Population and Communities.

No Australian Heritage sites were identified within the study area.

⁸ Weeping Myall Woodlands listing advice,
www.environment.gov.au/biodiversity/threatened/communities/pubs/98-listing-advice.pdf

5.1.6 Wetlands of International Importance

The study area is located within the same catchment as one internationally important wetland (Ramsar site).

The Shoalwater and Corio Bays Area Ramsar site is located about 50km north of Rockhampton, and is set around Shoalwater Bay in the Shoalwater Bay Military Training Area and includes adjacent lands and marine waters from Broome Head in the north to the southern boundary of the training area. The area contains a wide diversity of landscape types, and includes wetlands comprising freshwater lagoons, swamps and streams leading to estuarine, intertidal and marine wetlands. The site supports a wide diversity of species and a number of nationally threatened species including the Green Turtle, Hawksbill Turtle, Flatback Turtle, Loggerhead Turtle and Honey Blue-eye fish and Oxleyan Pygmy Perch. Additionally many migratory bird species protected under international conservation agreements have been recorded at the site.

5.2 Relevant stakeholders

Relevant stakeholders include landowners and overlapping tenure holders. These are discussed elsewhere. Other stakeholders are shown in Table 13.

Table 13 Identified stakeholders

Stakeholder	Role
Fitzroy Water Quality Advisory Group	This group (FWQAG) aims to provide a consultative forum to collect views and information as an input into effective Government decision making on water quality issues in the Fitzroy River Basin.
Fitzroy Basin Association	Community based organisation to promote sustainable development in Central Queensland
Central Highlands Regional Council	The local government authority for Bow's operations.
Agforce Queensland	Agforce represents Queensland's rural producers and with the aim to ensure long term growth, viability, competitiveness and profitability of broad acre industries of cattle, grain, sheep and wool.
Capricorn Conservation Council	This group is a not-for-profit organisation that campaigns on regional environmental issues in Central Queensland.
State and Federal electoral members	Federal electorate of Flynn member Ken O'Dowd. State electorate of Gregory member Vaughan Johnson.

5.3 Sensitive places

A sensitive place is defined by DERM⁹ to mean:

- A dwelling (including residential allotment, mobile home or caravan park, residential marina or other residential premises, motel, hotel or hostel); or
- A library, childcare centre, kindergarten, school, university or other educational institution; or
- A medical centre, surgery or hospital; or
- A protected area; or
- A public park or garden that is open to the public for use than for sport or organised entertainment; or
- A work place used as an office or for business or commercial purposes which is not part of the petroleum activities and does not include employees accommodation or public roads.

No sensitive receptors have been identified within the PL; however a few homesteads and buildings are located outside the PL (shown on Figure 6).

5.4 Category A, B and C environmentally sensitive areas

Category A and Category B environmentally sensitive areas are defined under Section 25 and 26 of the Environmental Protection Regulation 2008. Category C environmentally sensitive areas are most recently listed in Part 4 of the “Guideline for preparing an environmental management plan for coal seam gas activities” released on 31 March 2010.

Environmentally sensitive areas are shown on Figure 7.

5.4.1 Category A

Category A environmentally sensitive areas include:

- all national parks, conservation parks and forest reserves listed under the Nature Conservation Act 1992
- the wet tropics areas under the Wet Tropics World Heritage Protection and Management Act 1993;
- a restricted area under the Mineral Resources Act 1989 that includes a constructed water reservoir;
- the Great Barrier Reef Region under the Great Barrier Reef Marine Park Act 1975 (Cwth); and
- a marine park under the Marine Parks Act 2004, other than general use zones.

There are no Category A environmentally sensitive areas identified in the PL application area.

⁹ Model Level 1 conditions

Figure 6 Infrastructure and sensitive places

Figure 7 Environmentally sensitive areas

5.4.2 Category B

Category B environmentally sensitive areas include:

- a coordinated conservation area, a wilderness area, a world heritage management area, an international agreement area, an area of critical habitat or major interest identified under a conservation plan, and an area subject to an interim conservation order under the Nature Conservation Act 1992;
- areas subject to the following conventions to which Australia is a signatory:
 - the Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 23 June 1979)
 - the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar, 2 February 1971)
 - the Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 16 November 1972);
- a zone of a marine park under the Marine Parks Act 2004;
- an area to the seaward side of the highest astronomical tide;
- a place of cultural heritage significance or a registered place under the Queensland Heritage Act 1992;
- an area recorded in the Aboriginal Cultural Heritage Register under the Aboriginal Cultural Heritage Act 2003 other than the 'Stanbroke Pastoral Development Holding under the Land Act 1994;
- a feature protection area, State forest park or Scientific area under the Forestry Act 1959;
- a fish habitat area under the Fisheries Act 1994;
- a place in which a marine plant under the Fisheries Act 1994 is situated; and
- an endangered regional ecosystem identified in the DERM Regional Ecosystem Description Database.

A small area of endangered regional ecosystem in the north of the PL area is the only identified Category B environmentally sensitive area (refer to Figure 7).

5.4.3 Category C

Category C environmentally sensitive areas include:

- nature refuges as defined under the Nature Conservation Act 1992;
- koala habitat areas as defined under the Nature Conservation Act 1992;
- State Forest or Timber Reserves as defined under the Forestry Act 1959;
- Declared catchment areas under the Water Act 2000;
- Resources Reserves under the Nature Conservation Act 1992;
- an area identified as "essential habitat" defined under the Vegetation Management Act 1999, for a species of wildlife listed as Endangered, Vulnerable or Rare or Near Threatened under the Nature Conservation Act 1992;
- any wetland shown on the 'map of referable wetlands' available from DERM's website; or
- "Of concern" regional ecosystems identified in the database maintained by DERM called "Regional ecosystem description database" containing regional ecosystem numbers and descriptions.

Small areas of “of concern” regional ecosystem in the north of the PL area are the only identified Category C environmentally sensitive area (refer to Figure 7).

5.5 Other existing tenures and land use in vicinity

It is a requirement under the Petroleum and Gas (Production and Safety) Act 2004 that the holders of petroleum leases for coal seam gas consult with overlapping tenure holders for coal or oil shale exploration or development tenures issued under the Mineral Resources Act 1989.

5.5.1 Overlapping resource tenures

ATP 1025P was first granted on 24 February 2009. It is currently held by Bow Energy (100%). The PL area has been chosen so that there is only one overlapping coal tenure (refer to Table 14 and Figure 8).

There are no overlapping geothermal, mineral or greenhouse gas tenures.

Table 14 Overlapping tenure

Tenure	Status	Lodgement	Grant	Expiry	Holder
EPC 1827	Granted	17 Jul 2009	25 Nov 2009	24 Nov 2014	Area Coal Pty Ltd

5.5.2 Land use

Within the PL area, the primary land use is defined as ‘production from relatively natural environments’. A small area to the west of the PL, corresponding to the discrete strategic cropping land that is off-lease as shown on Figure 9, has been assigned a primary land use of ‘production from dryland agriculture and plantations’.

Agricultural land classes are described in Table 15 and shown on Figure 9. Agricultural land classes are based on an assessment of the agricultural suitability of the land for specified agricultural uses. Agricultural land suitability is a rating of the ability of the land to maintain a sustainable level of productivity; and factors that are used to assess this include soil, topography and climatic limitation. It does not include an evaluation of economic factors.

Table 15 Agricultural land classes¹⁰

Class	Description
Class A	Crop land – Land that is suitable for current and potential crops with limitations to production which range from none to moderate levels.
Class B	Limited crop land – Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is consideration suitable for cropping.
Class C	Pasture land – Land that is suitable only for improved or native pastures due to

¹⁰ Planning Guidelines: The Identification of Good Quality Agricultural Land, Department of Primary Industries and Department of Housing, Local Government and Planning Queensland. 1993

Class	Description
	limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment. C1 – Suitable for grazing high quality pastures, either sown pastures where ground disturbance is possible or native pastures on higher fertility soils. C2 – Suitable for grazing native pastures with or without the addition of pasture species introduced without ground disturbance. C3 – Suitable for light grazing of native pastures in accessible areas, otherwise very steep land more suited to forestry, conservation or catchment protection.
Class D	Non-agricultural land – Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Most of the PL area is mapped as Class C1 with the exception of the north-west most portion which is mapped as Class A. This Class A land coincides with the area mapped as Strategic Cropping Land shown on Figure 9.

5.5.3 Strategic cropping land

In 2009 the State Government undertook a review of the State Planning Policy on the conservation of cropping land¹¹. This review identified both urban development and mining, including petroleum and gas industries, as continued threats to Good Quality Agricultural Land (GQAL). A discussion paper was released in February 2010 and a consultation report in June 2010. This was followed on 23 August by the Strategic Cropping Land Policy Framework with new legislation planned for introduction in early 2011. This legislation is proposed to include:

- A new Act specifically for strategic cropping land (SCL) resources;
- A new State Planning Policy under the Sustainable Planning Act 2009; and
- Amendments to existing resource legislation to recognise the requirements of the new Act for strategic cropping land resources.

Whilst on the ground assessment will be necessary to confirm if a mapped area is strategic cropping land, trigger maps have been developed by the State government based on currently available soil, land and climate information. Mapped areas of SCL in the PL area are shown on Figure 9. These areas are subject to confirmation in accordance with criteria for identifying SCL which are not yet finalised. Mapped SCL is confined to the north-western most part of the PL.

¹¹ State Planning Policy 1/92 Development and the Conservation of Agricultural Land (SPP 1/92)

Figure 8 Overlapping tenures

Figure 9 Land use and strategic cropping land

5.6 Endangered, vulnerable, rare or near threatened species

No rare or threatened flora or fauna species were identified during database searches.¹²

However, field surveys undertaken in relation to the required approvals for the Blackwater Power Station¹³ identified one endangered species listed under the Nature Conservation Act 1992. *Solanum elachophyllum* (a solanum) was found associated with regrowth Brigalow on gilgai approximately 1/2km north-west of the power station site. This falls outside the PL area, but does indicate the possibility of the species being present in other regrowth Brigalow on black cracking clay gilgai soils. This species is known from limited collections in the Leichhardt district of Queensland, occurring on cracking clay soils associated with brigalow (*Acacia harpophylla*), belah (*Casuarina cristata*), and Dawson River blackbutt (*Eucalyptus cambageana*)¹⁴.

5.7 Dominant ecosystems

The regional ecosystems classification scheme and the associated Biodiversity Planning Assessments are part of the biodiversity planning framework. The Regional Ecosystem Description Database lists the status of regional ecosystems as gazetted under the Vegetation Management Act 1999 and the Biodiversity Status as recognised by the DERM. The Vegetation Management Act 1999 status is based on an assessment of the pre-clearing and remnant extent of a regional ecosystem, whilst the Biodiversity Status is based on an assessment of the condition of the remnant vegetation in addition to the pre-clearing and remnant extent of a regional ecosystem. The criteria are described below in Table 16¹⁵.

Table 16 Criteria for regional ecosystems

Status Criteria	Vegetation Management Act 1999	Biodiversity status
Endangered	Remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares.	Less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss; or 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or

¹² Wildlife Online

¹³ Biodiversity Assessment and Management Pty Ltd, 2009 :Blackwater Power Station Project, Flora and Fauna Habitat Assessment

¹⁴

http://www.flora.sa.gov.au/efsa/lucid/Solanaceae/Solanum%20species/key/Australian%20Solanum%20species/Media/Html/Solanum_elachophyllum.htm

¹⁵ After www.epa.qld.gov.au/nature_conservation/biodiversity/regional_ecosystems/introduction_and_status/

Status Criteria	Vegetation Management Act 1999	Biodiversity status
		It is a rare regional ecosystem subject to a threatening process.
Of concern	Remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 30 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares.	10-30 per cent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.
Not of concern/No concern at present	Remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares.	The degradation criteria listed above for endangered or of concern regional ecosystems are not met.

Each regional ecosystem was defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil; and represented by a three part identifying number (bioregion:landform:vegetation).

Regional ecosystems present in PL 388 area are shown in the table below and on Figure 10.

Table 17 Regional ecosystems

Regional ecosystem	Status ¹⁶	Description	Area in PL
11.3.3	Of concern (BD) Of concern (VMA)	Eucalyptus coolabah (coolibah) woodland on alluvial plains. Woodland to open-woodland with a grassy understorey. Mid-layer often absent, but scattered tree or shrub species such as E.populnea (poplar box), Melaleuca bracteata (black tea-tree), Alectryon oleifolius (bullock bush), Terminalia oblongata (yellow-wood), Acacia pendula (weeping myall), A.cabbagei (gidgee) and occasionally Muehlenbeckia florulenta (lignum) may be present. The ground layer is dominated by a range of grass and forb species	2.1 hectares 0.12%

¹⁶ BD = biodiversity status, VMA = Vegetation Management Act 1999 status

Regional ecosystem	Status ¹⁶	Description	Area in PL
		depending on season, soil and management conditions. Can include small areas of grassland with scattered trees.	
11.3.25	Of concern (BD) Least concern (VMA)	<p>Eucalyptus tereticornis (forest red gum) or E.camaldulensis (river red gum) woodland fringing drainage lines.</p> <p>Open forest to woodland. Other species such as Casuarina cunninghamiana (river she-oak), E.coolabah, Melaleuca bracteata, Melaleuca viminalis (weeping bottle brush), and Angophora floribunda (rough-barked apple) are commonly present and may be locally dominant. An open to sparse, tall shrub layer is frequently present dominated by species including Acacia salicina (sally wattle), A. stenophylla (belalie) or Lysiphyllum carronii (Queensland ebony). Low shrubs are present but rarely form a conspicuous layer. Ground cover is open to sparse and dominated by perennial grasses, sedges or forbs.</p>	In combination with 11.3.25/11.3.3/11.3.3c 14.4 hectares 0.87%
11.3.1	Endangered (BD) Endangered (VMA)	<p>Acacia harpophylla (brigalow) and/or Casuarina cristata (belah) open forest on alluvial plains.</p> <p>Open forest with or without scattered emergent Eucalyptus spp. including E.coolabah, E.largiflorens (black box), E.populnea, E. orgadophila (mountain coolibah) and E.pilligaensis (grey box). A low tree layer dominated by Geijera parviflora (wilga) and Eremophila mitchellii (false sandalwood) is usually present. Tree height is generally 11-15m and low tree layer between 2 and 8m where present. Ground cover is</p>	6.6 hectares 0.4%

Regional ecosystem	Status ¹⁶	Description	Area in PL
		generally sparse.	
11.3.3c	Of concern (BD) Of concern (VMA)	Palustrine wetland (e.g. vegetated swamp). Eucalyptus coolabah woodland to open woodland with a sedge or grass understory in back swamps and old channels. The ground layer is dominated by a range of sedge or grass species depending on hydrological regime, soil and management conditions. Characteristic ground layer species include Eleocharis spp (spikerushes) or Marsilea spp (water clover) (in more frequently inundated sites tending toward a greasy ground layer in less frequently flooded sites.	In combination with 11.3.25/11.3.3/11.3.3c 14.4 hectares 0.87%
Non remnant			98%

Areas of high value regrowth are identified from existing mapping, and are shown on Figure 10. Small areas comprising 22.61 hectares (1.37%) of high value regrowth containing endangered regional ecosystems and 7.5 hectares (0.45%) of high value regrowth containing of concern regional ecosystems are present within the PL area.

Figure 10 Regional ecosystems

5.8 Weeds

Under section 555 of the Petroleum & Gas (Production & Safety) Act 2004 the holder of a petroleum authority must take reasonable steps to ensure that in entering or leaving land in the area of the authority, or in carrying out any authorised activity for the authority, that no reproductive material of any declared pest is dispersed. This includes declaration under the Land Protection (Pest & Stock Route Management) Act 2002 and declarations under a relevant local law.

The Land Protection (Pest and Stock Route Management) Act 2002 defines the Pest Classes:

- Class 1 pests are not commonly present in Queensland and, if introduced, would cause an adverse economic, environmental or social impact. Class 1 pests established in Queensland are subject to eradication from the state. Landholders must take reasonable steps to keep land free of Class 1 pests.
- Class 2 pests are established in Queensland and have, or could have, an adverse economic, environmental or social impact. Their management requires coordination and they are subject to existing programs. They may also be new pests requiring state coordination, and subject to local government, community or landholder-led programs. Landholders must take reasonable steps to keep land free of Class 2 pests.
- Class 3 pests are established in Queensland and have, or could have, an adverse economic, environmental, or social impact. Their impact is primarily environmental. A pest control notice for Class 3 pests can be issued only for land that is, or is adjacent to, an environmentally significant area.

Twenty introduced plants have been further identified as Weeds of National Significance (WoNS) based on the potential for spread, invasiveness, impact and socioeconomic and environmental values. Seventeen of these currently occur in Queensland. Four of these were identified in the EPBC desktop search as having habitat that is likely to or may occur in the area. These are shown in Table 18.

