Environmental Impact Assessment

Bowra Coal Seam Gas Project

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1.0 Introduction

This is an *Environmental Impact Assessment* for the proposed development of six coal seam gas plants at Bowra Station, Cunnamulla, in Queensland. The proposed development involves the construction and ongoing operation of the plants, which will likely incur negative environmental impacts for the region. This report will assess these impacts across four areas: (1) conservation of flora, (2) conservation of fauna, (3) geology and soils and (4) surface and groundwater. Within each of these areas the report will examine existing conditions, provide an impact assessment, suggest mitigation and monitoring options and evaluate the impacts.

Bowra Station is a 140 square kilometre property near Cunnamulla in the Shire of Paroo (figure 1) that lies in the Mulga Lands Bioregion in southwest Queensland (Australian Wildlife Conservancy 2013). Purchased by the Australian Wildlife Conservancy in 2010, it was originally used for cattle farming, but now supports 15 regional ecosystems with high biodiversity (Australian Wildlife Conservancy 2013). It is positioned in the Mulga Lands, a *high priority* bioregion that has less that 5 per cent reservation level (Australian Wildlife Conservancy 2013). Bowra contains a variety of landforms and types of geology, and hosts a confirmed 296 animal species and 93 plant species (Mulder et al. 2012; Clegg et al. 2012).

Figure 1: Shire of Paroo in southwest Queensland

Source: LGAM 2010

The Mulga lands are made up of flat plains and small hills that stretch across parts of Queensland and New South Wales. They predominantly consist of sandy infertile soils, grasses, shrubs and some eucalypts and mulga trees (Witt et al. 2011). They are extremely fragile environments and have prominent ecosystem degradation from soil erosion, grazing and native woody weeds (Purdie et al. 2986). They contain a web of wetland areas and are flooded seasonally (Witt et al. 2011)

The proposed project involves constructing six coal seam gas wells (table 1), five of which are closely grouped and one that is approximately 110 kilometres to the north (figure 2). The coal seam gas industry is rapidly growing in Australia but can cause significant ecological impacts and land-use conflicts. Coal seam gas mining involves drilling wells and extracting methane gas that is absorbed within the structure of the coal (Jarvie 2011). Although the wells do not take up much space, the process requires removing significant amounts of groundwater to release pressure, storing the groundwater, building pipes to transport water, and constructing roads to access the sites (Jarvie 2011).

Table 1: Location of six gas well sites.

SITE	LATITUDE	LONGITUDE
SITE 1	-27.95859	145.578
SITE 2	-27.9852	145.5996
SITE 3	-27.99305	145.6106
SITE 4	-27.961	145.585
SITE 5	-26.949	145.5379
SITE 6	-28.04778	145.5379

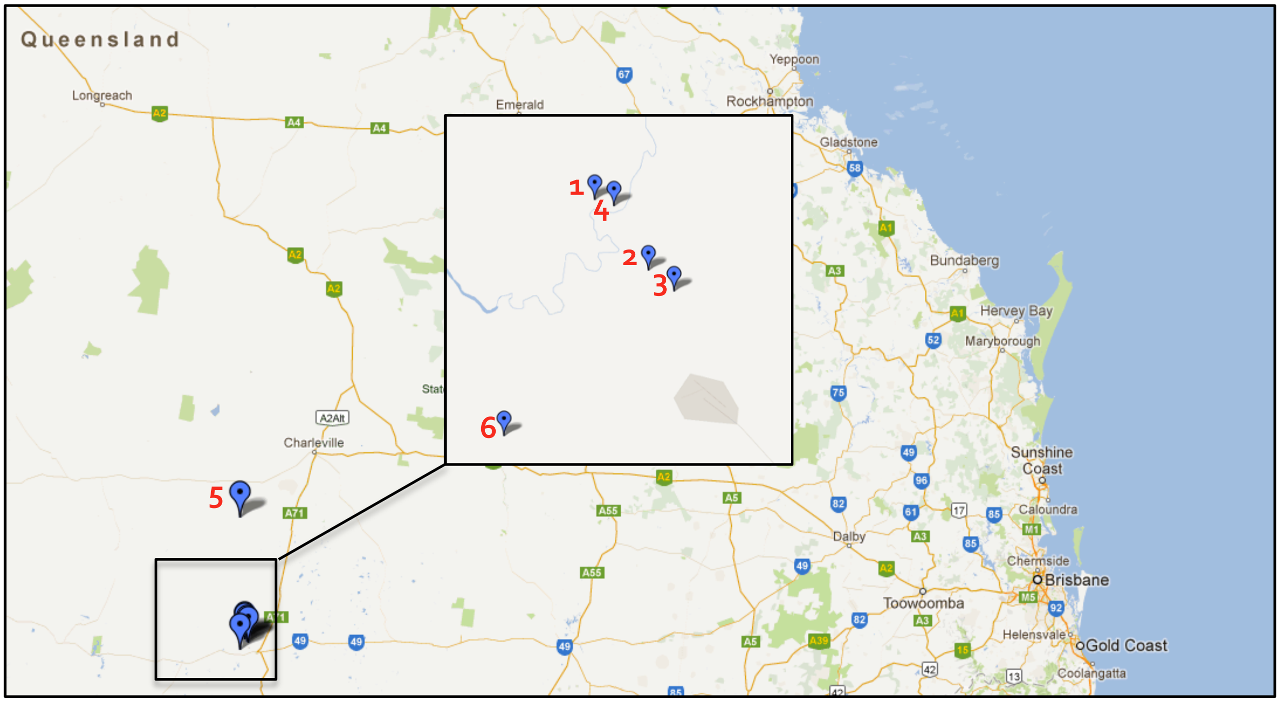

Figure 2: Location of six proposed sites for gas wells.

Source: Google Maps, 2013.

This report will outline the methods used in this study, provide an in-depth assessment of the four areas mentioned above (looking at existing conditions, impacts assessment, mitigation and monitoring and impact evaluation), examine project alternatives and summarise the findings.

2.0 Methods

Firstly, to determine the geographical context of the subject sites, *Google Maps* was used to create a map and assess the structure and layout of the region. Secondly, species lists for an area with a three-kilometre radius around each site were obtained from the Queensland Department of Environment and Heritage Protection (DEHP), available online from the following site: http://www.ehp.qld.gov.au/wildlife/wildlife-online. From these lists, it was determined what species had a Queensland conservation status that suggested they were of concern for each site, as classified under the *Nature Conservation Act 1992*. Also, species with an Australian conservation status under the *Environment Protection and Biodiversity Conservation Act 1999* that suggested they were of concern for the study were noted. Additionally, the results of two studies conducted by Clegg et al. (2012) and Mulder et al. (2012) were used to provide a more comprehensive list of flora and fauna species present at each site.

To determine the types of ecosystems occurring at each of the six sites, regional ecosystem maps (appendices 1-6) were obtained from the DEHP, available online at the following website: http://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems. On each map of each site, several regional ecosystems can be seen, depicted in a 3-number code. This code describes (1) the bioregion, (2) the land zone and (3) the region. All of the sites fall within the *Mulga Lands Bioregion*, and occur within two different land zones; described in more detail in section 3.4.1 Geology and Soils. It was noted that there were many types of regions that occur on the six sites, each with different vegetation structures, many of which were not of concern but some of which were of biodiversity concern.

To determine the location of waterways, the DEHP wetland maps were used, which are available at: http://www.ehp.qld.gov.au/wetlandmaps/. Finally, a risk matrix was developed to quantify and evaluate the impacts, and provide direction and guidance as to the actions required (table 2). Then the literature was examined to identify risks to the types of ecosystems present at each site and to research the potential impacts of coal seam gas mining. The literature also provided mitigation and monitoring options to lessen these impacts. Google Earth was used as a tool to locate sparsely vegetated areas and roads and to identify possible locations for alternative sites, that would be likely to have less environmental impacts.