Table 18 WoNS which may be present

Common name	Scientific name	Status	Occurrence
Hymenachne, West Indian grass	Hymenachne amplexicaulis	WoNS Class 2	Species or species habitat may occur within area
Lantana, red-flowered sage, white sage, wild sage	Lantana camara	WoNS Class 3	Species or species habitat may occur within area
Parkinsonia, jelly bean tree, horse bean	Parkinsonia aculeata	WoNS Class 2	Species or species habitat may occur within area
Parthenium, bitter weed, false ragweed	Parthenium hysterophorus	WoNS Class 2	Species or species habitat likely to occur within area

Prior to council amalgamation on 15 March 2008, Central Highlands Regional Council comprised a number of shire council areas. The PL area falls within the previous Duaringa Shire area. Duaringa Shire had declared pests under Subordinate Local Laws. These are shown in Table 19.

Table 19 Locally declared weeds

Common name	Scientific name	Status
African love grass	Eragrostis curvula	Declared Duaringa Shire
Blue heliotrope	Heliotropium amplexicaule	Declared Duaringa Shire
Sword pear	Acantherocereus tetragonus	Declared Duaringa Shire
Feral leucaena	Leucaena leucocephala (spp leucocephala and spp glabrata)	Declared Duaringa Shire
Sisal	Agave (various spp)	Declared Duaringa Shire`

A desktop search¹⁷ identified three introduced plant species which have been reported in the search area. These are tabulated below.

Table 20 Introduced plants identified in PL area

Common name	Scientific name	Records	Status
Velvety tree pear	Opuntia tomentosa	1	Class 2
Mother of millions	Bryophyllum delagoense	1	Class 2
Athel tree	Tamarix aphylla	1	Class 3

Field surveys undertaken in conjunction with the approval process for the Blackwater power station¹⁸ identified one weed species, harrisia cactus (Harrisia martini) in the area of the power station. This is a Class 1 pest and commonly occurs in disturbed ground (i.e. adjacent to fence posts). Its presence adjacent to the power station indicates that it potentially could occur in the PL area. Since there will almost certainly be project movements between the power station and the PL area, appropriate management to prevent the spread of harrisia will be required.

5.9 Topography

The PL area falls within Land Zone 3 in the regional ecosystem descriptions. Land zone 3 comprises Quaternary alluvial systems including flood plains, alluvial plains, alluvial fans, terraces, levees, swamps, channels, closed depressions and fine textured palaeo-estuarine deposits. It also includes estuarine plains currently under fresh water influence, inland lakes and associated dune systems. It includes a diverse range of soils, predominately Vertosols and Sodosols.

The topography of PL 388 is relatively flat, gently sloping from east to west towards Blackwater Creek.

¹⁷ Wildlife Online http://www.derm.qld.gov.au/wildlife-ecosystems/wildlife/wildlife_online/

¹⁸ Biodiversity Assessment and Management Pty Ltd, 2009 :Blackwater Power Station Project, Flora and Fauna Habitat Assessment

5.10 Geology and soils

5.10.1 Regional Geology - Bowen Basin Geological Setting

The PL area is within the Bowen Basin.

The Bowen Basin represents a major rifting event that took place in the Late Permian along the eastern part of the current Australian continental landmass. The 'rift valley' extended from northern Queensland, south of Townsville, and extended southward, approximately parallel to the current coastline, through Queensland and New South Wales, intersecting the current coast around Sydney.

This was an environment characterised by major coal measure development in several basins along the length of this large rift valley. During this time, the major Late Permian coal measure sequences were deposited in the Bowen Basin in central Queensland and the Bowen Basin sequence underlying the Surat Basin in southern Queensland. Across into New South Wales, analogous coal measures were deposited in the Gunnedah Basin, and across the Sydney Basin from the Hunter to the Illawarra regions.

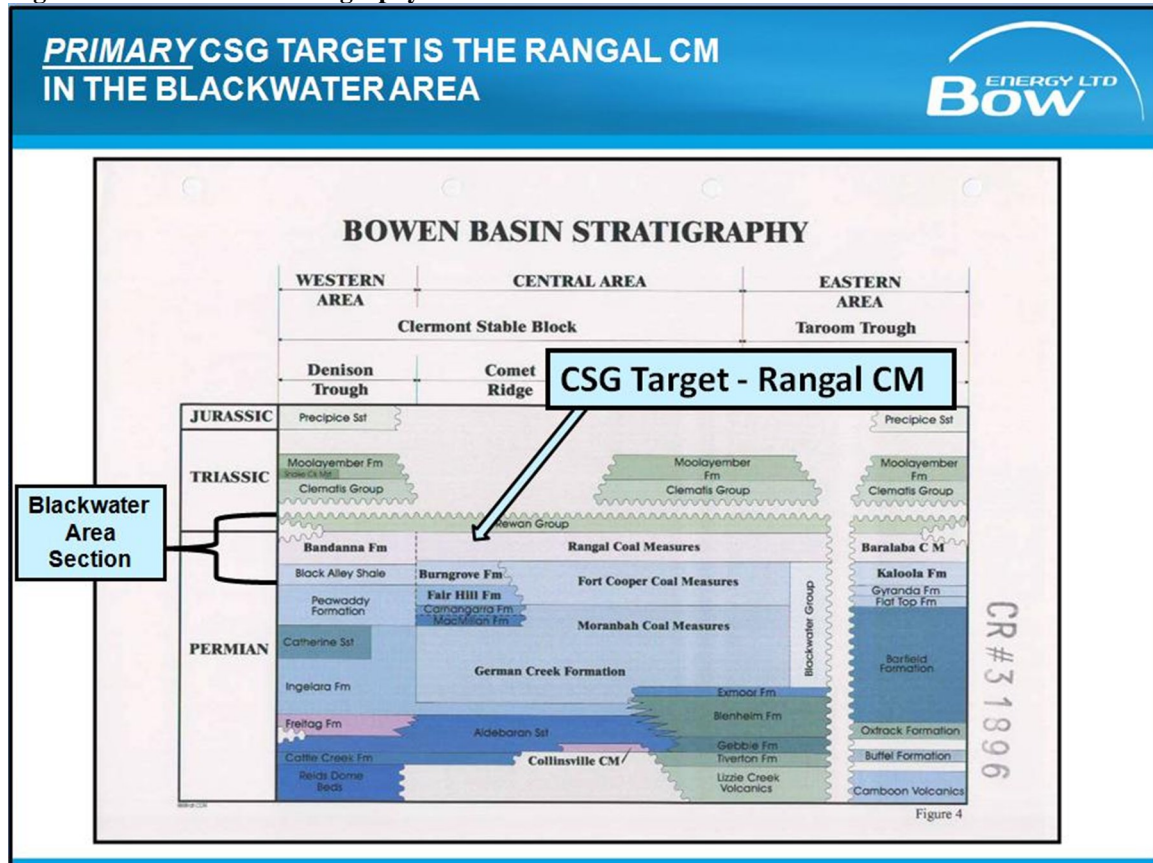
The Bowen, Hunter and Illawarra areas are world class coal mining regions. During the last few years, the Bowen Basin has also been recognised as a world class coal seam gas region.

The tectonic/depositional model for the Bowen Basin consists of a narrow NNW-SSE striking depocentre, rapidly subsiding during the Late Permian, with thick sequences of organic rich, argillaceous and lithic, sediment wedges prograding southward into marine environments. A nearby volcanic arc and associated intrusive activity to the east provided both high geothermal gradients and a source of lithic and occasionally tuffaceous sediment input.

The three cycles of sedimentation most relevant to Bowen Basin coal deposition, from oldest to youngest, are the Moranbah-German Creek Coal Measures, the Fort Cooper Coal Measures, and the Rangal Coal Measures. This stratigraphy is summarised in Figure 11.

The Late Permian Moranbah-German Creek Coal Measures (Moranbah in the north, German Creek in the south) experienced a southerly progradation from fluvial and upper delta plain sedimentation to paralic or marginal marine sedimentation that formed during a period of foreland loading in the Bowen Basin. Together they form a clastic wedge intercalated with laterally continuous coal seams that split and coalesce for some 250 km along the strike of the basin. The coal measures are underlain by and pass laterally to the south into sequences of marine-derived sandstones and siltstones. The MacMillan Formation records a marine transgression that ingressed partially into the basin prior to the main phase of foreland loading and southerly progradation of terrestrial conditions that resulted in the accumulation of the thick, occasionally tuffaceous coal seams of the Fort Cooper Formation and its equivalents during the Late Permian.

Figure 11 Bowen Basin stratigraphy



Thrusting built up the cratonic basin margin in the east, providing abundant clastic input to the basin and continued burial of the coal measures. Foreland loading was maintained by further emplacement of major thrust sheets from the east and sedimentation was characterised by non-marine, lithic sediments with widespread development of the Rangel Coal Measures prior to basin closure and subsequent deformation in the Triassic. coal measures achieved maximum burial during this time, with relatively high geothermal gradients.

5.10.2 Local geology

ATP 1025P is located in the central Bowen Basin and is positioned off the eastern flank of the Comet anticline which is a major structural basin feature. The geological strata present in ATP 1025P consist of Triassic and Permian sediments outcropping and then dipping easterly from the Comet Ridge high. This is shown in Figure 12 and Figure 13 below.

Figure 12 Comet Block Geology

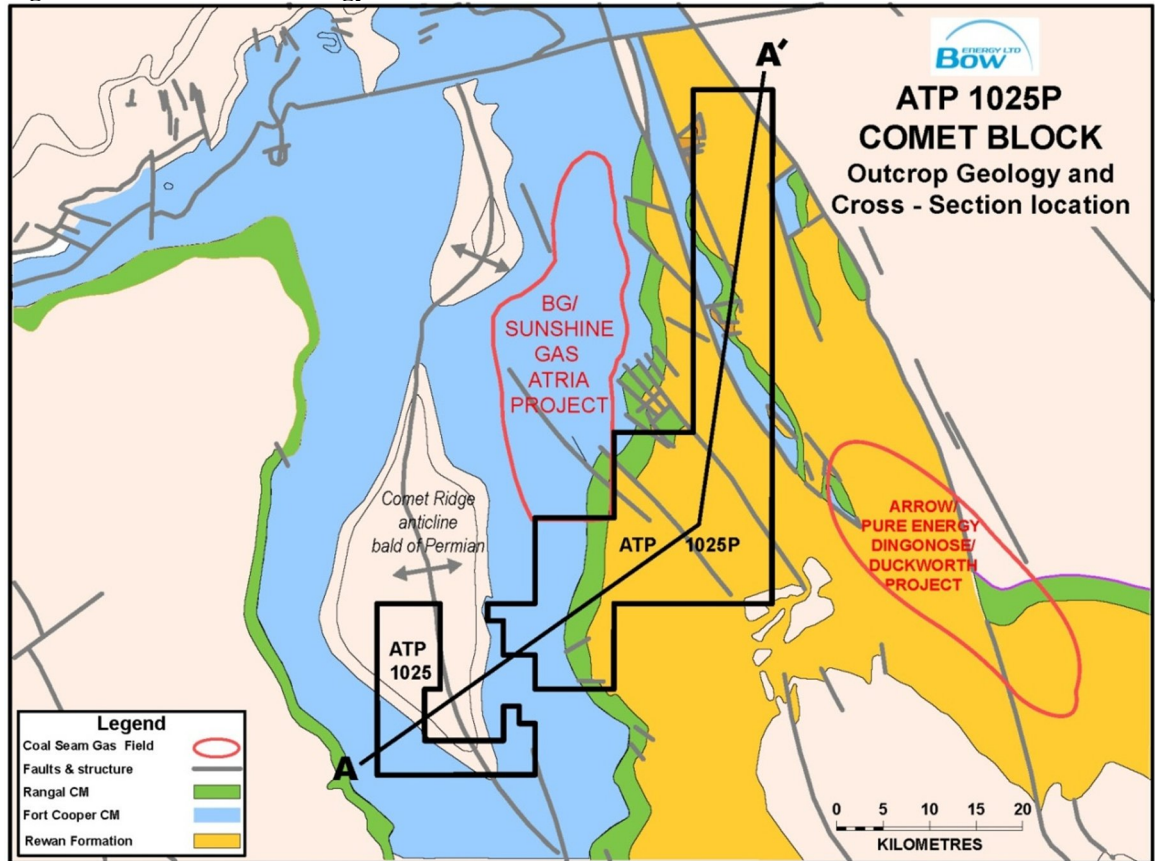
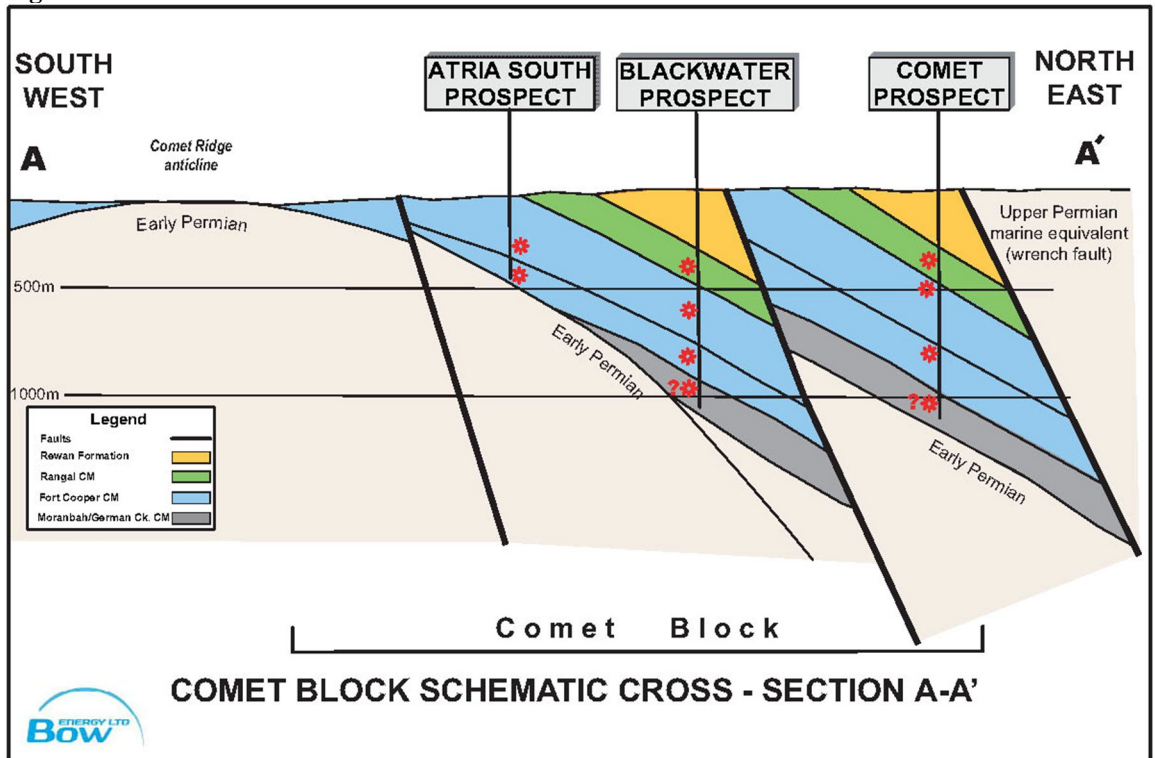


Figure 13 Comet Block Cross Section



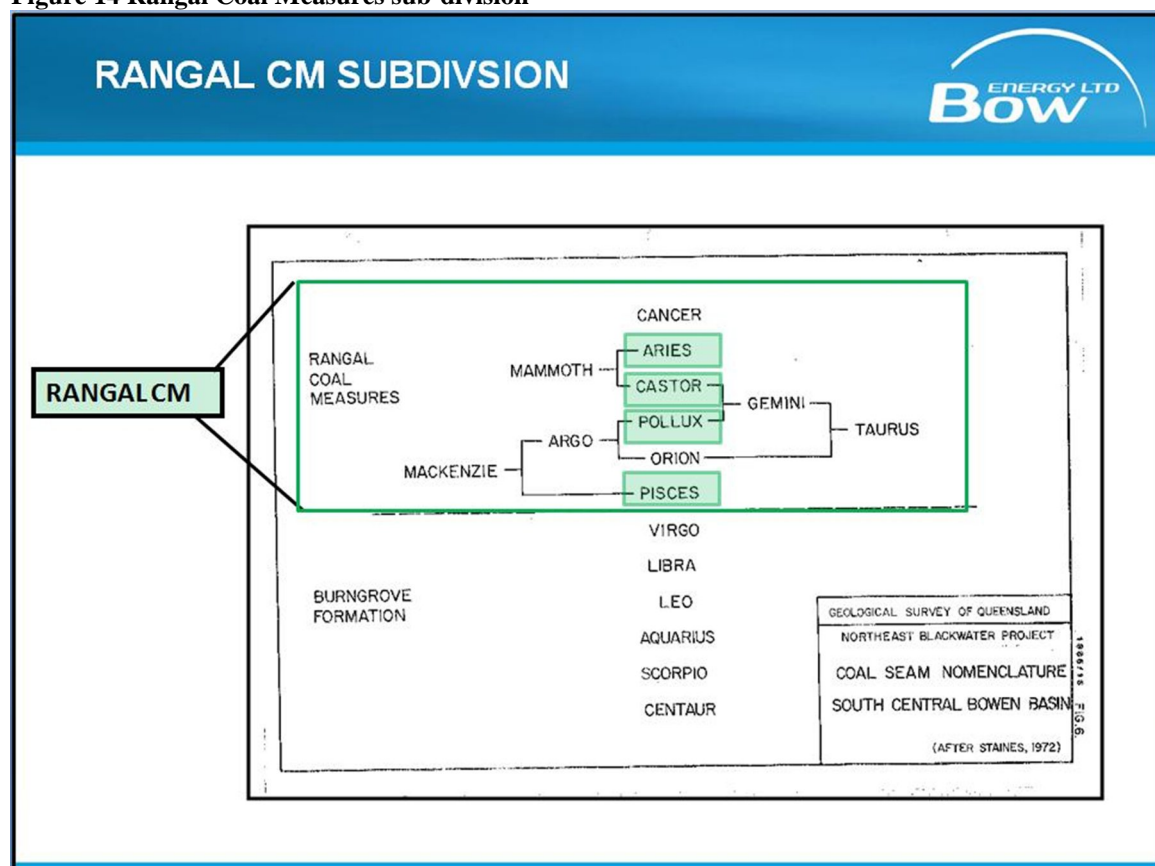
The Comet Ridge was a stable shelf which formed the eastern margin of sedimentation into the Denison Trough during the Early Permian. The Comet Ridge was then eventually overlapped by late early Permian sediments, which were subsequently overlain and overlapped by a largely uniform thickness of Late Permian and Triassic sediments.

The Early Permian Reids Dome Beds and Cattle Creek Formation thin and eventually cease, as they overlap onto the elevated basement of the Comet Ridge. Subsequent Late Permian strata such as the Fair Hill Formation thin and are partially eroded across the Comet Ridge with no Permian or younger sediments being present on the Comet Ridge anticline (as shown in the above A-A' cross section).

The Upper Fair Hill Formation and Rangal Coal Measures outcrop in the western side of ATP1025P and dip towards the southeast. The Rangal Coal Measures represent the main coal seam gas target, with four main correlatable coal seams being present (Figure 14).

Within ATP 1025P, the Rangal Coal Measures deepen up to 1000m in the south east of the permit and have approximately 8-10m of coal with gas contents ranging up to 19m³/t (on a dry ash free basis).

Figure 14 Rangal Coal Measures sub-division



5.10.3 Soils

Soil classification can be made using the Australian Soil Classification¹⁹ (ASC) which is the current preferred standard, and has been in use since about 1996. Classes are defined on the basis of diagnostic horizons or materials and their arrangement in vertical sequence as seen in an exposed soil profile. Prior to the ASC, the most widely used classification was the Northcote Factual Key, which dates from 1960. It is a hierarchical scheme with 5 levels; most attributes are physical soil characteristics and can be determined in the field. Because of the large amount of existing soils classified using the Factual Key it is still an important standard. There is no simple translation between the ASC and the Factual Key since they are fundamentally different in the way they classify the soils.

Soil types within the PL area are shown on Figure 15 and described in Table 21.

Vertosols are clay soils with shrink-swell properties which exhibit strong cracking when dry. At depth these soils have slickensides and/or lenticular structural aggregates. Many exhibit gilgai micro relief. These soils cover the majority of the PL area.

Sodosols are soils with a strong texture contrast between the A horizon and a sodic B horizon which are not strongly acid. There is a clear or abrupt textural B horizon.

Kandosols are soils which lack strong texture contrast, and have massive or weakly structured B horizons, and are not calcareous throughout.

Table 21 Summary of mapped soil types

Map unit	Section	Summary description	Detailed description
Va31	Dy3	Sodosol Yellow duplex	Gentle or moderately undulating lands with some more strongly dissected marginal slopes: dominant soils are loamy-surfaced (6-8 in.) (Dy3.43) and (Dy3.33). Also occurring, more particularly on the marginal slopes, are duplex soils with deeper sandy A horizons (1-20 in.) which are often gravelly. Common forms are (Dy3.43 and Dy3.42). Other duplex soils also occur, particularly along drainage lines; these are chiefly (Db1.13), (Dy2.43), (Dy2.33), (Dd1.13), (Dd1.33), and (Dy4.32). Included in the unit are small areas of moderately to strongly gilgaied cracking clays (Ug5.24) and occasional small areas of sandy red earths (Gn2.11).
CC23	Ug5	Vertosol Cracking clay	Level alluvial flood-plains associated with major streams, often dissected by numerous braided channels and

¹⁹ http://www.clw.csiro.au/aclep/asc_re_on_line/soilhome.htm

Map unit	Section	Summary description	Detailed description
			mostly subject to irregular flooding: dominant soils are deep grey clays (Ug5.24 and Ug5.25) with smaller areas of black or brown clays (Ug5.15) and (Ug5.34); in certain areas the clays may be moderately gilgaied (1-2 ft). Other clays occurring (Ug5.5) and (Ug5.4) have a massive surface. Small levees adjacent to some stream channels have other uniform-textured soils (Uf6.32) and (Um5.4), together with small areas of loamy duplex soils (Dd1.13) and (Dy2.33)
My24	Gn2	Kandosol Massive earths	Gently undulating plains with occasional high ridges: dominant soils are sandy and often gravelly red earths (Gn2.12) with lesser (Gn2.11) and (Gn2.22). Closely associated are sandy duplex soils with moderately deep A horizons and hard clay subsoils (Dy3.42 and Dy3.43). In lower sites are thin-surfaced loamy duplex soils (Dd1.13) and (Dd1.33) or gilgaied cracking clays (Ug5.24) and (Ug5.16)

5.10.3.1 Acid sulfate soils

Acid sulfate soils (ASS) occur predominately in low-lying coastal areas, but may also occur some distance from the coastline where historic low-lying areas have been covered by younger geological material. Areas where there is a high probability of containing ASS can be determined using the following criteria where there is no existing mapping:

- Land with elevation less than 2m AHD;
- Soil and sediment of recent geological age (Holocene);
- Marine or estuarine sediments and tidal lakes;
- Low-lying coastal wetland or back swamp areas, waterlogged or scalded areas, stranded beach ridges and adjacent swales, interdune swales or coastal sand dunes;
- Coastal alluvial valleys;
- Areas where the dominant vegetation is tolerant of salt, acid and/or waterlogging conditions, e.g. mangroves, saltcouch, swamp-tolerant reeds, rushes, grasses, paperbarks (*Melaleuca* spp.) and swamp oak (*Casuarina* spp.); and
- Areas identified as bearing sulfide minerals, coal deposits or marine shales/sediments and deep old estuarine sediments below ground surface of either Holocene or pre-Holocene age.

When exposed to air as a result of drainage or disturbance, ASS produce sulfuric acid and may release toxic quantities of iron, aluminum and heavy metals. This can have significant environmental, health, engineering and economic effects. The main ecological effects of ASS are habitat degradation and poor plant productivity. In waterway habitats drainage from oxidised ASS may destroy food resources, displace biota, precipitate iron that smothers vegetation and microhabitat, alter the physical and chemical properties of the water and degrade spawning and nursery grounds. Poor productivity and stunted growth at low soil pH can be caused by the toxic effects of aluminium, iron and manganese, deficiency in calcium, magnesium and potassium, decrease in soil microbes responsible for nitrogen fixing and low availability of nutrients.

The exposure and disturbance of ASS should be limited as much as possible; and where it cannot be avoided, development should include treatment and management to mitigate the potential adverse impacts.

State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils (SPP 2/02) deals with development assessment in areas where ASS may be present.

It is considered unlikely that ASS will be present in the PL area; however the presence of coal in the area, depending upon the depth of overburden, indicates that a precautionary approach is advisable.

Figure 15 Soils

5.11 Watercourses, wetlands, springs

5.11.1 Declared Catchments

Areas immediately surrounding particular water storages are declared as “catchment areas” under the Water Act 2000, to protect water quality. Development within these areas requires development approval from the relevant State Government department. They may also be Restricted Areas under the Mineral Resources Act 1989.

There are no declared catchments or restricted areas in the PL area.

5.11.2 Catchments and Watercourses

The PL area is located within the Fitzroy River Basin catchment (see Figure 16). The Fitzroy River catchment covers an area of almost 150,000 km² and is the second largest catchment in Australia. The Mackenzie River and Dawson River form the Fitzroy River where they join at Daringa. Because of its size and fan-like shape, the catchment is capable of producing severe flooding after heavy rainfall events. Major floods can result from either the Dawson or the Mackenzie Rivers and their tributaries, including the Comet River, Nogoia River, and Isaac-Connors River. The PL area is located within the Mackenzie River sub-catchment.

A draft consultation paper was released by the State Government in December 2010: “Establishing Environmental Values, Water Quality Guidelines and Water Quality Objectives for Fitzroy Basin Waters”²⁰. The State Government is working towards establishing the environmental values for waters of the Fitzroy Basin.

Locally, Blackwater Creek and a number of unnamed tributaries flow through the PL area. Blackwater Creek is ephemeral and has undergone a number of diversions by Wesfarmers Curragh Pty Ltd as a result of the Curragh Mine operation. Blackwater Creek upstream of the PL area and Curragh Mine receives treated effluent from the Blackwater Sewage Treatment Plant.

The water quality of Blackwater Creek has been reported as highly variable²¹. pH is neutral to slightly alkaline. Turbidity is highly dependent on flow and can vary by many orders of magnitude. Salinity generally increases with decreasing flow as the water is evaporated.

Flood flows were estimated for the Blackwater Creek diversions at 84 m³/s for a two year annual recurrence interval (ARI) and 857 m³/s for a 100 year ARI.

²⁰

http://www.derm.qld.gov.au/environmental_management/water/environmental_values_environmental_protection_water_policy/pdf/draft-values-objectives-fitzroy.pdf

²¹ PB, 2007: Blackwater Creek Diversion Initial Advice Statement. Prepared for Wesfarmers Curragh Pty Ltd. Unpublished report, December 2007.

Figure 16 Water resources

5.11.3 Wetlands

5.11.3.1 Wetlands of International Significance

The study area is located within the same catchment as the Shoalwater and Corio Bays Ramsar site, an internationally important wetland (refer to Section 5.1.6). The PL area is located more than 200km from this Ramsar site and it is considered unlikely that petroleum activities carried out on the PL will impact directly or indirectly on the Ramsar site.

5.11.3.2 Nationally Important Wetland Sites

There are no nationally important wetland sites within the PL area.

5.11.3.3 Wetlands Protection Areas

On 2 May 2010, the Queensland Government introduced a package of wetland protection measures including the Temporary State Planning Policy 1/10: Protecting Wetlands of High Ecological Significance (HES) in Great Barrier Reef Catchments. This was to ensure that development involving high impact earthworks in or near HES wetlands is appropriately planned, located, designed, constructed and operated. This temporary SPP is in effect for 12 months while a permanent policy is developed. The temporary SPP applies to freshwater, non-riverine wetlands of high ecological significance with the Great Barrier Reef catchments, mapped as wetland protection areas.

A draft SPP was released for public consultation on 10 December 2010, Draft State Planning Policy: Protecting Wetlands of High Ecological Significance in Great Barrier Reef (GBR) Catchments, which includes the catchments covered by the temporary SPP and the southern Great Barrier Reef catchments within the Wide Bay-Burnett region.

The PL area lies within a Great Barrier Reef catchment, however there are no Wetlands Protection Areas within or in the vicinity of the PL area.

5.11.3.4 Wetlands Management Areas

Wetland Management Areas comprise a wetland of ecological significance plus a 100m trigger area. Conservation values of wetlands were assessed by DERM using the Aquatic Biodiversity Assessment and Mapping Method²². These assessments are non-social and non-economic, identifying conservation values of wetlands using available data.

There are no mapped Wetlands Management Areas in the PL area, although two small areas are identified to the east of the PL area associated with a small unnamed creek.

²² <http://www.epa.qld.gov.au/wetlandinfo/site/SupportTools/AssessmentMethods/AquaBAMM.html>

5.11.4 Wild Rivers

To help preserve wild rivers in their near-pristine condition, declaration under the Wild Rivers Act 2005 can be made which may prohibit some development or impose conditions upon some development within the declared wild river area.

Queensland has a number of river systems which have been almost untouched by development and are therefore in near natural condition, with all, or almost all, of their natural values intact. They are important because they:

- help sustain healthy ecosystems for native plants and animals;
- support sustainable economic activities, such as grazing, fishing and eco-tourism; and
- provide unique opportunities for recreation and tourism.

There are no Wild Rivers located within the relevant local government area.

5.11.5 River Improvement Trust

There are no River Improvement Trust areas in the PL area.

5.11.6 Groundwater and aquifers

Groundwater resources are not heavily utilised in the area, and although 154 private bores are located within 10km of ATP 1025P and ATP 1031P²³ none of these are located in the PL area. These bores are most likely accessing water from alluvial aquifers. Groundwater sampling reported by Curragh Mine indicates that the local groundwater is saline, with total dissolved solids in the range of 7,000 to 12,000 mg/L.²⁴

The major aquifers in the wider region are the Quaternary Alluvium, the sand and gravel horizons of the Tertiary sediments and the Tertiary basalts.

There are no springs identified in the PL area or its vicinity.

5.11.7 Environmental values and assets in Water Resource Plans

Water resource plans endeavour to achieve a sustainable balance between meeting environmental and human needs within each catchment; and are prescribed under the Water Act 2000. Each water resource plan has a 10 year life and is the legal document specifying the outcomes and strategies used to address the social, economic and environmental goals for each plan area. A resource operations plan is then developed to implement the water resource plan; and sets out the administrative arrangements that are used to put the strategies into effect; including the process under which water allocations can be traded; the process for making available any unallocated water; rules for accessing water; detailed operating rules for infrastructure operators and detailed monitoring and reporting requirements.

²³ Vink, S and Cammerman N, 2010: Potential impact of CSG development in the area of ATP 1025P and ATP 1031P – a desktop assessment for Bow Energy. Unpublished report, July 2010.

²⁴ Curragh Queensland Mining Ltd, 2002: Curragh Mine Environmental Management Overview Strategy PJ 80028. October 2002.

The Water Resource (Fitzroy Basin) Plan 1999 underwent its scheduled 10 year review and the draft Water Resource (Fitzroy Basin) Plan 2010 was released on 14 December 2010. Once finalised, this will replace the Water Resource (Fitzroy Basin) Plan 1999.

The PL area falls within the proposed Highlands Groundwater Management Area, comprising the following:

- Highlands Groundwater Unit 1 containing the aquifers of the quaternary alluvium;
- Highlands Groundwater Unit 2 containing all sub-artesian aquifers within the groundwater management area other than those contained in Unit 1.

5.12 Heritage values

5.12.1 Indigenous heritage

No indigenous heritage sites have been identified from the Cultural Heritage Register during the desk-top assessment. Site assessments will be required to determine if there are previously unidentified sites.

5.12.2 Non-Indigenous heritage

No sites are listed on the Queensland Heritage Register within the PL area. No National Heritage sites are within the PL area.

5.13 Annual and long term climatic conditions

The Bureau of Meteorology has five data collection sites (Table 22) in the general region, and statistics from the sites are summarised in Table 23. Four of the five collection sites are still active. The Emerald Post Office site closed in 1992.

The region has seasonal rainfall with 70% of rainfall occurring between November and March. Rainfall and stream flow is highly variable. Severe drought conditions for about 10 years were followed by widespread flooding in the 2007-2008 wet season, and again in the 2010-2011 wet season.

Table 22 Climate Data Collection Sites

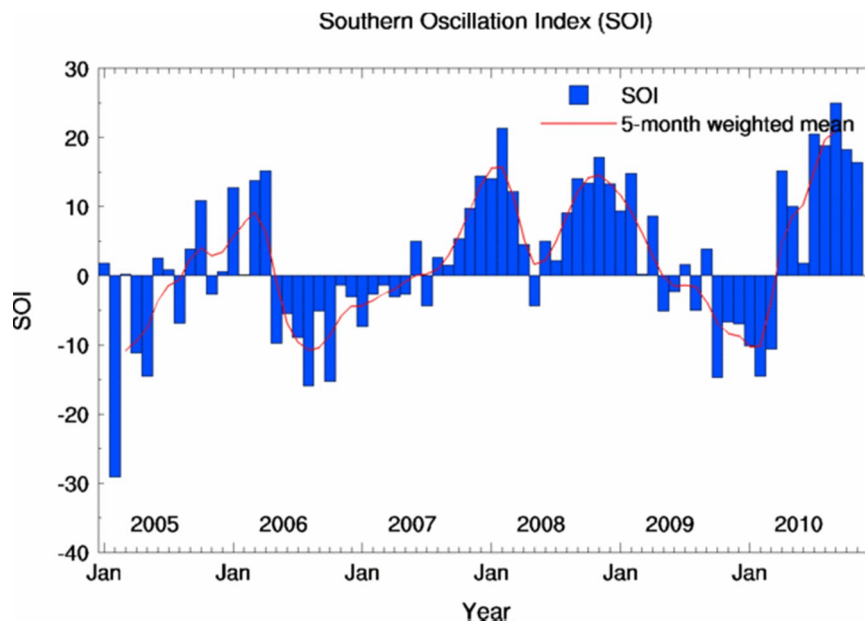
Site name	Site number	Commenced records	Last record	Latitude Degrees S	Longitude Degrees E	Elevation m
Blackwater Water Treatment Plant	035290	1995	2010	23.60	148.87	187
Emerald Airport	035264	1981	2010	23.57	148.18	189
Emerald Post Office	035027	1882	1992	23.53	148.16	179
Rolleston	035059	1889	2010	24.46	148.63	214
Springsure Comet St	035065	1865	2010	24.12	148.09	345

Table 23 Climate data

Site	Mean Max temp JAN	Mean Max temp JULY	Mean min temp JAN	Mean min temp JULY	Mean rainfall mm JAN	Mean rainfall Mm JULY	Highest rainfall Mm (annual)	Lowest rainfall mm (annual)	Mean no. days rain (annual)
035290	34.1	23.4	22.4	8.5	67.7	15.1	1097.3	315.3	57.1
035264	34.4	23.3	22.3	8.9	90	12	981.7	284.1	61.4
035027	34.2	22.4	21.4	6.9	103.4	28.8	1407.2	205.6	59.5
035059	34.8	22.9	21	5.6	93.7	28.9	1275.9	194	53.4
035065	34	22.2	20.8	6.2	107.4	28.4	1589	303.1	61.5

Currently, Australia is experiencing La Nina conditions associated with the extensive cooling of the central and eastern Pacific Ocean. This translates into an increased probability of wetter than average conditions. It is also associated with high (positive) values of the Southern Oscillation Index (SOI). The SOI is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. Sustained negative values of SOI often indicate El Nino conditions, when Australia can expect drier conditions than normal. Figure 17 shows the Southern Oscillation Index.