Table 2: Risk matrix for assessing ecological and environmental impacts from proposed development

PART A – Likelihood, Consequences and Associated Risk Score

LIKELIHOOD	CONSEQUENCES: **Insignificant** *Little to no environmental impacts*	**Minor** *Minor impacts, easy to mitigate*	**Moderate** *Requires thorough mitigation process*	**Major** *Major impacts, require restoration/ management*	**Catastrophic** *Irreversible environmental impacts*
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

PART B – Likelihood Rating and Probability

RATING	PROBABILITY
Almost Certain	>90% of the time
Likely	61-90%
Possible	36-60%
Unlikely	10-35%
Rare	<10% of the time

PART C – Risk Score and Action Required

RISK SCORE	ACTION REQUIRED
Extreme	Action should be avoided, as irreversible impacts are highly likely.
High	Action plan required, senior management attention needed.
Medium	Specific monitoring or procedures required, management responsibility must be specified.
Low	Manage through routine procedures. Unlikely to need specific application of resources.

3.0 Assessment

The following section provides an assessment of the existing conditions across four areas; conservation of flora, conservation of fauna, geology and soils, and surface and groundwater. It also outlines an impact assessment, possible mitigation and monitoring techniques, and an impact evaluation across each area for the proposed development.

3.1 Conservation of Flora

3.1.1 Existing Conditions

Bowra has important plant biodiversity, which supports the habitats for the many birds and other fauna that reside in the region. The six subject sites have a range of higher dicots and monocots and there is a total of 92 plant species found in total between them (Clegg et al. 2012). The number of species within a three-kilometre radius of each site varies from 16 to 27, with site 5 having the lowest species richness (Clegg et al. 2012). Only one species is considered to be of concern, *Rhodanthe rufescens*, which occurs within a three-kilometre radius of sites 1 and 4 (see table 3) (DEHP 2013d, 2013g).

The vegetation around the sites is generally sparse and consists of grasses, low-lying shrubs, acacias and eucalypts (DEHP 2013c). The composition of vegetation and the ecosystem structure are defined by regional ecosystem codes and definitions and are mapped (see appendices 1-6). There are many regional ecosystem types that surround the six sites (DEHP 2013j, 2013k, 2013l, 2013m, 2013n, 2013o), all of which are of least concern under the *Vegetation Management Act 1999*, however some have the biodiversity statues ‘of concern’ (table 4) (DEHP 2013c).

Table 3: Table of total plant species and species of significance for the six sites

(Information adapted from Clegg et al. 2012 and DEHP 2013d, 2013e, 2013f, 2013g, 2013h, 2013i)

SITE	NUMBER OF SPECIES	SIGNIFICANT SPECIES
SITE 1	25	*Rhodanthe rufescens* (near threatened)
SITE 2	24	
SITE 3	27	
SITE 4	27	*Rhodanthe rufescens* (near threatened)
SITE 5	16	
SITE 6	19	

Table 4: Regional ecosystems of concern at each site.

SITE	REGIONAL ECOSYSTEMS OF CONCERN
SITE 1	6.3.22, 6.3.9, 6.3.13, 6.3.18
SITE 2	6.3.16
SITE 3	6.3.16, 6.3.13
SITE 4	6.3.13
SITE 5	6.3.1
SITE 6	6.3.2, 6.3.16

3.1.2 Impact Assessment

There are many factors that can be expected to impact on the region's flora during the construction and operation of the proposed mine sites. Firstly, during the construction of the development, significant land clearing will need to occur. Although the sites themselves would not require much of a cleared area, the roads and pipelines connecting each site would. However, as Jaarsma and Willems (2002, p. 125) note, the 'impacts go much further than the physical destruction of habitat produced by road construction.'

Apart from the initial habitat destruction, the roads connecting the sites would also cause habitat fragmentation, edge effects and changes to ecological systems (Rotholz & Mandelik 2013). Resler and Kolivras (2009) note that 'habitat fragmentation changes the functioning of an ecosystem by increasing the amount of edge habitat and reducing the area of functional interior habitat.' Resler and Kolivras (2009) explain that roads can change the ecosystem balance through creating an edge effect, which results in lower endemism but higher abundances of opportunistic plant species, like grasses and weeds along the road edge.

Additionally, trucks moving on and off the site throughout construction and operation are likely to import foreign plant species as seeds in tyre tracks. These species can 'reduce the abundance and diversity of native flora and fauna, and alter ecosystem processes' (Reid et al. 2009, p. 2342). Finally, to install the pipes needed to connect the sites and distribute water, trenches need to be built. Although efforts can be made to revegetate the area after they are put in, the initial dredging and constructing process can be very harmful in itself. It can cause soil disruptions and changes to hydrology that could negatively affect plant species that rely on the current conditions.

3.1.3 Mitigation and Monitoring

To mitigate the potential impacts on flora in the region due to the development, there are several strategies that can be implemented. Firstly, to minimize the land that needs to be cleared to connect sites with roads and pipes, all sites should be within close proximity to one another. Additionally, sites and connecting transects should be located where there is minimal clearing required, and where no vulnerable or near threatened species will be compromised. For example, *Rhodanthe rufescens* was found within a three-kilometres proximity to sites 1 and 4. A careful inspection of the site is required to ensure the location of wells 1 and 4 do not jeopardize the success of this species.

Secondly, to ensure invasive foreign species aren't introduced to the region on vehicles, a quarantine point should be set up to remove organic matter from tyre treads. A supervisor should be appointed with the responsibility of overseeing this process. Thirdly, to lessen the disruptions to and removal of flora, the trenches for pipes should be built alongside the roads, minimising habitat fragmentation and edge effects. Finally, subsequent revegetation should occur after the project has ceased to restore the region to its natural condition.

3.1.4 Impact Evaluation

The destruction of habitats is almost certain and has moderate consequences, habitat fragmentation and edge effects are likely and have moderate consequences, and invasive species introduction is possible and has major consequences. Therefore, using the risk matrix in section 2.0 Methods, the risk score is high for each of these three impacts and a comprehensive action plan and senior management attention is required.

3.2 Conservation of Fauna

3.2.1 Existing Conditions

Bowra has high biodiversity, especially of bird species, with between 123-175 species being confirmed within a three-kilometre radius of sites 1-4 (table 5) (Mulder et al. 2012; DEHP 2013d, 2013e, 2013f, 2013g, 2013h, 2013i). There are several species that are confirmed within a three-kilometre radius of the sites and that are considered vulnerable or near threatened under the *Nature Conservation Act 1992* (DEHP 2013d, 2013e, 2013f, 2013g, 2013h, 2013i). These include birds such as the redthroat (*Pyrrholaemus brunneus*), the square-tailed kite (*Lophoictinia isura*) and the grey falcon (*Falco hypoleucos*), which are near threatened and Major Mitchell's cockatoo (*Lophochroa leadbeateri*) and the painted honeyeater (*Grantiella picta*), which are vulnerable (table 5) (DEHP 2013d, 2013e, 2013f, 2013g, 2013h, 2013i). Although sites 1-4 have high species richness, sites 5 and 6 have do not, with only 3 and 17 species, respectively, being found at each (table 4) (Mulder et al. 2012).

Table 5: Species richness at each site and significant species, i.e. considered near threatened (NT) or vulnerable (V) under the *Nature Conservation Act 1992*.

(Information taken from Mulder et al. 2012 and DEHP 2013d, 2013e, 2013f, 2013g, 2013h, 2013i)

SITE	AMPHIBIANS	BIRDS	MAMMALS	REPTILES	SIGNIFICANT SPECIES
SITE 1	1	123	0	2	*Pyrrholaemus brunneus* (NT), *Lophochroa leadbeateri* (V), *Grantiella picta* (V), *Rhodanthe rufescens* (NT)
SITE 2	7	175	2	5	*Pyrrholaemus brunneus* (NT), *Lophochroa leadbeateri* (V), *Grantiella picta* (V), *Lophoictinia isura* (NT), *Falco hypoleucos* (NT)
SITE 3	7	174	2	3	*Pyrrholaemus brunneus* (NT), *Lophochroa leadbeateri* (V), *Grantiella picta* (V), *Lophoictinia isura* (NT), *Falco hypoleucos* (NT)
SITE 4	7	162	2	4	*Pyrrholaemus brunneus* (NT), *Lophochroa leadbeateri* (V), *Grantiella picta* (V), *Rhodanthe rufescens* (NT), *Lophoictinia isura* (NT), *Falco hypoleucos* (NT)
SITE 5	0	3	0	0	
SITE 6	0	17	0	0	*Lophochroa leadbeateri* (V)

3.2.2 Impact Assessment

There are many impacts that are likely to affect the fauna in the Bowra region as a result of the proposed coal seam gas development. Firstly, the clearing of vegetation for roads and pipes will destroy habitats essential for the prosperity of some species. The roads and pipelines will cause habitat fragmentation, edge effects and habitat alteration (Jaarsma & Willems 2002). Constant traffic of trucks will deter animals from crossing the road, creating a barrier effect, and can result is casualties. Figure 3 depicts habitat alteration, the barrier effect and disturbances that can impact surrounding fauna.

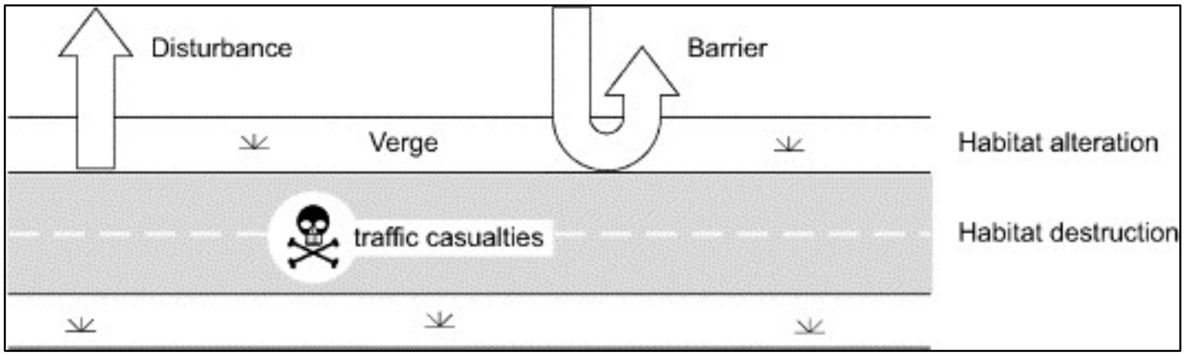

Figure 3: Possible effects of roads on wildlife.

Source: Jaarsma and Willems 2002

Also, although a mine in itself located at site 5 would have little to no impacts for fauna, its location makes the potential impacts high. A road and pipes connecting the site to the rest of the development would require significant habitat destruction and alteration, causing many negative impacts on fauna, such as those outlined in the previous paragraph. Additionally, there are non-direct impacts that can be expected and planned for. These include changes in hydrology, impacts on aquatic species from water run-off, and changes to the geological landscape.

3.2.3 Mitigation and Monitoring

There are several actions that need to be undertaken to mitigate the impacts outlined above. Firstly, as described in section 3.1.3, important habitats that support vulnerable or near threatened species should not be cleared for roads and pipes. Secondly, efforts should be made to minimise the disturbances and barrier effects caused by roads. Traffic should be limited to short, defined periods within the day as constant traffic could deter road crossings by animals. To limit traffic casualties and decrease noise disturbances, slow speed limits should be enforced. Efforts should also be made to encourage crossings, by making the roads narrow and minimising changes to the road surface (e.g. allow vegetation to grow). Additionally, the number of personnel and vehicles allowed onto the site should be kept to an absolute minimum to limit these negative impacts.

Also, prior to beginning construction, a comprehensive analysis should be composed of the ecosystem structure where the development will be located. This will become a reference for when the project ceases and rehabilitation of the site occurs (Morrison et al. 2005). Mitigation and monitoring of the impacts on fauna caused by changes to geology and soils or surface and groundwater is outlined in the subsequent sections.

3.2.4 Impact Evaluation

The small-scale destruction of habitats is almost certain and has moderate consequences, habitat alteration and occasional traffic casualties are likely and have minor causes and, finally, habitat fragmentation, ecological barriers and edge effects are likely and have moderate consequences. Therefore, using the risk matrix in section 2.0 Methods the risk scores for destruction of habitats, habitat fragmentation, ecological barriers and edge effects are high. These practices need a comprehensive action plan and senior management's attention is required. Additionally, habitat alteration and occasional traffic casualties have a medium risk score, meaning these risks can be managed through specific monitoring procedures and a specifically appointed manager.

3.3 Geology and Soils

3.3.1 Existing Conditions

There are two types of land zones located within three kilometres of the sites (table 6), according to DEHP (2013a, 2013j, 2013k, 2013l, 2013m, 2013n, 2013o). They are land zone 3, which consists of alluvial river and creek flats, and land zone 7, which is made up of ironstone jump-ups (table 5) (DEHP 2013a; Wilson & Taylor 2012). Land zone 3 is made up of alluvial sediments, and, that have an ongoing relationship with freshwater systems (figure 4) (Wilson & Taylor 2012). Land zone 7 involves Cainozoic duricrusts that are formed on rock, which form mesas or scarps (figure 5) (Wilson & Taylor 2012). Both land types consist of soils such as Rudosols, Tenosol, Sodosols, Chromosols and Kandosols, however land zone 3 also has Vertosols, Dermosols, Kurosols and Hydrosols (Wilson & Taylor 2012).

Table 6: Land zones present within three kilometres of each site.

(Information taken from DEHP 2013j, 2013k, 2013l, 2013m, 2013n, 2013o)

SITE	LAND ZONE 3	LAND ZONE 7
SITE 1	✔	✔
SITE 2	✔	✗
SITE 3	✔	✗
SITE 4	✔	✗
SITE 5	✔	✔
SITE 6	✔	✗

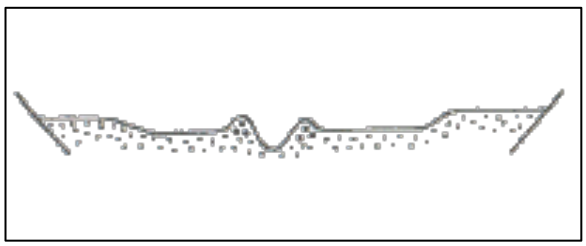

Figure 4: Land zone 3 - alluvial river and creek flats

(Source: Wilson & Taylor 2012)

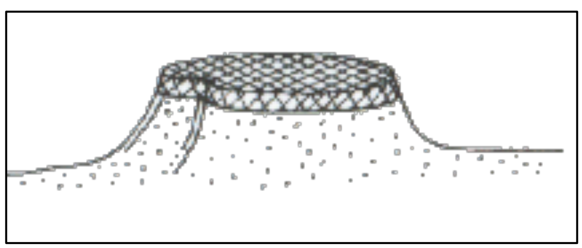

Figure 5: Land zone 7 - ironstone jump-ups

(Source: Wilson & Taylor 2012)

3.3.2 Impact Assessment

Soil composition and geology can have a major impact on the success of flora and fauna species (Catterall 2001). The proposed development is likely to impact upon the soil and geology in a number of ways. Firstly, vegetation will need to be cleared for roads and sites to be developed and Kirschbaum et al. (2008) found that clearing mulga had significant impacts on the soil composition, altering levels of carbon and nitrogen, which could impact species of flora and fauna.