Figure 17 Southern Oscillation Index (Source: Bureau of Meteorology <http://www.bom.gov.au/watl/enso/>)



6 ENVIRONMENTAL VALUES, POTENTIAL IMPACTS FROM ACTIVITIES AND ENVIRONMENTAL PROTECTION COMMITMENTS

Bow has developed an in-house impact assessment process that has been tailored to suit the nature of its coal seam gas development program. Unlike traditional mining (e.g. coal) related projects, which have a clearly defined field disturbance footprint, the extent of disturbance for coal seam gas projects is dependent on the progressive outcome of the exploration and development activities. Therefore, impact assessment has been designed to occur over the life of the field development program and incorporates a phased approach including:

- Development of environmental constraints maps for the areas of Bow's development activities;
- For areas where new ground is proposed to be disturbed, conduct of site scouting (ground truthing) to ensure environmentally sensitive areas are avoided, development footprints are minimised, impacts to existing or proposed land uses are minimised and compliance with existing environmental approval conditions is maintained; and
- For areas not subject to new ground disturbances, desk top assessment only undertaken as the site would either have been subject to a previous site scouting program or the site has been subject to previous significant disturbance.

This section presents the proposed mitigation measures that will be implemented in order to reduce the potential impacts on environmental values. For each environmental element, the following information is provided:

- Identification of potentially impacted environmental values;
- Description of potential impacts to the identified environmental values;
- Statement of relevant management objectives for the environmental value;
- Development of performance standards and measurable indicators for monitoring; and
- Development and implementation of control measures, or mitigation strategies that are aimed at reducing potential Project impacts on environmental values. These include monitoring and auditing requirements, proposed reporting and corrective actions.

It should be noted that in accordance with the organisational chart provided in Figure 1, the Environment Liaison, reporting to the General Manager (Project Services) is responsible for the implementation, monitoring, auditing and reporting of the environmental protection commitments.

6.1 Environmental induction and training

A process for inducting new personnel, including contractors, onto the site will be implemented. The objective will be to ensure the entire workforce is aware of the environmental obligations of the project.

Before any person is permitted to commence work, including contractors, he/she will be given a workplace induction, which includes but is not limited to safety, environment, quality and community content. The induction will be delivered by project site management. All visitors to the site will be given a visitor specific induction.

Before attending the site induction, all staff must show evidence of having undergone the training required in accordance with their trade and activities and which meets the guidelines in the relevant State occupational health and safety regulation (general industry induction). Copies of all trade and safety qualifications will be put on file.

Management Plan 1 Induction and Training Plan

Induction and Training Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Ensure all Project staff and contractors are aware of their environmental obligations and comply with all requirements.
Performance Standards and Indicators	<ul style="list-style-type: none"> • All staff, contractors and visitors have undergone site induction and relevant training.
Control Strategies	<ul style="list-style-type: none"> • A site induction program will be developed that addresses the key site environmental requirements including locations of Category A, B and C environmentally sensitive areas. The induction program will be flexible and regularly updated to reflect changes in environmental requirements. • Additional training will be targeted to staff with specific responsibilities. • A training and induction register will be maintained and records kept for a minimum of five years.

6.2 Incidents and complaints

It is a requirement to implement a management system for environmental incidents particularly those involving hazardous substances including fire, explosion, spillage, leakage or other escape into the environment. The following table provides a management plan for the effective control of potential environmental incidents.

Management Plan 2 Environmental Incident Management Plan

Environmental Incident Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise environmental harm from fire, explosion, spillage, leakage or other escape of harmful substances.
Performance Standards and Indicators	<ul style="list-style-type: none"> • The response to and reporting of environmental incidents is appropriate to the environmental risk of the incident. • An emergency response capability and suitable number of spill kits or suitably stocked area in a proximate container is maintained.
Control Strategies	<ul style="list-style-type: none"> • Prepare a Contingency Plan for Emergency Environmental Incidents which addresses the following: <ul style="list-style-type: none"> - Definition of what constitutes an environmental emergency event - Identification of the types of environmental incidents that may occur - Response procedures to be implemented to prevent or minimise the risk of environmental harm arising from incidents - Response procedures to minimise the extent and duration of

Environmental Incident Management Plan

- environmental harm caused by an incident
- The practices and procedures to be employed to restore the environment or mitigate any environmental harm caused
- Communication procedures and lines of communication within and beyond Bow Energy to be employed in responding to incidents
- The resources to be used in response to an incident
- Procedures to investigate the cause of any incidents, including releases, and where necessary, the remedial actions to be implemented to reduce the likelihood of recurrence of similar events
- A receiving environment monitoring program, to be specifically implemented in the event of a release to waters/land to examine and assess environmental impacts
- The provision and availability of documented procedures to staff attending any incident to enable them to effectively respond
- Training of staff that will be called upon to respond to incidents
- Timely and accurate reporting of the circumstance and nature of incidents to the administering authority and any affected landholder or occupier
- Procedures for accessing monitoring points during incidents.
- Take immediate action to reduce any risk associated with unauthorised discharges to air, land and water.
- Investigate the incident to determine the likely cause, record the outcome of the investigation (keep these records for the life of the Project) and take appropriate remedial actions.
- Review the risk assessment required in the relevant State regulations and take appropriate actions to reduce risk.
- Excavate or remove contaminated ground (spills up to five litres or less) in a sensitive area, or remedy through an approved process.
- Report spills of any volume of contaminants to water to the administering authority.
- Report releases greater than 200 L hydrocarbons, 1000 L of brine, or 5000 L coal seam gas water to land to the administering authority.
- Report releases of any volume to the administering authority where potential serious or material environmental harm has occurred or may occur.
- Notify relevant landowners in the event of an unauthorised release likely to impact on landowner activities and/or safety.
- Conduct soil, surface water and/or groundwater sampling and monitoring of the cleanup area if required.
- Obtain inputs from consultants if required.
- Notify the appropriate authorities in accordance with the Emergency Response Plan and legislative requirements.
- A complaints register and handling system will be maintained.

Enquiries/complaints will be dealt with in a responsive manner so that stakeholders feel their concerns are being seriously dealt with and not dismissed. This will assist in building a relationship of trust and reliability between the community and Project team.

Management Plan 3 Complaints Register and Management Plan

Complaints Register and Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> Deal with enquiries and complaints in a responsive manner.
Performance Standards and Indicators	<ul style="list-style-type: none"> All complaints and responses recorded in the complaints register. The response to and reporting of complaints is appropriate.
Control Strategies	<ul style="list-style-type: none"> A central point of contact will be maintained for enquiries and complaints, to enable the content and distribution of information to the community to be managed and monitored. Each complaint will be assessed for its validity and potential risk and investigated as soon as practicable. Corrective action will be implemented where appropriate to address the cause of the complaint and to minimise reoccurrence of similar complaints. The following details will be recorded in the complaints register for all complaints received: <ul style="list-style-type: none"> Name, address and contact number for complainant Time and date of complaint Reasons for the complaint as stated by the complainant Investigations undertaken in response to the complaint Conclusions formed Actions taken to resolve complaint Any abatement measures implemented to mitigate the cause of the complaint Name and contact details of person responsible for resolving the complaint. Records will be kept for a minimum of five years.

6.3 Air

6.3.1 Description of environmental values

PL 388 is located within a rural area. Existing sources of air pollution within approximately 80 km of the site, from information within the National Pollutant Inventory database, includes two coal seam gas-fired power stations (Oak Creek and German Creek), nine coal mining operations (Curragh, Yarrabee, Blackwater, Ensham, Gregory, Kestrel, Oak Creek, German Creek and Minerva), and fuel loading operations at Mobil Emerald and Shell Aviation.

The power stations are located over 60 km to the north of the PL and are considered unlikely to contribute to the existing air quality of the PL area. Similarly, the fuel loading operations are located in Emerald, approximately 75 km to the west of the PL. Mining operations will generate significant quantities of particulate matter which has the potential to impact upon the health and amenity of surrounding sensitive receptors. Bow's Blackwater Power Station will be commissioned in 2011 and may contribute to the existing air environment of PL388.

No air quality monitoring data is available for the area surrounding the PL. The air emissions of interest for the environmental authority are oxides of nitrogen (NO_x) (primarily NO₂) and carbon monoxide (CO). The closest DERM air quality monitoring instruments are located in Gladstone, which is approximately 240 km to the east of

the PL. However, as CO is not monitored in Gladstone, data from Toowoomba monitoring station has been used. Table 24 provides indicative background concentrations of CO and NO₂ that have been adopted. These are considered to be conservative given the nature of the PL and the surrounding land uses.

Table 24 Adopted background pollutant concentrations

Pollutant	Concentration	Averaging Period
NO ₂	79 µg/m ³	1 hour maximum
	7.5 µg/m ³	Annual average
CO	3.9 mg/m ³	8 hour maximum

The environmental values relevant to the air environment that will be protected or enhanced are:

- The health and biodiversity of ecosystems;
- Human health and wellbeing;
- The aesthetics of the environment, including the appearance of buildings, structures and other property; and
- Agricultural use of the environment.

6.3.2 Potential adverse or beneficial impacts

Development and decommissioning activities on PL 388 will generate air emissions such as dust from earthworks and use of unsealed roads, and NO₂ and CO from engine exhausts (vehicles and diesel generators).

Production of coal seam gas from the PL may produce emissions of methane (CH₄), NO₂, CO and particulate matter.

The potential impacts to the air values from the development, production and decommissioning activities will be dust nuisance to nearby sensitive receptors and a local decrease in human and ecosystem health.

6.3.3 Proposed environmental protection commitments, objectives and control strategies

The Air Quality Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on air quality and other air environment values relevant to the PL area.

Management Plan 4 Air Quality Management Plan

Air Quality Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise impacts on existing air quality as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Consultation with potentially affected landholders/occupiers (sensitive receptors). • Limited or no air quality complaints from sensitive receptors. • Comply with the following maximum ground level concentration criteria: <ul style="list-style-type: none"> - NO_x as nitrogen dioxide: 250 µg/m³ (at 0°C) over 1 hour averaging time (health and wellbeing);

Air Quality Management Plan

	<ul style="list-style-type: none">- NOx as nitrogen dioxide: 62 µg/m³ (at 0°C) over 1 year averaging time (health and wellbeing);- NOx as nitrogen dioxide: 33 µg/m³ (at 0°C) over 1 year averaging time (health and biodiversity of ecosystems);- Carbon monoxide: 11 mg/m³ (at 0°C) over 8 hours averaging time (health and wellbeing);- Total suspended particles: 90 µg/m³ (at 0°C) over 1 year averaging time (health and wellbeing)- PM₁₀: 50 µg/m³ (at 0°C) over 24 hours averaging time (health and wellbeing);- PM_{2.5}: 25 µg/m³ (at 0°C) over 24 hours averaging time and 8 µg/m³ (at 0°C) over 1 year averaging time (health and wellbeing);- Dust deposition: 4g/m² over 1 month averaging time.
Control Strategies	<ul style="list-style-type: none">• Location and construction of access roads will give consideration to soil types to avoid generating a dust nuisance.• Materials that have the potential to generate dust will be covered before transportation.• Speed will be limited on unsealed access roads adjacent to sensitive human and environmental areas.• Vehicles and machinery will be maintained regularly.• Dust control measures will be implemented during clearing activities where appropriate.• Areas and duration of disturbance will be minimised where practicable to minimise the potential for dust generation.• Disturbed areas will be rehabilitated to protect the soil surface and promote vegetation growth.• Weather conditions will be considered prior to and during disturbance activities to minimise potential for dust generation.• Contaminants emitted from fuel burning and combustion equipment point sources will be directed vertically upwards.• Venting of coal seam gas at well heads will be limited to maintenance activities and emergency situations.• A register of fuel burning and combustion equipment (capable of burning at least 500 kg of fuel in an hour) will be maintained.• For fuel burning equipment that is designed to burn >500kg/hr, dispersion modeling will be undertaken to calculate ground level concentrations of NOx and CO prior to the installation of the fuel burning or combustion equipment.• If requested by DERM, Bow will monitor dust deposition at agreed locations and provide the monitoring results to DERM.• A complaints register and handling system will be maintained.

6.4 Greenhouse gas emissions

6.4.1 Description of environmental values

The Greenhouse Gas Protocol (WRI/WBCSD, 2005) establishes an international standard for accounting and reporting of greenhouse gas (GHG) emissions by entities. It defines three “Scopes” of emissions (Scope 1, Scope 2 and Scope 3) for GHG accounting and reporting purposes. This terminology has been adopted in

Australian greenhouse reporting and measurement methodologies and is described below:

- **Scope 1 (direct GHG emissions)** - Direct GHG emissions are defined as those emissions that occur from sources that occur as a direct result of the facility or assets that are owned or controlled by the entity. Direct GHG emissions principally result from the following types of activities:
 - Generation of onsite electricity, heat or steam (i.e. combustion of fuels in stationary sources);
 - Physical or chemical processing (i.e. manufacture of cement, aluminium);
 - Transportation of materials, products, waste and employees (i.e. combustion of fuels in mobile combustion sources – motor vehicles, ships, aeroplanes); or
 - Fugitive emissions (i.e. intentional or unintentional releases from equipment).
- **Scope 2 (energy product use indirect GHG emissions)** - Scope 2 emissions are indirect emissions from the use of energy products (i.e. electricity, steam/heat) purchased or otherwise brought into the Project boundary. Scope 2 emissions physically occur at the facility where electricity is generated.
- **Scope 3 (other indirect GHG emissions)** - Scope 3 emissions are a consequence of the Project's activities but these sources are not owned or controlled by the Project. Some examples of Scope 3 activities provided in the Greenhouse Gas Protocol (WRI/WBCSD, 2005) are:
 - Waste disposal;
 - Extraction, processing and transport of materials or fuels;
 - Leased assets or outsourced activities; or
 - Use of sold products and services.

It is usual that for the purposes of compliance there is a focus on direct (Scope 1) emissions from the Project and/or indirect (Scope 2) emissions from energy consumption rather than Scope 3 emissions.

6.4.2 Potential adverse or beneficial impacts

Scope 1 emissions from activities proposed for PL 388 will primarily be generated by combustion of coal seam gas in equipment such as compressors. Flaring of the coal seam gas will also contribute to Scope 1 emissions, although flaring activities are proposed to be minimised as the test gas will be directed to the Blackwater Power Station for domestic power generation purposes (refer Section 1.3). Petrol and diesel use in vehicles and generators also contributes to scope 1 emissions. Scope 2 emissions may occur if electricity, steam or heat is transported to the PL, for example directly from the Blackwater Power Station. There are currently no plans to import power to the PL from external sources.

6.4.3 Proposed environmental protection commitments, objectives and control strategies

The Greenhouse Gas Management Plan is provided in the table below.

Management Plan 5 Greenhouse Gas Management Plan

Greenhouse Gas Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none">• Minimise greenhouse gas emissions as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none">• Compliance with National Greenhouse and Energy Reporting Framework.
Control Strategies	<ul style="list-style-type: none">• Undertake regular review of technologies used during activities in order to identify opportunities to minimise energy consumption and emissions. Transport logistics will be optimized and fuel efficient vehicles /machinery will be used to minimise consumption of fuel.• Investigate the use of waste recovery units on compressor exhausts.• Minimise clearing of vegetation for PL activities.• Flaring and venting will be minimised.• Leak detection program will be implemented.• Implement automatic well control to assist in regulating the production of coal seam gas in the event of maintenance or upset of Blackwater Power Station.• GHG emissions will be reported in accordance with the National Greenhouse and Energy Reporting Act 2007.• Energy audits will be undertaken every 5 years to improve energy efficiency.