Secondly, the alteration of the geology of the landscape for roads and pipelines could destroy essential habitats and structures upon which plant and animal species rely. The construction and use of roads and pipes will also promote erosion and soil degradation. Finally, chemical and organic pollution, distributed through water and air, are likely to contaminate surrounding soils as a result of the operation of the wells (Liang & Thomson 2008).

3.3.3 Mitigation and Monitoring

Kirschbaum et al. suggest that changes to nitrogen and carbon concentration is the soil due to clearing vegetation can be fixed or managed, post-development, through 'fertiliser addition or inclusion of legumes' (2008, p. 402). However, the best solution is minimising or avoiding disruptions before restoration is needed (Kirschbaum et al. 2008). Additionally, continual monitoring of soils in the surrounding area can ensure pollution is not occurring. Preventative measures at each site are required to prevent contaminated water reaching surrounding soils.

3.3.4 Impact Evaluation

The alteration of soil composition due to clearing of vegetation is likely and has moderate impacts, the destruction of geological structures for roads and pipes is possible, depending on the chosen routes, and has major impacts, erosion is likely and has major impacts and, finally, soil pollution is possible but has catastrophic impacts. Using the risk matrix in section 2.0 Methods, it can be seen that the risk score is high for each of these three impacts and therefore a comprehensive action plan and senior management attention is required.

3.4 Surface and Groundwater

3.4.1 Existing Conditions

All six sites are located within close proximity to waterways and sites 1, 4 and 5 have strong interactions with riverine regional ecosystems (figures 6 and 7) (DEHP 2013b). Additionally, all six sites are either on or near a floodplain, shown in yellow in figures 6 and 7 (DEHP 2013b). All sites are surrounded by land zone 3 (see table 6 above), which involves strong environmental interactions with freshwater waterways (DEHP 2013a).

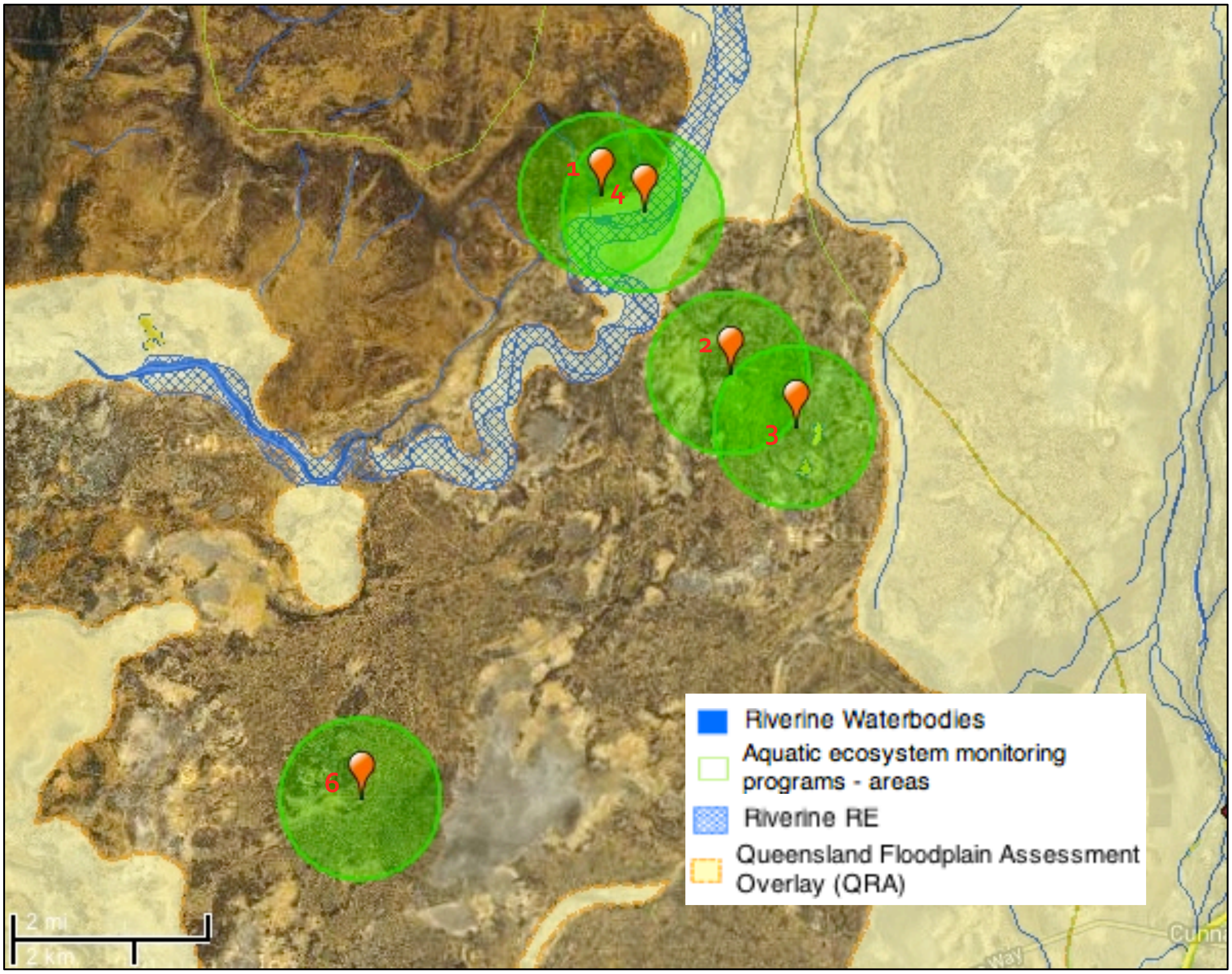

Figure 6: Map showing hydrological features around sites 1, 2, 3, 4 & 6, each with a 1.5 kilometre-wide buffer zone (green)