6.5 Dams

On 20 October 2008 the State Government announced its Coal Seam Gas Water Management Policy. The finalised Coal Seam Gas Water Management Policy was released in June 2010²⁵. The use of evaporation dams is restricted to a very limited set of circumstances, and other water management options are preferred. Dams (other than evaporation dams) for coal seam gas water storage must meet hydraulic performance conditions set out by DERM in the latest version of the “Manual for Assessing Hazard Categories and Hydraulic Performance of Dams”²⁶ and the regulated dam guidelines.

6.5.1 Description of environmental values

The values applicable to the design and operation of dams as part of the proposed petroleum activities are related to the environment and human health. Relevant environmental values will be those described in Sections 6.6 Land and 6.11 Water.

6.5.2 Potential adverse or beneficial impacts

Dams constructed on the PL area have the potential to cause environmental harm due to spills or releases from the dam, or the collapse of the dam structure itself. Therefore the potential to impact on environmental values includes long term affects to groundwater systems, surface water systems and soils from release of

²⁵ http://www.derm.qld.gov.au/environmental_management/coal-seam-gas/pdf/water-management-policy.pdf

²⁶ Released for consultation August 2010, not finalised at time of writing.

contaminants contained within the dam, or the flooding caused by the volume of liquid released from the dam. In addition, there may be potential for impacts on human health and wellbeing from consumption of contaminated water or injury during dam failure.

It is important to ensure that the hydraulic performance of the dam is not affected by floods and that contaminants are contained or if releases are necessary, they occur at acceptable concentrations.

6.5.3 Proposed environmental protection commitments, objectives and control strategies

The Dam Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on identified environmental values.

Management Plan 6 Dam Management Plan

Dam Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> Contaminants are safely contained within any proposed dam. The design storage allowance is maintained at all times.
Performance Standards and Indicators	<ul style="list-style-type: none"> Target annual probability for hydraulic design, equivalent to cumulative probability of failure over the operational life of the project of 1% if the dam has a significant hazard rating and 0.1% if dam has a high hazard rating. The dam is protected against overtopping and has erosion protection from external flooding events at or above the Annual Exceedance Probability (AEP) used in determining the spillway capacity. The dam is not constructed in an area estimated to be submerged by a flooding event from a recognised watercourse, at or above an AEP of 0.01 (1 in 50). Compliance with all environmental authority conditions related to regulated dams.
Control Strategies	<ul style="list-style-type: none"> The hazard category for each dam proposed for the PL area will be assessed according to the most recent version of the Manual for Assessing Hazard Categories and Hydraulic Performance of Dams (the Manual). Any dams that are assessed to be in the significant hazard or high hazard category will be classified as regulated dams. The assessment will be undertaken by a suitably qualified and experienced person. The spillway of a regulated dam will be designed to have sufficient capacity to meet the requirements of the Manual. Levees diverting flood water around a regulated dam will be designed to isolate and divert peak flows according to the Manual. Site water management systems will be designed to prevent harm from release of contaminants. All regulated dams will be designed and operated such that inputs and outputs throughout the year are handled appropriately and the design storage allowance is provided at the first of November each year for the coming wet season. Regulated dams proposed to receive coal seam gas water, coal seam gas water concentrate or brine will be designed to include the following: <ul style="list-style-type: none"> A floor and sides of material that will contain the wetting front

- and any entrained contaminants within the bounds of the containment system during its operational life including any period of decommissioning and rehabilitation,
- Have a system that will detect any passage of the wetting front or entrained contaminants through either the floor or sides of the dam,
- Either be capable of repair to rectify any passage of the wetting front through either the floor or sides of the dam, or else be decommissioned and rehabilitated,
- If it is receiving brine, have a system for the collection and proper disposal of any contaminants that move beyond the bounds of the containment system,
- Prevent floodwaters from entering to the annual exceedance probability specified in the “Manual for Assessing Hazard Categories and Hydraulic Performance of Dams”,
- Prevent wall failure due to erosion by floodwaters, and
- Prevent overtopping as a result of a flood event of the annual exceedance probability specified for the spillway.
- A design plan for each regulated dam will be prepared to demonstrate how the identified hazard scenarios are addressed in the planned design and operation of the dam. The design plan will include all relevant information as required by the administering authority.
- The design plan will be certified by a suitably qualified and experienced person to confirm that the proposed design and operating procedures will meet the specific performance requirements for the dam. The certification will be accompanied by a statement of reasons for the conclusions and be supported by evidence demonstrating the qualifications of the person giving the certification.
- Two hard copies and one electronic copy of the certified design plan will be submitted to the administering authority before construction of a regulated dam commences.
- Two hard copies and one electronic copy of ‘as constructed’ drawings will be submitted to the administering authority on completion of construction of a regulated dam. The ‘as constructed’ drawings will be certified by a suitably qualified and experienced person to confirm that the dam as constructed will deliver the performance stated in the design plan.
- The name of each regulated dam will be clearly signposted at the dam location at all times.
- A Register of regulated dams will be maintained and include all relevant information as required by the administering authority.
- The hazard category will be reassessed by a suitably qualified and experienced person prior to any proposed change to the purpose or content of a regulated dam.
- No new dam will be constructed or modifications made to existing dams until details and a design plan are entered into the Register.
- All entries in the Register will be certified by the chief executive officer or their delegate as being accurate and correct.
- The mandatory reporting level will be estimated for each proposed regulated dam and be clearly marked.
- The administering authority will be notified immediately when the level in a regulated dam reaches the mandatory reporting level.

- Measures will be taken immediately to prevent (or if unable to prevent, to minimise) any actual or potential environmental harm.
- The regulated dam will be inspected annually by a suitably qualified and experienced person and assessed for:
 - Its hazard category in accordance with the most recent version of the Manual,
 - Condition and adequacy for dam safety,
 - Its structural, geotechnical and hydraulic performance against the criteria contained in the certified design plan, and
 - Adequacy of the available storage in the dam based on an actual dam level observed in the month of October each year.
 - The administering authority will be immediately notified if the assessment of available storage indicates that the design storage allowance will be exceeded, or at any other time that the design storage allowance may or has been exceeded. Immediate action will be undertaken to prevent or minimise environmental harm.
 - The administering authority will be notified within one month of receiving the annual inspection report of the recommendations of the report and the actions that will be taken to ensure the integrity of the regulated dam.

6.6 Land

6.6.1 Description of environmental values

The environmental values relating to the land environment of PL 388 are summarised below. Further information is provided in Section 5 of this EM Plan.

6.6.1.1 Regional ecosystems and threatened communities

There are four regional ecosystems identified within the PL area. These are described in Section 5.7.

The Commonwealth listed Endangered community of Brigalow (*Acacia harpophylla* dominant and co-dominant) is known to occur in the PL search area while two other threatened communities (Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin and Weeping Myall Woodlands) may occur within the PL search area.

6.6.1.2 Threatened flora and fauna species

No flora or fauna species listed as endangered, vulnerable or rare under State legislation have been recorded in the PL area. A search of the Commonwealth database identified 11 threatened fauna species under the EPBC Act may occur or has habitat that may occur within the PL area.

6.6.1.3 Soils

A variety of soil types has been identified onsite through desktop studies. Of interest are soils identified as potentially sodic, dispersive or erosive. Management strategies will have to be implemented to minimise the loss and potential impacts to these soil types.

The majority of the PL is identified as Good Quality Agricultural Land (GQAL) Class C1. The small north-west portion of the PL contains strategic cropping land (as defined in the State Government's Strategic Cropping Land Policy Framework) and GQAL Class A which is the best quality and suitable for cropping.

6.6.1.4 Landscape and land use

The topography of PL 388 is relatively flat, gently sloping from east to west towards Blackwater Creek.

The primary land use of the PL is "production from relatively natural environments". The land is used for cattle grazing; however coal mining operations do occur throughout the area, in particular, the Curragh Coal Mine located to the west of the PL and the coal mines operated by Jellinbah Group Pty Ltd located to the north and east.

6.6.1.5 Land and tenure holders

There are five relevant freehold properties associated with PL 388 as described in Section 2.3.

There is one overlapping tenure holder as described in Section 5.5.1, who will, together with the affected landholders, be consulted on an ongoing basis in accordance with all land access laws and company policies.

6.6.2 Potential adverse or beneficial impacts

Potential impacts to land values as a result of petroleum activities within PL 388 include the following:

- Clearing of protected plants or habitat of protected animals that have not been identified on database searches;
- Clearing of remnant vegetation that leads to other impacts such as edge effects and fragmentation;
- Clearing of threatened ecological communities;
- Introduction or promotion of weed and pest species;
- Detrimental effects and mortality of protected animals through vehicle collision, trapping in excavations or within stockpiles, and dust effects;
- Removal of flora and fauna species by accidental fire events;
- Changes to topography, local drainage patterns and flooding;
- Loss of GQAL;
- Destabilisation and loss of soils through erosion;
- Increased soil compaction;
- Loss of topsoil quality and quantity;
- Degradation of soils through contamination;
- Changes to stream morphology; and
- Disruption to property activities.

6.6.3 Proposed environmental protection commitments, objectives and control strategies

The control strategies in the management plans below will combine to protect land values identified in Section 6.6.1.

The Vegetation Clearing Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on terrestrial flora values, fauna habitat values and sensitive environmental areas and communities.

Management Plan 7 Vegetation Clearing Management Plan

Vegetation Clearing Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise vegetation clearing as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No unauthorised clearing of native vegetation. • No unauthorised disturbance to flora species or habitats of flora species listed as endangered, vulnerable or rare under State or Commonwealth legislation.
Control Strategies	<ul style="list-style-type: none"> • Complete pre-disturbance field surveys for communities, regional ecosystems and flora species of special conservation significance. • If significant communities, regional ecosystems or species are found to occur, avoidance, buffering and monitoring for long-term health will be implemented. • If required, a species management plan will be developed for specific threatened species (as per Environment Protection and Biodiversity Conservation (EPBC) Act 1999). • If required an Offset Strategy will be developed in consultation with SEWPaC and DERM during the detailed planning/design stage. The strategy will provide details of the ecosystems to be offset, appropriate offset ratios, the means of securing the offset areas for conservation purposes, and the proposed areas and locations of the required offsets – including an analysis of the suitability of the proposed offsets (ecological equivalence) to replace the values of those areas lost. • Landholders will be consulted on the nature and extent of clearing and the proposed disposal techniques. • Vegetation clearing will be avoided during wet conditions. • Ground cover and understory of vegetated areas required for construction will be flattened rather than removed where practical. • Existing access roads and cleared areas will be used where practicable. • A buffer of 200 m will be maintained between areas of disturbance and ground-truthed significant habitat. • All vegetation and buffer extents that are not to be disturbed by clearing activities will be clearly cordoned off creating ‘no go zones’ for vehicles, materials, machinery, workers, excavated soil or fallen timber. • Clearing of mature trees will be avoided where practical. • Machinery access and subsequent soil compaction within and adjacent to retained vegetation will be minimised. • ‘Go slow zones’ (40km/hr) for vehicles and machinery will be established where non-gazetted roads or tracks are located adjacent to areas identified as priority habitat for significant species. • Following disturbance, cleared woodland and grassland areas that are not required for on-going maintenance, access and/or fire safety obligations will be allowed to regenerate naturally. Revegetation may be used where natural regeneration is not successful.

Vegetation Clearing Management Plan

	<ul style="list-style-type: none"> • Accidental clearing of vegetation not authorised will be reported and rehabilitated in a manner agreed with the administering authority. • Details of significant disturbance to existing vegetation on the PL area will be recorded. • Progressive rehabilitation will be undertaken where possible and rehabilitation activities commenced as soon as an area becomes available. • A fire risk management plan will be developed and will include the following: <ul style="list-style-type: none"> - Identification of potential sources of fire and activities that have the potential to ignite flammable materials, - Identification of flammable materials and vegetative fuel that may be present in activity areas, - Description of management procedures for flammable materials, - Daily assessment of local fire hazard conditions issued by the Bureau of Meteorology and the Queensland Rural Fire Service, - Description of strategies to avoid the potential for fires to be ignited as a result of project activities, and - Description of procedures for fighting fires and evacuation to identified safe areas in the event of a fire.
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The Fauna and Pest Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise direct and indirect impacts on terrestrial fauna values. Pest species identified in the desk-top assessment as likely to have habitat in the area are the common cat, European rabbit, pig and red fox.

Management Plan 8 Fauna and Pest Management

Fauna and Pest Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise impacts on significant fauna species as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No unauthorised disturbance to fauna species or habitats of fauna species listed as endangered, vulnerable or rare under State or Commonwealth legislation.
Control Strategies	<ul style="list-style-type: none"> • Pre-disturbance field surveys for fauna species of special conservation significance will be completed. • If required, a species management plan will be developed for specific threatened species (as per EPBC Act). • An appropriately qualified person will be present during clearing activities to check vegetation and landscape for fauna and breeding sites. • Project personnel will be instructed to check for any trapped wildlife in excavations or under stockpiles of materials. This issue will be covered in toolbox talks so employees are aware of dangers to both themselves and the trapped wildlife. A fauna spotter/catcher will be consulted for removal of trapped fauna. • Appropriate treatment of injured/orphaned animals will be ensured through liaison with local wildlife carers and veterinarians. • Where clearing hollow-bearing trees cannot be avoided, installation of nest boxes in nearby suitable vegetation will be

	<p>considered.</p> <ul style="list-style-type: none"> • Some felled timber will be retained to locate within adjacent habitat or rehabilitated areas to increase sheltering opportunities for displaced animals. • Pest animals will be controlled by: <ul style="list-style-type: none"> - Limiting the introduction of pest animals into the area of interest, - Rapidly controlling any pest animals that become established on the PL, - Regularly monitoring the PL area, - Consulting the landholder where appropriate, - Preparing a control/eradication plan with follow up action when and where needed, and - Banning domestic animals (belonging to personnel and subcontractors) from the PL area.
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The Weed Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts from weeds on terrestrial flora values and land use.

Management Plan 9 Weed Management Plan

Weed Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise impacts on vegetation, significant flora species and ecological communities as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No introduction of new weed species to the PL area as a result of Bow’s project activities. • No increase in abundance or distribution of weed species on the PL area as a result of Bow’s project activities.
Control Strategies	<ul style="list-style-type: none"> • Weed wash down procedures will be developed and implemented where necessary. • Weed control procedures will be followed for weeds that become established on the PL area as a result of project activities. • Regular weed monitoring will be carried out at disturbance areas and along access tracks. • Training in weed awareness and procedures will be given to all relevant personnel. • A movement protocol for vehicles and plant will be established. • Vehicle and equipment parking areas will be defined on the PL. These will be regularly inspected for weeds and weeds eradicated when found. • A summary of weed control procedures and results of monitoring will be reported to Bow management. • Where weed infestation is reported, a review of weed control procedures and training will be carried out. Change of procedures will be implemented where necessary. New infestations will be removed and disposed of appropriately.

The Soil and Erosion Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on land and soil quality values, including GQAL.

Management Plan 10 Soil and Erosion Management Plan

Soil and Erosion Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise soil erosion and sedimentation that may result from development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No failure of erosion and sediment control measures that result in release of sediment. • No degradation of topsoil quality as a result of project activities.
Control Strategies	<ul style="list-style-type: none"> • Undertake targeted investigations to identify areas with reactive/erosive/dispersive soils. • Minimise vegetation clearing and leave root stock in-situ where practicable to minimise potential for soil erosion. • Reuse stripped topsoil in areas to be rehabilitated with similar topsoil characteristics where possible. If topsoil cannot be effectively reused immediately, stockpile ensuring the height of the stockpile is no more than 2 m. Long term topsoil stockpiles will be re-vegetated with appropriate cover crops to minimise the loss of topsoil. • Topsoil and subsoils will not be mixed. Replace subsoils at depth and cover with topsoil. • Where practicable, mulch cleared vegetation and spread as protective layer over exposed soil. • Stabilise problem areas that have the potential for erosion or soil movement with surface stabilisers, crushed rock or scour protection as necessary. • Slow the overland flow of water and floodwaters through installation of frequent contour banks in appropriate areas. • Direct discharges to multiple locations to decrease volumes. Discharges will be to stable drainage lines. Implement engineering controls in drainage lines where necessary. • Reference will be made to the guidelines Best Practice Erosion and Sediment Control (International Erosion Control Association Australasia, 2008). Any erosion and sediment control devices installed will remain in place until the area is stabilised through rehabilitation. • Install trench breakers when constructing pipe trenches down slopes. Contour banks will be installed in the same areas on the surface to divert water from exposed disturbed soil. • Re-establish the bed and banks profile of any waterways or creeks disturbed by PL activities. • Prepare and implement an Erosion and Sediment Control Plan which includes: <ul style="list-style-type: none"> - managing and/or diverting uncontaminated stormwater runoff around areas disturbed by petroleum activities or where contaminants or wastes are stored or handled that may contribute to stormwater, - ensuring that contaminated stormwater runoff and incident rainfall is collected, treated, reused, or released in accordance with the conditions of this environmental authority, - roofing or minimising the size of areas where contaminants or wastes are stored or handled, - revegetating disturbed areas as soon as practicable after the completion of works, - using alternate materials and or processes (such as dry absorbents) to clean up spills that will minimise contamination of waters,

Soil and Erosion Management Plan

	<ul style="list-style-type: none"> - placing erosion and sediment control structures to minimise erosion of disturbed areas and prevent the contamination of waters, - an inspection and maintenance program for the erosion and sediment control measures, - provision for adequate access to maintain all erosion and sediment control measures especially during the wet season months from November to April, - additional erosion and sediment control measures for construction of wells and pipelines on slopes >10%, - a surface water monitoring program designed to detect sediment runoff into watercourses, - identification of remedial actions that would be required to ensure compliance with the conditions of this environmental authority, and - details of community consultation strategies and processes to be used in further developing and implementing the Erosion and Sediment Control Plan. <ul style="list-style-type: none"> • Obtain certification for the Erosion and Sediment Control Plan by a suitably qualified person.
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A Land Use Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on land use, landholders and other land tenure holders.