Source: DEHP 2013b

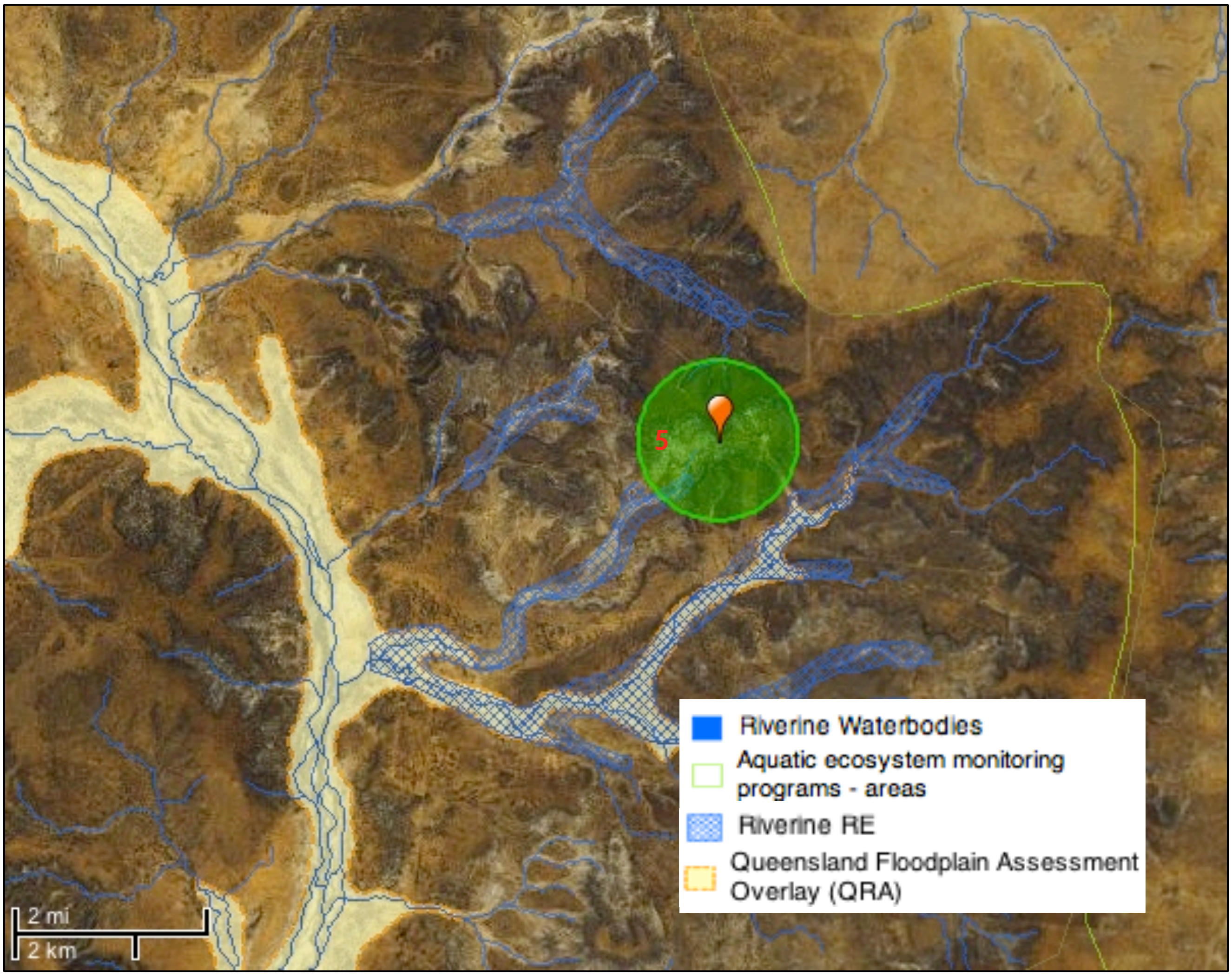

Figure 7: map showing the hydrological features around site 5 with a 1.5 kilometre-wide buffer zone (green)

Source: DEHP 2013b

3.4.2 Impact Assessment

Coal seam gas wells require that the water in the coal seam be pumped away to reduce pressure, resulting on a lot of water being produced at the surface (Jarvie 2011). The removal of this water can lead to subsequent changes in the movement of water to and from aquifers (Lowe 2013). The water that is removed must be transported and stored, along with the dissolved chemicals and substances it contains. After the mines are no longer in use, the aquifers need to be recharged, which requires significant amounts of water, usually taken from nearby waterways. These practices all have significant environmental impacts, which can then affect flora and fauna biodiversity.

The pumping of water to reduce pressure within the coal seams means that up to 480 kilolitres of water can be produced in a single day per well (Jarvie 2011). Pipes must be built to transport this water to and from sites and, as there are many waterways spreading across the region, the pipes are likely to have to transect these waterways, resulting in the direct impacts on these waterways during construction. Additionally, connecting the sites by road will mean that bridges need to be built over waterways.

3.4.3 Mitigation and Monitoring

There are mitigation and monitoring measure that must be undertaken to minimise the negative impacts outlined in the subsequent section. Firstly, the developers must seek to keep the water removed from the coal seams to a minimum; to lessen the amount of water needed to recharge the aquifers after the project has ceased. Secondly, constant monitoring of aquifers and nearby waterways needs to occur to ensure they don't decrease in water levels or water quality. Thirdly, the water removed from the coal seams needs to be stored in lined ponds, to prevent contamination of the surrounding environment (Jarvie 2011). To supply the project with a reliable water supply, bores need to be established, and will require constant monitoring, the importance of which is outlined by Jarvie (2011). Additionally, all efforts need to be made to protect the surrounding waterways from sedimentation and contamination from chemicals and salts. Constant monitoring, as well as on-site preventative measures, will ensure this does not occur.

3.4.4 Impact Evaluation

The production of excess water from depressurising the coal seams and the depletion of aquifers is almost certain and has moderate ecological impacts and the development of bridges and pipes near impacting upon waterways is possible and has major impacts. Therefore, using the risk matrix in section 2.0 Methods, the risk score is high for each of these three impacts and a comprehensive action plan and senior management attention is required.

4.0 Project Alternatives

The area of land cleared and affected must be kept to an absolute minimum because, although companies are required to restore and revegetate the area to its previous condition, Morrison et al. (2005) found that this is an over-optimistic and often unreachable goal. Therefore, site 5 should not be included in the project; due to the distance it is from the other sites and the amount of land needing to be cleared to connect it. Additionally, sites 1, 2 and 4 are located in dense shrubbery, and should be relocated to minimise the need for clearing and the destruction of habitats (figure 8) (Google Earth 2013). Near each of these three sites, an area of clear land exists by a road (Google Earth 2013). It is therefore recommended that these sites be relocated to the following locations (latitude, longitude): (site 1) 27.9628, 145.575, (site 2) 27.9844, 145.5939, and (site 4) 27.9581, 145.5903 (figure 8).

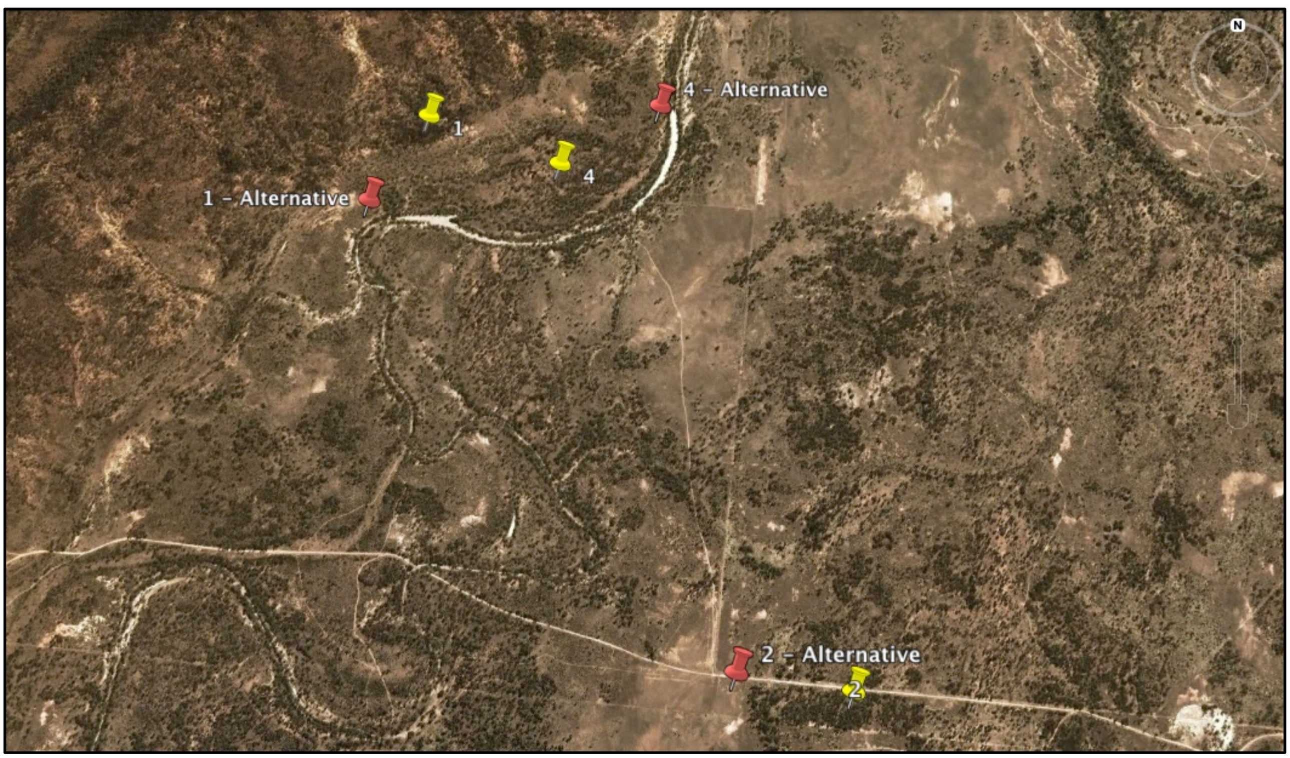

Figure 8: Map of alternative locations for sites 1, 3 and 4, in areas with minimal vegetation and adjacent to a road.

Source: Google Earth 2013

5.0 Summary

This environmental impact assessment has found various impacts across the four key areas looked at; conservation of flora, conservation of fauna, geology and soils, and surface and groundwater. The study has identified that there are several effects that would be irreversible and that should be changed through smart, strategic design of the development and through alterations to the initial proposal of site locations (see section 4.0). Apart from these serious impacts, of which alternatives have been suggested throughout the report, the other impacts can be easily mitigated through comprehensive plans, policies and appropriate administration by supervisors and higher management.

6.0 References

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DEHP (The State of Queensland Department of Environment and Heritage Protection) (2013g) *Wildlife Online Extract – Species List for a Specified Point: -27.961, 145.585 (Site 4)*, available: http://www.ehp.qld.gov.au/wildlife/wildlife-online/ (15 May 2013).

DEHP (The State of Queensland Department of Environment and Heritage Protection) (2013h) *Wildlife Online Extract – Species List for a Specified Point: -26.949, 145.5379 (Site 5)*, available: http://www.ehp.qld.gov.au/wildlife/wildlife-online/ (15 May 2013).

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7.0 Appendices

Appendix 1: Regional Ecosystem Map for site 1

Appendix 2: Regional Ecosystem Map for site 2

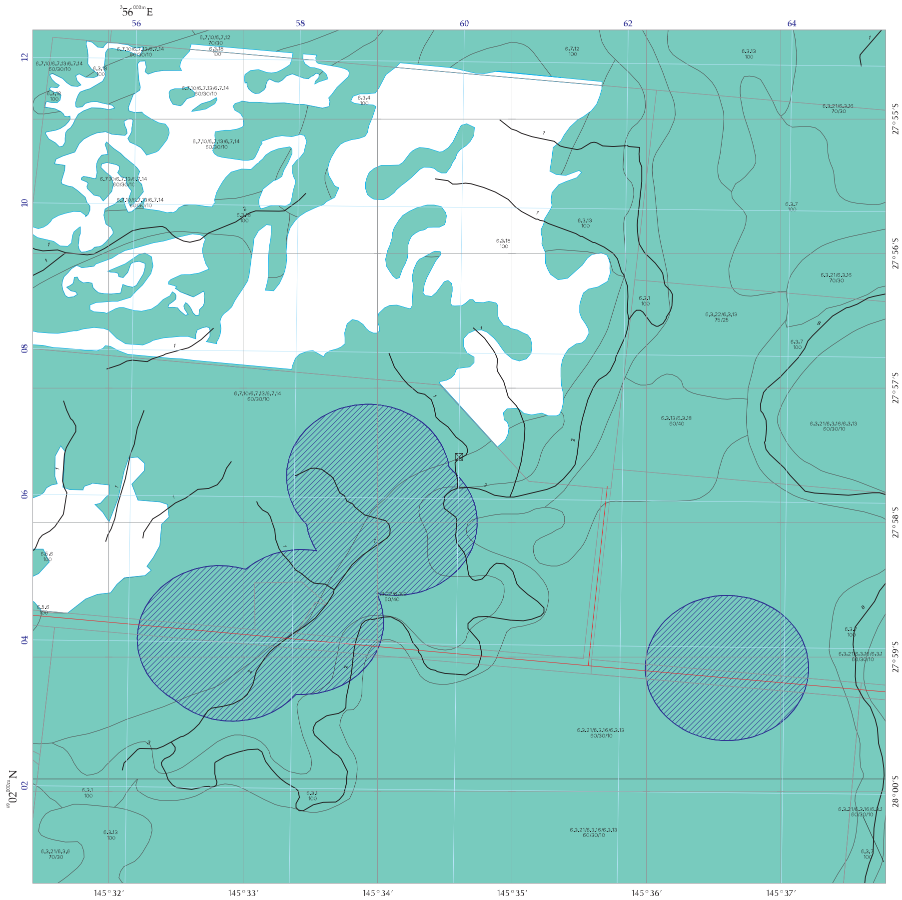
Appendix 3: Regional Ecosystem Map for site 3

Appendix 4: Regional Ecosystem Map for site 4

Appendix 5: Regional Ecosystem Map for site 5

Appendix 6: Regional Ecosystem Map for site 6

Appendix 1: Regional Ecosystem Map for site 1 (source: DEHP 2013j)



Vegetation Management Act Regional Ecosystem and Remnant Map-Version 6.1

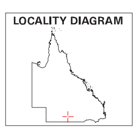
- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Great Barrier Reef Wetlands
- Vegetation Management Act Essential Habitat For further information on VMA Essential Habitat, please see the attached VMA Essential Habitat map.
- Subject Lot
- Watercourse (Stream order shown as black number against stream where available)
- Bioregion boundary
- Roads © Pitney Bowes Software 2012
- National Park, Conservation Area State Forest and other reserves
- Cadastral line Property boundaries shown are provided as a locational aid only.
- Towns
- Coordinate entered

Based on 2006 Landsat TM imagery

Requested By: J.STRICKLAND@GRIFFITH.EDU.AU
Date: 15 May 13 Time: 11.27.05

Centered on Coordinate:
Latitude: -27.9585 Longitude: 145.5768 (decimal degrees)
Bioregion: Mulga Lands

Queensland Government



Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

A remnant map covers areas not covered by a regional ecosystem map.

Defined map areas are labelled with the regional ecosystem (RE) code along with the percentage breakdown if more than one RE occurs within the area. Detailed definitions of regional ecosystems are available from www.ehp.qld.gov.au/REDD. Defined map areas smaller than 5ha may not be labelled.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/-100 metres. The extent of remnant regional ecosystems as of 2006, depicted on this map is based on rectified 2006 Landsat TM imagery (supplied by the Statewide Landcover and Trees Study (SLATS), Queensland Government).

Some watercourse lines are derived from GeoScience Australia 1:250 000 mapping.