Management Plan 11 Land Use Management Plan

Land Use Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise impacts on existing land uses and surrounding landholders/tenure holders as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Consultation with potentially affected landholders and tenure holders. • Limited or no complaints from landholders and tenure holders.
Control Strategies	<ul style="list-style-type: none"> • Coordinate clearing and disturbance activities with landholders to minimise disruption to property operations. • Use existing access roads where practicable. • Flowlines will follow existing fence lines or roads where practicable to minimise disturbance to property activities. • Consult with land/tenure holders on locations of field infrastructure to minimise impacts on property activities. • Maintain a complaints register and handling system.

A Land Degradation and Contamination Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts through contamination to landscapes and soils as a result of project activities.

Management Plan 12 Land Degradation and Contamination Management Plan

Land Degradation and Contamination Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise the degradation and/or contamination of land as a result of development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No new contaminated sites as a result of project activities. • All existing contaminated sites are identified.
Control Strategies	<ul style="list-style-type: none"> • Undertake pre-disturbance assessment (by suitably qualified person) to identify existing potentially contaminated areas. • Dispose of drilling fines in sumps. Sumps will be buried and the site rehabilitated with topsoil and vegetation cover. • Procedures for the use, handling and storage of chemicals, hydrocarbons and other hazardous substances will be developed and implemented to minimise accidental spills, as well as to ensure adequate clean up and reporting to minimise the risk of the accidental spillage occurring in the future. • Maintain a hazardous substance register for all hazardous substances used on the PL. • All containers of hazardous chemicals including oil and fuel, will be stored in a bunded area(s) so the capacity of the spillage containment compound is as follows: <ul style="list-style-type: none"> - At least 110% of a single storage tank or 100% of the largest storage tank plus 10% of the second largest storage tanks in multiple storage areas and - For drum storages, sufficient to contain at least 25% of the maximum design storage within the bund. • Where possible, the bunded storage area(s) will be covered to prevent rain and water filling the area. • Permanent storage area(s) will be clearly signposted and kept locked at all times to secure against unauthorised access. • Appropriate work force training will be provided for spill management and the use of spill response kits and supplies. • Incident reporting procedures will be followed in the event of a spill. • If unexpected land contamination is discovered, all work within the vicinity of the contamination will stop until an assessment and recommendations have been made by a suitably qualified person. No activities will recommence in the area until it has been deemed remediated or safe for work.

6.7 Noise

6.7.1 Description of environmental values

The environmental values for noise in the vicinity of the PL area are:

- The qualities of the acoustic environment that are conducive to protecting the health and biodiversity of ecosystems; and
- The qualities of the acoustic environment that are conducive to human health and wellbeing, including by ensuring a suitable acoustic environment for individuals to do any of the following –
 - sleep;
 - study or learn;
 - be involved in recreation, including relaxation and conversation; and

- The qualities of the acoustic environment that are conducive to protecting the amenity of the community.

6.7.2 Potential adverse or beneficial impacts

Petroleum activities on the PL area may cause an environmental nuisance at a sensitive or commercial place. Activities that may be a source of nuisance noise include:

- Construction of coal seam wells which may involve the use of diesel and hydraulic drivers, air compressors, air drilling, fracking and cementing well casings;
- Construction traffic including heavy vehicle transport of equipment and materials; and
- Operation of coal seam gas wells, that potentially creates a low-frequency hum.

It is possible that some activities have the potential to impact on terrestrial animals and birds, however this impact would be temporary and for short periods of time.

No noise modeling has been undertaken at this stage; however noise modeling will be undertaken prior to the commencement of relevant activities.

6.7.3 Proposed environmental protection commitments, objectives and control strategies

A Noise Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise noise impacts to sensitive receptors as a result of project activities.

Management Plan 13 Noise Management Plan

Noise Management Plan																													
Environmental Protection Objective	<ul style="list-style-type: none"> • Noise from activities associated with construction and operation will not cause an environmental nuisance at a sensitive or commercial place. • Minimise noise impacts to fauna where possible. 																												
Performance Standards and Indicators	<ul style="list-style-type: none"> • Maintain the acoustic quality objectives of the Environmental Protection (Noise) Policy 2008. • Where appropriate, comply with the following: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Time Period</th> <th></th> <th>Short Term Noise Event</th> <th>Medium Term Noise Event</th> <th>Long Term Noise Event</th> </tr> </thead> <tbody> <tr> <td>7:00am – 6:00pm</td> <td>$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$</td> <td>45 dBA 55 dBA</td> <td>43 dBA 51 dBA</td> <td>40 dBA 45 dBA</td> </tr> <tr> <td>6:00pm – 10:00pm</td> <td>$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$</td> <td>40 dBA 50 dBA</td> <td>38 dBA 46 dBA</td> <td>35 dBA 40 dBA</td> </tr> <tr> <td>10:00pm – 6:00am</td> <td>$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$</td> <td>28 dBA 38 dBA</td> <td>28 dBA 36 dBA</td> <td>28 dBA 33 dBA</td> </tr> <tr> <td>6:00am – 7:00am</td> <td>$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$</td> <td>40 dBA 50 dBA</td> <td>38 dBA 46 dBA</td> <td>35 dBA 40 dBA</td> </tr> </tbody> </table> <p>L_{Aeq} and Max L_{pA} are to be measured over any 15 minute period Deemed background noise levels (L_{ABG}) for above table are: 7:00 am - 6:00pm: 35 dBA 6:00 pm – 10:00 pm: 30 dBA 10:00 pm – 6:00 am: 25 dBA 6:00 am – 7:00 am: 30 dBA</p> • Evidence of consultation and planning for atypical noise events. 				Time Period		Short Term Noise Event	Medium Term Noise Event	Long Term Noise Event	7:00am – 6:00pm	$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$	45 dBA 55 dBA	43 dBA 51 dBA	40 dBA 45 dBA	6:00pm – 10:00pm	$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$	40 dBA 50 dBA	38 dBA 46 dBA	35 dBA 40 dBA	10:00pm – 6:00am	$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$	28 dBA 38 dBA	28 dBA 36 dBA	28 dBA 33 dBA	6:00am – 7:00am	$L_{Aeq,adj,15\ min}$ Max $L_{pA, 15\ mins}$	40 dBA 50 dBA	38 dBA 46 dBA	35 dBA 40 dBA
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Noise Management Plan

Control Strategies

- Selected operational monitoring will be undertaken to determine compliance with the noise limits above.
- Measured and/or predicted levels of noise sources and activities at noise sensitive receptors will be modeled, taking into account any tonal or impulsive noise impacts.
- Based on modeling results, practicable control or abatement measures (including relocating the activity, altering the hours of operation, maintaining buffer distances or having an alternate arrangement in place with any potentially affected person) will be implemented to reduce identified intrusive noise sources.
- Alternative arrangements with affected persons may be made for the duration of activities that are anticipated to impact on sensitive receptors.
- Noise monitoring will be carried out if requested by DERM and will be in accordance with the most recent edition of the DERM's Noise Measurement Manual.
- Landowners will be kept informed of activities which may impact on the noise level at a sensitive or commercial place, and advised of the steps taken to minimise the level or duration of the noise.
- A complaints register and management system will be maintained.

6.8 Social

6.8.1 Community

6.8.1.1 Description of environmental values

The social environment relevant to PL 388 includes local landholders and tenure holders, together with communities within local and regional towns.

The township of Blackwater is the closest town to the PL. It is approximately 12km from the southern boundary of the PL to the outskirts of Blackwater. Blackwater is located within the Central Highlands Regional Council and lies approximately 75 km east of Emerald (refer to Figure 1). Blackwater is the major township of a significant coal mining area. With a population of approximately 5000 people, it provides services and accommodation for six surrounding major open cut coal mines. The total Central Highlands Regional Council area covers an area of approximately 54,000km² and supports a population of approximately 29,250 people. The mining industry is the most significant employer in the region, with relatively large numbers of people also associated with agriculture, forestry and fishing, and construction.

Approximately 18km to the east of Blackwater along the Capricorn Highway is the small township of Bluff. Bluff is located 17km to the south east of the PL boundary; however the Bluff Jellinbah Road forms the north east boundary of the PL.

Landholder residences located in the vicinity of the PL are shown on Figure 6. The closest is approximately 500m from the western PL boundary while the remaining residences are all within 5km of the PL boundary. Note also that all of these residences are within 5km of an operating coal mine.

According to the Planning Scheme for the region (Duaranga Shire which was amalgamated into the current Central Highlands Regional Council Area), the relevant social values are:

- The character of the residential communities;
- Well serviced communities;
- High levels of safety and amenity;
- Accommodate growth by offering a range of housing options to meet the diverse needs of all members of the community;
- Access to facilities and services that meet local needs; and
- Continued park and recreation spaces.

6.8.1.2 Potential adverse or beneficial impacts

Positive impacts on individuals and communities from the development of PL388 may include direct and indirect employment opportunities, business development, support for local businesses, volunteer contributions to service groups, and potential introduction of new people and families into the community.

Negative impacts that may occur include:

- Direct impacts such as noise, dust, traffic, and health and safety;
- Loss of community through employment of itinerant workers; and
- Increased demand on health, volunteer, education and community facilities.

6.8.1.3 Proposed environmental protection commitments objectives and control strategies

A Social Management Plan is provided in the table below. This plan outlines the environmental protection commitments and control strategies that will be implemented to minimise social impacts to local and regional communities. Implementation of other management plans such as the Noise Management Plan, Land Use Management Plan, Weed Management Plan and the Complaints Register and Management Plan will also contribute to enhancing positive social impacts and minimising negative social impacts.

Management Plan 14 Social Management Plan

Social Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise the impacts to individuals and communities as a result of Bow's development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • A high standard of behavior from employees and contractors has been demonstrated. • Number of local businesses provided the opportunity to provide goods and services. • Percentage of local residents employed by Bow. • Number of complaints. • Number of health and safety incidents by incident type.
Control Strategies	<ul style="list-style-type: none"> • A register of key stakeholders will be developed and maintained. • A Community Engagement Plan will be developed to ensure affected individuals and communities are fully informed about proposed and ongoing activities. • Site managers will participate in community engagement activities and will report outcomes to the Corporate Head Office on a regular

Social Management Plan

	<p>basis.</p> <ul style="list-style-type: none"> • Landowners will be kept informed of activities which may impact on their amenity. • A Code of Conduct for employees and contractors will be developed and strictly enforced. Disciplinary action and corrective action taken will be recorded and reported. • Bow will participate in the CSG/LNG Skills Taskforce and other Government initiatives to help address skill shortages and other social impacts. • Bow will participate in regional planning processes and liaise directly with Central Highlands Regional Council and relevant State Government agencies. • A complaints register and handling system will be maintained.
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6.8.2 Cultural Heritage

6.8.2.1 Description of environmental values

There are no recorded Indigenous or non-Indigenous cultural heritage items or places within the PL area.

6.8.2.2 Potential adverse or beneficial impacts

There is potential for activities undertaken on the PL to disturb unrecorded items of cultural heritage. Therefore it is important for the project to have management plans to manage accidental finds of cultural heritage items.

6.8.2.3 Proposed environmental protection commitments, objectives and control strategies

A Cultural Heritage Management Strategy is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts as a result of project activities to known and undiscovered items and places of cultural heritage.

Management Plan 15 Cultural Heritage Management Strategy

Cultural Heritage Management Strategy

Environmental Protection Objective	<ul style="list-style-type: none"> • Minimise impacts to items and places of Indigenous and non-Indigenous cultural heritage significance as a result of Bow's development, production and decommissioning activities.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Compliance with an approved Aboriginal Cultural Heritage Management Plan (CHMP) pursuant to the provisions of the Aboriginal Cultural Heritage Act 2003. • No unauthorized impacts to items or places of cultural heritage significance.
Control Strategies	<ul style="list-style-type: none"> • A CHMP will be developed, agreed and implemented to ensure appropriate management of Indigenous cultural heritage. The CHMP may include procedures for: <ul style="list-style-type: none"> - Identification, salvage, storage and management of cultural heritage items and areas; - Unexpected finds or discovery of human remains; - Conflict resolution;

Cultural Heritage Management Strategy

- Monitoring; and
- Reporting.
- Field investigations for items and places of non-Indigenous cultural heritage significance will be completed for areas proposed to be disturbed by PL activities.
- A Non-Indigenous Cultural Heritage Management Plan will be developed and implemented if any sites of significance are at risk from PL activities.
- Relevant approvals and associated conditions will be obtained before disturbing cultural heritage items or places.
- If unexpected finds of non-Indigenous cultural heritage items or sites are made, the following procedure will be followed:
 - All work in the vicinity of the find will stop and a buffer of at least 50m will be established.
 - The Environment Liaison and General Manager (Project Services) will be notified.
 - A suitably qualified person will be engaged to assess the significance of the find and advise on how it should be managed in accordance with provisions of the Queensland Heritage Act 1992.
- A component of the workforce induction program will provide information on the importance of cultural heritage sites and procedures to follow if unexpected finds are made.
- Implementation of all cultural heritage procedures and commitments will be monitored and reported where required.

6.9 Waste

6.9.1 Waste generating activities

Limited amounts of waste are expected to be generated by the petroleum activities, however examples of waste generated may include:

- Green waste resulting from vegetation clearing or weed clearing;
- Kitchen wastes and putrescibles from temporary camps and work sites;
- Packaging materials, including pallets, drums, boxes, plastics, ropes etc;
- Oil and chemicals (e.g. from servicing equipment);
- Sewage from temporary camps and work sites; and/or
- Coal seam gas water and brine.

Coal seam gas water and brine are discussed in Section 6.10. Sewage is discussed in Section 6.11.

6.9.2 Description of environmental values

The environmental values to enhance or protect include:

- The life, health and wellbeing of people;
- The diversity of ecological processes and associated ecosystems; and
- Land use capability, having regard to economic considerations.

6.9.3 Potential adverse or beneficial impacts

Activities that have the potential to impact on the environmental values described

above include:

- Release of hazardous waste to land or waters either through inappropriate waste disposal protocols or accidental release(s);
- Inadequate waste management leading to inappropriate disposal or inadequate re-use and recycling; or
- Compromised land use, ecosystems or well-being of people resulting from inappropriate waste disposal.

6.9.4 Proposed environmental protection commitments, objectives and control strategies

A Waste Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise environmental harm from the generation and handling of wastes.

Management Plan 16 Waste Management Plan

Waste Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Waste management practices conform with statutory and industry standards. • Waste management incorporates the waste management hierarchy of waste avoidance, waste re-use, waste recycling, energy recovery from waste and waste disposal. • No release or likely release of a hazardous contaminant to land or water resulting from CSG related activities in the PL area.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No inappropriate disposal or management of waste. • Record of regulated waste disposal. • No contamination of soil, air or water as a result of any spillages.
Control Strategies	<ul style="list-style-type: none"> • Regulated waste and recyclable materials will be salvaged and removed to an appropriate licensed depot (batteries, empty drums, lubricating oils and oil filters, tyres). • Where the waste is defined as trackable waste by the Environmental Protection (Waste Management) Regulation 2000 it will be transported by a person with a current authority to transport such waste under the provisions of the Environmental Protection Act 1994, and recorded as required under section 23 of Environmental Protection (Waste Management) Regulation 2000. • Waste tracking records will be maintained for five years as required by the Environmental Protection (Waste Management) Regulation 2000, and will include date of transport, quantity and type of waste removed and transported, route selected for transport of waste, and quantity of waste delivered. • All relevant personnel will be trained to ensure the proper identification, segregation and labeling of waste so that where appropriate waste re-use and recycling are maximised. • All equipment and facilities will be maintained in a clean and safe condition, with an emphasis on good housekeeping practices. • General waste will be collected and transported to the local Council approved disposal site. • No green waste will be burnt. • Sewage will either be collected and disposed of offsite at an appropriate facility or treated and disposed of onsite in accordance with all regulatory requirements.