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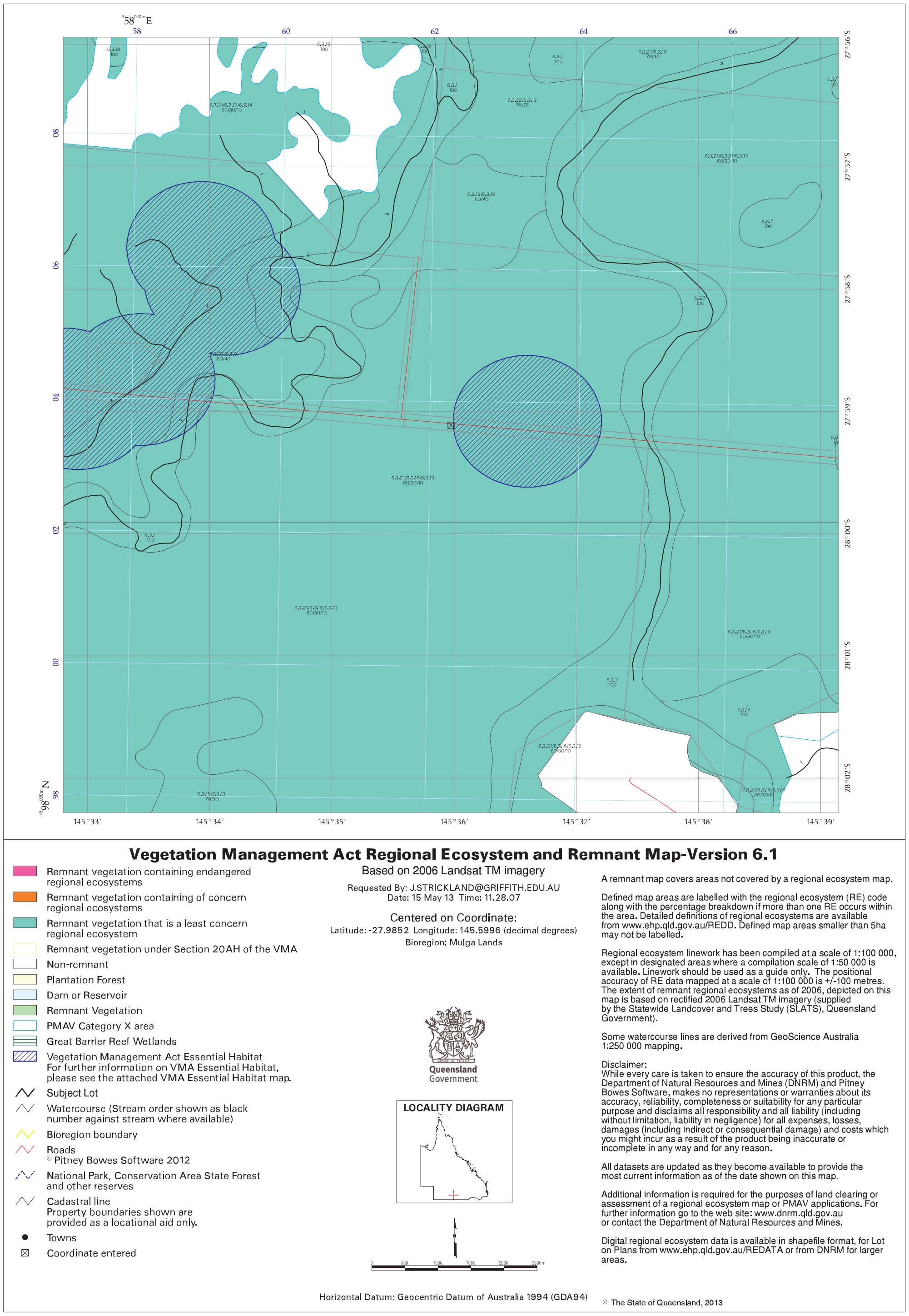
All datasets are updated as they become available to provide the most current information as of the date shown on this map.

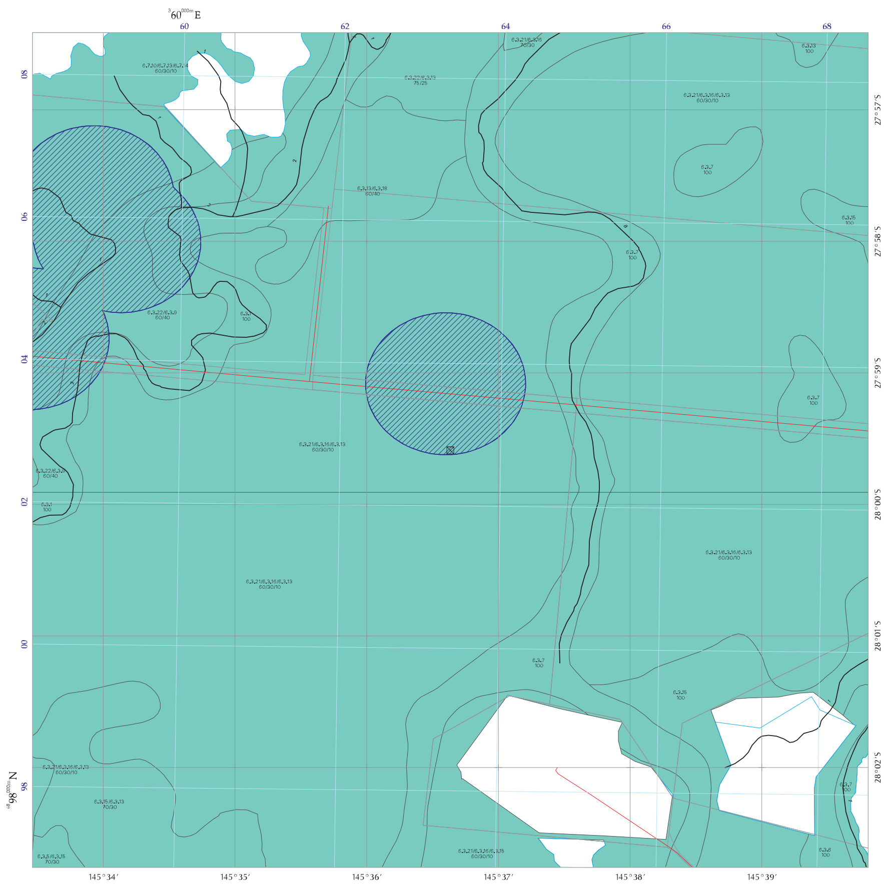
Additional information is required for the purposes of land clearing or assessment of a regional ecosystem map or PMAV applications. For further information go to the web site: www.dnrm.qld.gov.au or contact the Department of Natural Resources and Mines.

Digital regional ecosystem data is available in shapefile format, for Lot on Plans from www.ehp.qld.gov.au/REDATA or from DNRM for larger areas.

Appendix 2: Regional Ecosystem Map for site 2 (source: DEHP 2013k)



Appendix 3: Regional Ecosystem Map for site 3 (source: DEHP 2013l)



Vegetation Management Act Regional Ecosystem and Remnant Map-Version 6.1

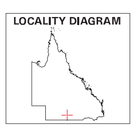
- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Great Barrier Reef Wetlands
- Vegetation Management Act Essential Habitat For further information on VMA Essential Habitat, please see the attached VMA Essential Habitat map.
- Subject Lot
- Watercourse (Stream order shown as black number against stream where available)
- Bioregion boundary
- Roads © Pitney Bowes Software 2012
- National Park, Conservation Area State Forest and other reserves
- Cadastral line Property boundaries shown are provided as a locational aid only.
- Towns
- Coordinate entered

Based on 2006 Landsat TM imagery

Requested By: J.STRICKLAND@GRIFFITH.EDU.AU
Date: 15 May 13 Time: 11.29.24

Centered on Coordinate:
Latitude: -27.9931 Longitude: 145.6106 (decimal degrees)
Bioregion: Mulga Lands

Queensland Government



Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

A remnant map covers areas not covered by a regional ecosystem map.

Defined map areas are labelled with the regional ecosystem (RE) code along with the percentage breakdown if more than one RE occurs within the area. Detailed definitions of regional ecosystems are available from www.ehp.qld.gov.au/REDD. Defined map areas smaller than 5ha may not be labelled.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/-100 metres. The extent of remnant regional ecosystems as of 2006, depicted on this map is based on rectified 2006 Landsat TM imagery (supplied by the Statewide Landcover and Trees Study (SLATS), Queensland Government).

Some watercourse lines are derived from GeoScience Australia 1:250 000 mapping.