Waste Management Plan

- No untreated sewage effluent is to be released to waters.
- Plant and equipment used for sewage treatment or disposal will be installed, maintained and operated in a proper and efficient manner.
- The disposal of sewage effluent will not cause the contamination of any water used for drinking, domestic or manufacturing purposes or for consumption by animals.
- If sewage sludge is to be buried on land, the sludge will be covered with at least 250mm of soil and where practicable located above known flood levels.
- Any chemical wastes will be collected in appropriate sealed and labeled for safe transport to an approved chemical waste depot or collection by a liquid waste treatment service.
- Storage, transport and handling of all hazardous wastes will be managed in accordance with the requirements of relevant legislation and industry standards.
- All hazardous wastes will be appropriately stored in bunded areas away from watercourses and in accordance with legislative requirements.
- Containment devices will be checked periodically and drained if necessary so as to prevent overflow and subsequent pollution of the surrounding land and/or water body. Drained liquids will either be transported off-site to an appropriate disposal facility or treated and discharged on site with approval from the administering authority.
- Material Safety Data Sheets (MSDSs) for hazardous materials will be available on-site during construction.
- Hydrocarbon wastes, including lube oils, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations.

6.10 Coal seam gas water

6.10.1 Coal seam gas water management

Since 2009, the Queensland Government has been developing a Coal Seam Gas Water Management Policy in response to the anticipated increase in coal seam gas production and therefore an increase in coal seam gas water production. Production is expected to increase as a result of:

- Government policies intended to shift electricity production from coal-fired to gas-fired generation including the Queensland Gas Scheme and ClimateSmart 2050;
- The need to meet the production shortfalls arising as conventional natural gas resources in the State decline; and
- Additional demand created by the proposed coal seam gas to liquefied natural gas projects.

The Queensland Government's policy position in relation to coal seam gas water includes:

- Discontinuing the use of evaporation ponds as a primary means of disposal of coal seam gas water. Transitional arrangements will be developed by the government in consultation with industry to address issues with existing evaporation ponds. Remediation of existing evaporation ponds is to occur within 3 years;
- Making coal seam gas producers responsible for treating and disposing of coal seam gas water. Unless the producers use direct injection of coal seam gas water or have arrangements for environmentally acceptable direct use of untreated coal seam gas water, coal seam gas water must be treated to a standard defined by DERM before disposal or supply to other water users;
- Ponds necessary for water aggregation and the storage of brine from treatment facilities are to be fully lined to a standard determined by DERM;
- An associated coal seam gas water management plan is to be incorporated into the environmental management plan required for a level 1 environmental authority application; and
- Water which is in excess to that which can be directly injected or beneficially used is to be aggregated for disposal.

The preparation of an associated coal seam gas water management plan for this PL area is limited by current unavailability of water quality and quantity measurements, which are expected to become available during the production testing phase under ATP 1025P. Bow Energy is still in the early phases of work and this is reflected in the current state of knowledge on coal seam gas water quality and quantity. Based on limited testing undertaken so far, it is expected that a very small quantity of associated coal seam gas water will be produced from these Bowen Basin coal measures, compared with the amounts produced in the Surat Basin.

Bow Energy's objectives for coal seam gas water management are to:

- Ensure compliance with Government regulations, legislation and policy; and including where applicable, relevant Codes of Practice, Australian Standards and accepted industry practices;
- Define appropriate performance objectives, standards and measurement criteria with reference to the environmental values;
- Ensure that systems are in place to minimise the environmental effects associated with the operations; and
- Ensure that continual improvement in environmental practice occurs.

6.10.1.1 Description of environmental values

Coal seam gas water is water that is initially contained within the coal measures. The removal of this water to the surface releases the pressure on the coal seam gas, allowing it to be recovered/produced from the coal seam. Therefore the removal of the coal seam water is integral to the production of coal seam gas.

Production testing of coal seam gas has not been carried out in the PL area, therefore detailed coal seam gas water characterisation has not been undertaken. The volume of coal seam gas water produced during coal seam gas extraction will vary with the location of the coal seam gas well and will vary over time depending on the stage of production. Similarly the quality of the coal seam gas water will vary

however it may contain high concentrations of salt and other contaminants.

6.10.1.2 Potential adverse or beneficial impacts

The production of coal seam gas water in association with the production of coal seam gas can have adverse environmental impacts in two ways:

- The impact of the extraction of the coal seam gas water on groundwater aquifers; and
- The impact on environmental values such as land and water from the use and disposal of the coal seam gas water.

The impact of the extraction of the coal seam gas water will be monitored during the production testing phase. This is discussed further in Section 6.10.2.

Once the coal seam gas water quality and quantity parameters are established, then realistic assessments of the potential for use, treatment and disposal can be addressed. Discharge of coal seam gas water to land, surface water and groundwater may have the potential to cause the following impacts:

- Changes to water quality of the surface or groundwater resulting in impacts to aquatic ecology and other users of the resource, including potential for migration of injected coal seam gas water from the target aquifer to surrounding aquifers;
- Alteration of the physical integrity of the groundwater aquifer and impacts on surrounding aquifers;
- Change to the flow regime or alteration to geomorphology of the surface water resulting in decrease of bank and channel stability, and increased erosion;
- Erosion at discharge points when disposed to land or surface waters; and
- Contamination of land from salt and other contaminants.

Depending on the management option chosen for the coal seam gas water, beneficial use can be made of coal seam gas water such as supply to landholders or reuse for petroleum activities.

6.10.1.3 Coal seam gas water management options

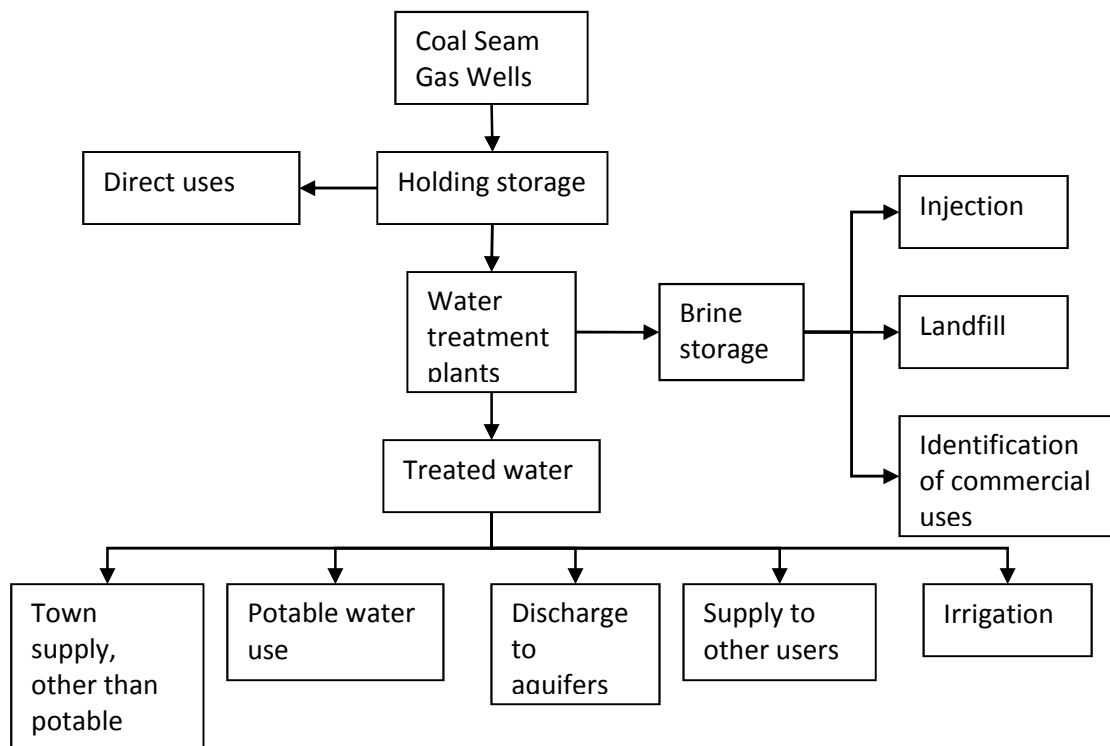
The Queensland Government has identified a number of preferred management options for coal seam gas water and management options that are not preferred. These are listed below:

- Preferred management options
 - Injection into a groundwater aquifer where detrimental impact is unlikely
 - Untreated use of coal seam gas water such as livestock watering, domestic uses, feedlot operations, aquaculture dust suppression and in mining or industrial applications
 - Treatment of coal seam gas water to remove or reduce contaminants and use as potable water supply or irrigation water
 - Direct supply via pipeline to a water supply dam managed by a water service provider; and
- Non-preferred management options
 - Disposal via evaporation dams

- Disposal via injection where a detrimental impact is likely
- Disposal to surface waters
- Disposal to land.

The use or disposal of coal seam gas water will necessarily involve the aggregation of the water and storage in purpose built coal seam gas water storages. The design, operation and decommissioning of coal seal gas water storages are discussed further in Section 6.5 together with the Dam Management Plan.

The flowchart below gives a summary of treatment and use/disposal options for coal seam gas water.



Water use can be divided into consumptive and non-consumptive uses. Non-consumptive uses are generally associated with recreation and tourism.

Subject to water quality and quantity, which are unable to be determined with any degree of certainty at this stage, potential beneficial uses for coal seam gas water from this PL area may include replacement of the following current consumptive water uses:

- Use within the PL area for authorised (under the Petroleum and Gas (Production and Safety) Act 2004) petroleum activities such as drilling and other incidental activities such as dust suppression;
- Supply to local landholders for stock watering or small area fodder crop irrigation;
- Supply to nearby coal mine operations for use in coal wash plants or for dust suppression; or
- Supply to Central Highlands Regional Council for local construction activities such as road building and maintenance.

These uses will be investigated to determine if any represent viable management options for coal seam gas water from the PL.

The coal seam gas water must have suitable quality for the proposed use/disposal or will have to be treated to the appropriate quality. Treatment options such as desalination (for example by reverse osmosis or ion exchange technologies), chemical treatment or filtration will be investigated and management of by-products and wastes from the treatment process will be determined.

6.10.1.4 Proposed environmental protection commitments, objectives and control strategies

It will be necessary to prepare a Coal Seam Gas Water Management Plan in accordance with DERM's Guideline for Preparing an EM Plan for Coal Seam Gas Activities. The Coal Seam Gas Water Management Plan will:

- Provide an estimate of the volume of coal seam gas water produced annually over the life of the PL activities;
- Describe the characteristics of coal seam gas water produced;
- Describe how and where coal seam gas water will be produced, aggregated, stored and kept separate from other waters until it is used, treated, distributed or disposed of;
- Describe how coal seam gas water will be dealt with in accordance with the coal seam gas water management hierarchy including a description of the estimated amount of coal seam gas water that will be dealt with under the preferred water management options and the water management options that are not preferred;
- Where coal seam gas water is proposed to be treated, describe:
 - the treatment process,
 - how and where the treated water will be stored and used, and
 - how and where the waste generated by the treatment process will be stored, used and/or disposed of;
- If any coal seam gas water is proposed for direct disposal as waste, provide information sufficient to demonstrate that legislative, environmental, technological, economic, and social requirements have all been evaluated and taken into consideration in deciding that disposal as waste is the only feasible option;
- Describe the detail of any pilot programs or trials for coal seam gas water solutions, including
 - objectives of project,
 - quantity and quality of coal seam gas water applied,
 - location/area,
 - duration of activity;
- Describe the characteristics of any receiving environment;
- Describe the control measures that will be implemented for each water management option (aggregation, storage, treatment, use, or disposal) to prevent or control the release of a contaminant or waste to the environment;
- Describe the indicators or other criteria against which the performance of the coal seam water management practices will be assessed;

- Describe a monitoring program sufficient for the prediction and early detection of any detrimental impacts on the receiving environment from coal seam gas water management practices;
- Describe the procedures that will be adopted to regularly review the monitoring program and to report to management and DERM should unforeseen or non-compliant monitoring results be recorded;
- Describe the procedures that will be implemented to prevent unauthorised environmental harm from unforeseen or non-compliant monitoring results;
- Describe procedures for dealing with accidents, spills, failure of containment structures, and other incidents that may arise in the course of the coal seam gas water management practices and result in the unexpected release of contaminants or waste to the environment; and
- Describe the procedures to be used to identify and implement strategies that minimise the quantity of coal seam gas water generated at the surface of the land, promote efficiency in the use of coal seam gas water as a resource through direct use and treatment, improve the water management practices employed where non preferred management options are being used, and minimise the total area of land disturbed by coal seam gas water dams.

No production testing has been undertaken on this PL, therefore at this stage, there is insufficient information available on the quality and quantity of coal seam gas water that will be produced by the PL activities to prepare the strategies and procedures necessary for the Coal Seam Gas Water Management Plan. Instead, a Coal Seam Gas Water Strategy has been developed to provide the environmental protection commitments and control strategies that will be implemented to minimise impacts on environmental values from treatment and use of coal seam gas water.

Management Plan 17 Coal Seam Gas Water Strategy

Coal Seam Gas Water Strategy

Environmental Protection Objective	<ul style="list-style-type: none"> • Manage coal seam gas water in a way that optimises its beneficial use and minimises adverse impacts on environmental values. 																										
Performance Standards and Indicators	<ul style="list-style-type: none"> • Coal seam gas water is contained and not released to land or waters. • Coal seam gas water is used for purposes specifically authorised by and in accordance with conditions of an approval under appropriate legislation. • Coal seam gas water used for domestic or stock purposes meets the requirements within the ANZECC 2000 Water Quality Guidelines or subsequent versions. • Coal seam gas water used for dust suppression on roads within this PL meets the following water quality limits: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #d9d9d9;">Water Quality Characteristics</th> <th style="background-color: #d9d9d9;">Unit</th> <th style="background-color: #d9d9d9;">Limit</th> <th style="background-color: #d9d9d9;">Limit type</th> </tr> </thead> <tbody> <tr> <td>pH</td> <td>pH units</td> <td>6.0 – 9.0</td> <td>range</td> </tr> <tr> <td rowspan="2">Sodium Adsorption Ration</td> <td rowspan="2">ratio</td> <td>8</td> <td>80th percentile</td> </tr> <tr> <td>12</td> <td>maximum</td> </tr> <tr> <td>Total Suspended Solids</td> <td>mg/L</td> <td>30</td> <td>maximum</td> </tr> <tr> <td>Total Dissolved Solids</td> <td>mg/L</td> <td>2000</td> <td>maximum</td> </tr> <tr> <td>Total Petroleum Hydrocarbons</td> <td>mg/L</td> <td>10</td> <td>maximum</td> </tr> </tbody> </table>	Water Quality Characteristics	Unit	Limit	Limit type	pH	pH units	6.0 – 9.0	range	Sodium Adsorption Ration	ratio	8	80 th percentile	12	maximum	Total Suspended Solids	mg/L	30	maximum	Total Dissolved Solids	mg/L	2000	maximum	Total Petroleum Hydrocarbons	mg/L	10	maximum
Water Quality Characteristics	Unit	Limit	Limit type																								
pH	pH units	6.0 – 9.0	range																								
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Total Suspended Solids	mg/L	30	maximum																								
Total Dissolved Solids	mg/L	2000	maximum																								
Total Petroleum Hydrocarbons	mg/L	10	maximum																								
Control Strategies	<ul style="list-style-type: none"> • Develop and implement a Coal Seam Gas Water Management Plan in accordance with requirements of the administering authority. 																										

Coal Seam Gas Water Strategy

- The Coal Seam Gas Water Management Plan will include provision for the following:
 - Treating coal seam gas water to a standard suitable for the intended use or disposal option.
 - Minimising the development footprint of water management infrastructure.
 - Obtaining an approval under the Environmental Protection (Waste Management) Regulation 2000 for use of the coal seam gas water as a resource if beneficial use of the coal seam gas water is planned.
 - Characterising coal seam gas water during production testing of wells on the PL.
 - Pilot testing of improved water management technologies and by-product (such as brine) disposal.
 - Developing and implementing a Stimulation Impact Monitoring Program of the quality and quantity of coal seam gas water from fracture stimulation wells in accordance with requirements of the administering authority.
- Procedures for dealing with accidents, spills, failure of containment structures, and other incidents will be developed and implemented.
- Design, operation and decommissioning of coal seam gas water dams will be undertaken in accordance with the Dam Management Plan.
- Bow Energy will make sufficient resources available to implement the coal seam gas water management strategy.
- A receiving environment monitoring program will be developed and implemented to monitor and record any impacts from the discharge of coal seam gas water to the receiving environment.
- Monitoring results, incidents and audit results will be reported to Bow management and as required to the administering authority.

6.10.2 Management of impacts on groundwater from coal seam gas water extraction

One of the impacts that extraction of coal seam gas water may have is on groundwater aquifers. Both the quality and levels in the aquifers may be impacted. This can have an indirect impact on groundwater dependent ecosystems and landholders who access the aquifer as a water resource. The Water Act 2000 provides the head of power to regulate these impacts and makes provision for the minimisation of impacts with separate monitoring and reporting requirements which are outside this EM Plan.

A Groundwater Resource Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on groundwater as a result of the extraction of coal seam gas water. Additional management strategies for impacts on groundwater from other petroleum activities on the PL, such as fracture stimulation (fracking), are discussed in Section 6.11 in the Groundwater Management Plan.

Management Plan 18 Groundwater Resource Management Plan

Groundwater Resource Management Plan

Environmental Protection Objective	<ul style="list-style-type: none">• To minimise the impacts to groundwater quality and groundwater levels.
Performance Standards and Indicators	<ul style="list-style-type: none">• Minimal impact on existing groundwater bores from coal seam gas activities.• Minimal drawdown impacts to landholders.• Minimal impact to groundwater dependent ecosystems.
Control Strategies	<ul style="list-style-type: none">• Baseline assessment of all identified bores in the PL area will be completed prior to production testing being carried out.• Collation of historical water level data for bores in the PL area to establish natural variation in aquifer levels will be undertaken.• Modeling of the hydrological regime to demonstrate connectivity or otherwise of coal seams with groundwater sources in the area will be undertaken.• Springs in the area will be identified and hydrological assessment extended if necessary to include estimates of likelihood of coal dewatering on surface water refugia.

6.11 Water

The Environmental Protection (Water) Policy 2009 commenced on 28 August 2009 and seeks to achieve protection of Queensland waters while allowing for development that is ecologically sustainable. This purpose is achieved by:

- identifying environmental values for Queensland waters (aquatic ecosystems, water for drinking, water supply, water for agriculture, industry and recreational use); and
- deciding and stating water quality guidelines and water quality objectives to enhance or protect the environmental values.

A draft consultation paper was released in December 2010: “Establishing Environmental Values, Water Quality Guidelines and Water Quality Objectives for Fitzroy Basin Waters”²⁷

6.11.1 Description of environmental values

As discussed in Section 5.11, the PL is located within the Mackenzie River sub-catchment of the Fitzroy River Basin. The local surface water values are associated with Blackwater Creek and its unnamed tributaries that flow through the PL area. The local groundwater quality is reported as saline.

6.11.2 Potential adverse or beneficial impacts

It is not anticipated that petroleum activities proposed for this PL will impact on peak flood levels of the local river and creek systems.

²⁷

http://www.derm.qld.gov.au/environmental_management/water/environmental_values_environmental_protection_water_policy/pdf/draft-values-objectives-fitzroy.pdf

Potential impacts to water resources due to proposed petroleum activities include:

- Loss of water for other water users (managed by provisions of the Water Act 2000 and Groundwater Resource Management Plan);
- Disruption of permanent pools if connectivity to river base flows or alluvial aquifers exist;
- Flooding of infrastructure and wells;
- Increased erosion and sedimentation from stormwater flows;
- Spills contaminating surface waters and groundwater affecting aquatic habitat and water quality;
- Failure of dams causing erosion and sedimentation or local flooding (managed by the Dam Management Plan);
- Coal seam gas water discharge to surface waters changing flow regimes and increasing sedimentation resulting in water quality impacts and impacts on aquatic ecology (managed by the Coal Seam Gas Water Management Plan and Strategy);
- Storage of coal seam gas water in dams impacting shallow groundwater resources;
- Changes in groundwater flows and quality from injection of coal seam gas water or brine concentrate, or as a result of stimulation activities;
- Alterations to groundwater recharge rates as a result of surface alterations;
- Disruption to natural flow and geomorphology of surface waters as a result of filling or direct disturbance within a watercourse or wetland; and
- Erosion, sedimentation and scouring of surface waters as a result of stormwater flows or other water discharges.

6.11.3 Proposed environmental protection commitments, objectives and control strategies

The impacts listed above not already being managed by other management plans within this EM plan are dealt with in this section.

A Groundwater Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on groundwater values as a result of petroleum activities undertaken on the PL.

Management Plan 19 Groundwater Management Plan

Groundwater Management Plan	
Environmental Protection Objective	<ul style="list-style-type: none"> • Manage petroleum activities in a manner that minimises impacts to groundwater quality and levels.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Stimulation activities do not result in a change in groundwater quality other than that within the stimulation impact zone of the target gas producing formation. • Stimulation activities do not cause the connection of a target gas producing formation and another aquifer. • No changes in groundwater quality detected by the monitoring program.
Control Strategies	<ul style="list-style-type: none"> • A stimulation risk assessment, in accordance with the requirements of the administering authority, will be developed prior to fracture

Groundwater Management Plan

	<p>stimulation activities being carried out on the PL.</p> <ul style="list-style-type: none"> • Procedures will be developed and implemented prior to stimulation activities commencing that will detect, as soon as practicable, any fractures that cause the connection of a target gas producing formation and another aquifer. • Drilling fluids will be biodegradable and water based. • During development of production wells, hydraulic isolation will be maintained between aquifers. • Prior to well stimulation, the internal and external mechanical integrity of the well system will be checked. • A groundwater monitoring program will be developed and implemented. The groundwater monitoring program will include sampling of groundwater to meet the requirements of the Stimulation Impact Monitoring Program (refer to the Coal Seam Gas Water Strategy – Management Plan 17). • If monitoring shows stimulation activities have resulted in a change in water quality other than that within the stimulation impact zone or have caused connection of the target gas producing formation and another aquifer, rectification measures will be investigated. • Implementation of the groundwater management plan will be audited annually and a report provided to management.
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A Watercourse and Wetland Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise activities in, within or in close proximity to watercourses and wetlands. The implementation of other management plans contained within this EM Plan will also assist in minimising impacts on watercourses and surface water by petroleum activities, including the Dam Management Plan, Soil and Erosion Management Plan, Land Degradation and Contamination Management Plan, Waste Management Plan, Coal Seam Gas Water Strategy, Stormwater Management Plan and the Sewage Management Plan.

Management Plan 20 Watercourse and Wetland Management Plan

Watercourse and Wetland Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Undertake petroleum activities in a manner that has minimal impact on watercourses.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Time of disturbance to a watercourse is as short as practicable. • The natural flow of a watercourse has not been interfered with through placing fill, excavation, impoundment or diversion.
Control Strategies	<ul style="list-style-type: none"> • Design of infrastructure and activities will be such that they are located outside watercourses and drainage lines where practicable. • Vegetation will not be cleared, nor fill placed in or within: <ul style="list-style-type: none"> - 200m from any wetland, lake or spring, or - 100m of the high bank of any other watercourse (as defined in Section 5 of the Water Act 2000). • Activities for constructing pipelines or access tracks will be undertaken in no or low flow conditions if necessary. • Significant disturbance to the bed or banks of a watercourse will be: <ul style="list-style-type: none"> - No greater than the minimum area necessary for the purpose of the significant disturbance,

Watercourse and Wetland Management Plan

- Undertaken where necessary and where no reasonable alternative exists. Upon cessation of the activities or works, rehabilitation will be started immediately such that the final rehabilitation is to a condition that will ensure the ongoing physical integrity and the natural ecosystem values of the site,
- Designed and undertaken by a suitably qualified person taking into account the matters listed in DERM's Guideline – Activities in a watercourse, lake or spring associated with mining operations, dated April 2008, or more recent editions as such become available, and
- Rehabilitated upon cessation of the petroleum activities.
- Routine, regular and frequent visual monitoring will be undertaken while construction work is carried out in a watercourse.

A Stormwater Management Plan is provided in the table below. This plan provides the environmental protection commitments and control strategies that will be implemented to minimise impacts on water values as a result of stormwater runoff. Most aspects of erosion and sedimentation are covered by the Soil and Erosion Management Plan described in Section 6.6.3 and cross referenced in the Stormwater Management Plan.

Management Plan 21 Stormwater Management Plan

Stormwater Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Undertake petroleum activities in a manner that minimises impact to surface water geomorphology, hydrology, quality and dependent ecosystems from stormwater runoff.
Performance Standards and Indicators	<ul style="list-style-type: none"> • No unauthorised discharge to surface waters of contaminants through stormwater runoff.
Control Strategies	<ul style="list-style-type: none"> • The Land Degradation and Contamination Management Plan will be implemented to minimise risk of spills. • Refueling of plant and equipment on the PL will occur at least 30m from a watercourse or other drainage feature. • Hazardous and dangerous goods stored on the PL will be a minimum of 100m from a watercourse or other drainage feature. • Fuels and other flammable liquids will be stored in accordance with AS 1940:2004 - The storage and handling of flammable and combustible liquids. • Infrastructure will not be constructed over tributaries or flow paths where practicable. • Erosion and sediment controls will be installed where necessary at disturbed areas such as dam construction sites and drill pads. The erosion and sediment controls will be implemented and maintained in accordance with Best Practice Erosion and Sediment Control published by IECA. • The Soil and Erosion Management Plan will be implemented including effective monitoring of erosion and sedimentation control works.

It is unclear at this stage whether a sewage treatment facility will be required on this PL during the life of the petroleum activities. Temporary or permanent facilities which may be installed will be in accordance with the following Sewage Management Plan.

Management Plan 22 Sewage Management Plan

Sewage Management Plan

Environmental Protection Objective	<ul style="list-style-type: none">To install and operate a sewage treatment or disposal facility in a manner that minimises environmental harm.
Performance Standards and Indicators	<ul style="list-style-type: none">The installation and operation of a sewage treatment or disposal facility has not caused environmental harm.
Control Strategies	<ul style="list-style-type: none">The details of any proposed sewage treatment/disposal facility will be provided to the administering authority prior to the construction or installation of the facility.A monitoring program will be implemented to assure the effective performance of the facility.

6.12 Rehabilitation

Final land use will be determined by a number of factors including:

- Regulatory and legislative requirements current at the time of decommissioning and rehabilitation;
- Current best practice;
- Stakeholder views including those of landowners, particularly where continued use of infrastructure such as access roads, dams, water bores, fences and gates, may be required;
- Land use of surrounding areas and local community needs, for example land may be used for future community development rather than return to agricultural use;
- The nature of the receiving environment and the environmental values of the area.

The Petroleum & Gas (Production & Safety) Act 2004 requires under section 560 that the PL holder removes all equipment and infrastructure from the land prior to relinquishment of the tenure, unless the landowner agrees otherwise. A written agreement for any permanent infrastructure left to the landowner is required with the Final Rehabilitation Report required under the Environmental Protection Act 1994.

At this stage of the project the detail of rehabilitation cannot be provided, since most sites are not yet constructed and locations are subject to landowner agreement and site assessments of vegetation and heritage values. The following management plan therefore proposes general objectives, indicators and control strategies. Refer also to Table 25 for further information on rehabilitation goals and completion criteria.

6.12.1 Proposed rehabilitation goals, objectives, indicators and completion criteria

Management Plan 23 Rehabilitation Management Plan

Rehabilitation Management Plan

Environmental Protection Objective	<ul style="list-style-type: none"> • Final land form that is safe, non-polluting, stable and self-sustaining. • Significantly disturbed land reinstated to pre-disturbed land use, except where otherwise agreed between the landholder, administering authority and Bow. • Significantly disturbed land is rehabilitated to a stable landform requiring no on-going management greater than that required pre-disturbance.
Performance Standards and Indicators	<ul style="list-style-type: none"> • Dams to be rehabilitated to become a stable landform similar to surrounding undisturbed areas OR with agreement maintained for use by the landowner. • Decommissioning of all infrastructure no longer required at cessation of activities. • No ongoing contamination of surface or groundwater. • Maintain 80% foliage cover of immediate surrounds for at least 3 years. • Maintain 80% of flora species in immediate surrounds for at least 3 years. • Maintain 80% of fauna species diversity in immediate surrounds for at least 3 years. • Stable landform with no subsidence or erosion gullies maintained for 5 years.
Control Strategies	<ul style="list-style-type: none"> • Progressive rehabilitation of disturbed areas as practicable, including reshaping significantly disturbed land to a stable profile and remediation of contaminated land. • Re-establish surface drainage lines. • Reinstatement of top layer of soil profile. • Continue weed management protocols (refer to Weed Management Plan). • Promote establishment of vegetation. • Regular maintenance of rehabilitated areas until performance standards are met. • Monitoring at least annually, or as appropriate, to measure progress of rehabilitation until performance standards are met. • Written agreements with landowners for rehabilitation works. • Written agreements with landowners for any infrastructure remaining on the property for their use. • Prepare Final Rehabilitation Report.

6.12.2 Proposed final land use

In the absence of specific landowner agreements at this stage of the project, the proposed final land use will be consistent with the current pre-disturbed land use. The Land Use Management Plan seeks to minimise the disturbance to the extent that is practicable and safe. This approach should facilitate rehabilitation and a return to the pre-disturbed land use at cessation of activities.

6.12.3 Remediation of contaminated land

Refer to Land Degradation and Contamination Management Plan. Remediation of any contaminated land arising from project activities will be in accordance with accepted industry practice current at the time and the relevant current regulatory and legislative requirements.

At this time, it is not clear what coal seam gas water treatment may be required and therefore what brine may be produced over the life of the project. The disposal of brine is an important issue, and may give rise to contaminated land if, for example, a landfill monocell for salt is constructed. However, there are insufficient details available at present to make specific commitments.

Table 25 Rehabilitation table – PL 388

Petroleum activity feature	Rehabilitation goal	Rehabilitation objectives	Indicators	Completion criteria
Wells	1. safe	Site safe for humans and animals.	Reported accidents, incidents and injuries.	Plugged with cement to isolate aquifers. Surface facilities removed. Re-contoured to condition consistent with surrounding area or proposed land use. No reported accidents, incidents or injuries as a result of Bow's activities.
	2. non-polluting	Stormwater runoff does not pollute nearby watercourses.	All equipment and chemicals from site are removed. No leakage.	Monitoring meets background quality.
	3. stable	Stormwater runoff does not cause erosion. Surface contours reestablished.	Subsidence. Erosion gully formation.	No significant erosion events. Landform reestablished.
	4. self-sustaining	Land use returned to pre-disturbance use.	Foliage cover. Species diversity. Weed survey.	Foliage cover established at 80% of the surrounding area. No ongoing management required beyond that required for surrounding areas with similar land use. Vegetation successfully self-propagating and reseeded. Key species present. No weed species

Petroleum activity feature	Rehabilitation goal	Rehabilitation objectives	Indicators	Completion criteria
				introduced.
Flowlines	1. safe	Site safe for humans and animals.	Reported accidents, incidents and injuries.	Lines isolated, drained, purged and vented. Flushed and cleaned. Capped and left in situ. No reported accidents, incidents or injuries as a result of Bow's activities.
	2. non-polluting	Stormwater runoff does not pollute nearby watercourses.	Surface water quality.	Monitoring meets background quality.
	3. stable	Stormwater runoff does not cause erosion. Surface contours reestablished.	Subsidence. Erosion gully formation.	No significant erosion events. Landform reestablished.
	4. self-sustaining	Land use returned to pre-disturbance use.	Foliage cover. Species diversity. Weed survey.	Foliage cover established at 80% of the surrounding area. No ongoing management required beyond that required for surrounding areas with similar land use. Vegetation successfully self-propagating and reseeding. Key species present. No weed species introduced.
Access tracks	1. safe	Site safe for humans and animals.	Reported accidents, incidents and injuries.	Fences removed. Road closed. Condition of land similar to surrounding landscape. No reported accidents, incidents or injuries as a result of Bow's activities.
	2. non-polluting	Stormwater runoff does not pollute nearby watercourses.	Surface water quality.	Monitoring meets background quality.
	3. stable	Stormwater runoff does not cause erosion. Surface contours	Subsidence. Erosion gully formation.	No significant erosion events. Landform reestablished.

Petroleum activity feature	Rehabilitation goal	Rehabilitation objectives	Indicators	Completion criteria
		reestablished.		
	4. self-sustaining	Land use returned to pre-disturbance use OR Tracks maintained for use by landowner with agreement.	Foliage cover. Species diversity. Weed survey.	Foliage cover established at 80% of the surrounding area. No ongoing management required beyond that required for surrounding areas with similar land use. Vegetation successfully self-propagating and reseeding. Key species present. No weed species introduced.
Dams	1. safe	Site safe for humans and animals.	Reported accidents, incidents and injuries.	Fences removed. Condition of land similar to surrounding landscape. No reported accidents, incidents or injuries as a result of Bow's activities.
	2. non-polluting	No land contamination from contents of dam. Stormwater runoff does not pollute nearby watercourses.	Contaminated land assessment. Surface water quality.	Salts removed and disposed at purpose built facility. Above ground structures removed. Monitoring of soils and water meets background quality.
	3. stable	Stormwater runoff does not cause erosion. Surface contours reestablished.	Subsidence. Erosion gully formation.	No subsidence or major erosion gullies. Landform reestablished.
	4. self-sustaining	Land use returned to pre-disturbance use.	Foliage cover. Species diversity. Weed survey.	Foliage cover established at 80% of the surrounding area. No ongoing management required beyond that required for surrounding areas with similar land use. Vegetation successfully self-propagating and reseeding. Key species present.

Petroleum activity feature	Rehabilitation goal	Rehabilitation objectives	Indicators	Completion criteria
				No weed species introduced.

7 DATA AND REFERENCE SOURCES

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APPENDIX 1

Approvals for Blackwater Power Station

APPENDIX 2

Copy of Environmental Authority for PPL 160

APPENDIX 3

Copy of Initial Development Plan

Note: This Initial Development Plan was submitted in support of the application for petroleum lease and was developed for the entire ATP1025P. Further work since then has refined the 5 year well program and the updated well program is presented in this Environmental Management Plan as Figure 5.