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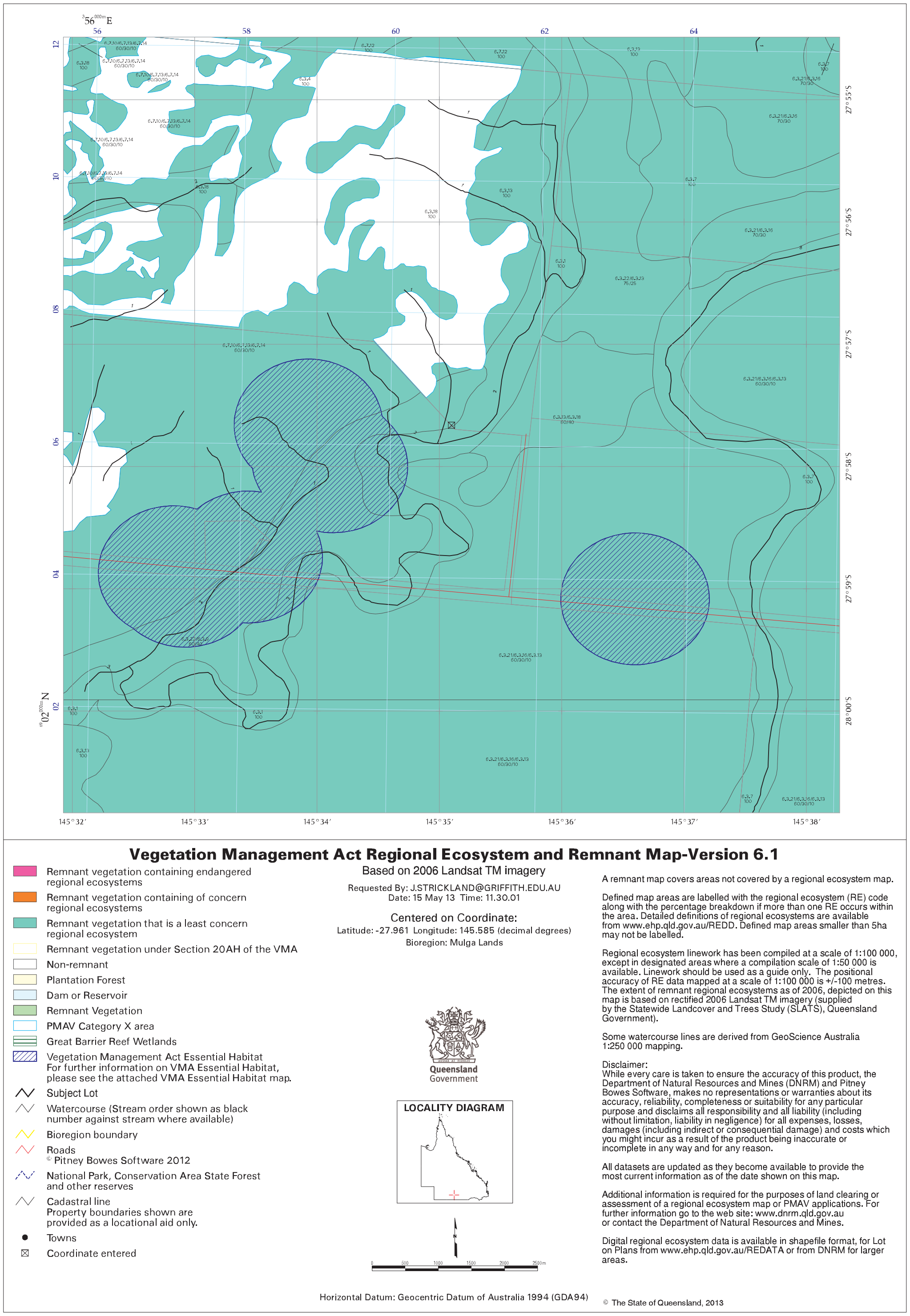
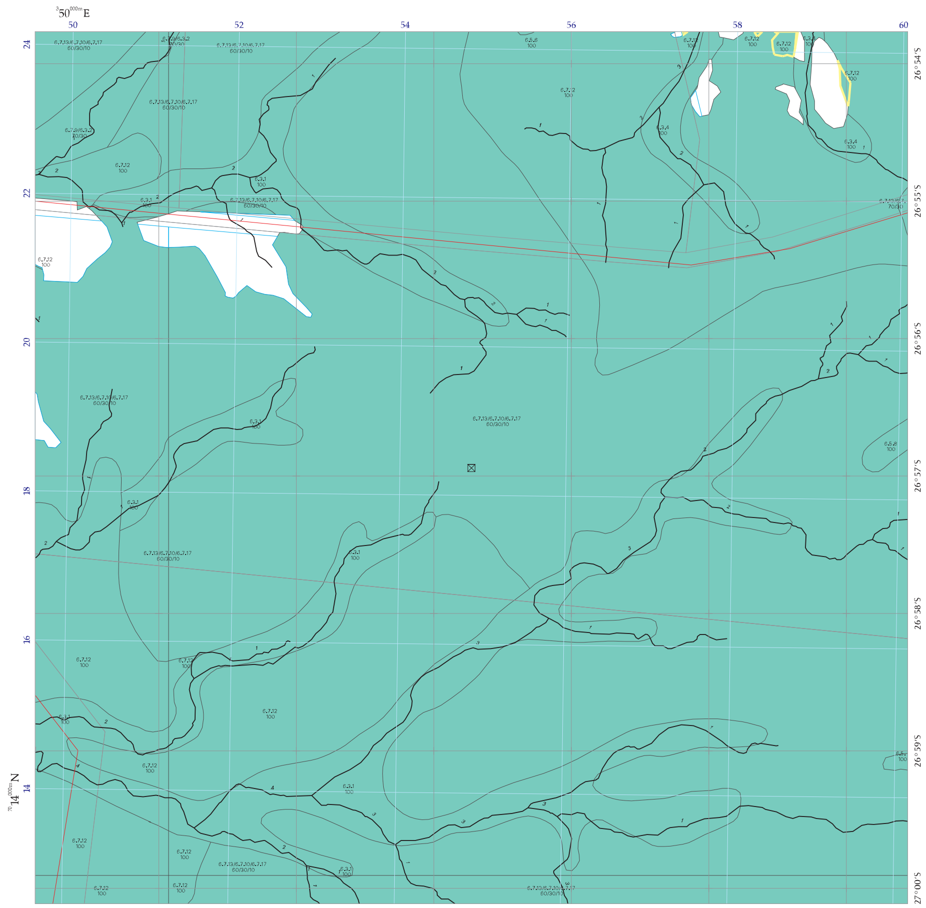
Appendix 4: Regional Ecosystem Map for site 4 (source: DEHP 2013m)



Appendix 5: Regional Ecosystem Map for site 5 (source: DEHP 2013n)



Vegetation Management Act Regional Ecosystem and Remnant Map-Version 6.1

Based on 2006 Landsat TM imagery

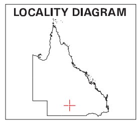
Requested By: J.STRICKLAND@GRIFFITH.EDU.AU
Date: 15 May 13 Time: 11.31.21

Centered on Coordinate:
Latitude: -26.949 Longitude: 145.5379 (decimal degrees)
Bioregion: Mulga Lands

- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Great Barrier Reef Wetlands
- Vegetation Management Act Essential Habitat For further information on VMA Essential Habitat, please see the attached VMA Essential Habitat map.
- Subject Lot
- Watercourse (Stream order shown as black number against stream where available)
- Bioregion boundary
- Roads © Pitney Bowes Software 2012
- National Park, Conservation Area State Forest and other reserves
- Cadastral line Property boundaries shown are provided as a locational aid only.
- Towns
- Coordinate entered

Queensland Government

LOCALITY DIAGRAM



Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

A remnant map covers areas not covered by a regional ecosystem map.

Defined map areas are labelled with the regional ecosystem (RE) code along with the percentage breakdown if more than one RE occurs within the area. Detailed definitions of regional ecosystems are available from www.ehp.qld.gov.au/REDD. Defined map areas smaller than 5ha may not be labelled.

Regional ecosystem linework has been compiled at a scale of 1:100 000, except in designated areas where a compilation scale of 1:50 000 is available. Linework should be used as a guide only. The positional accuracy of RE data mapped at a scale of 1:100 000 is +/-100 metres. The extent of remnant regional ecosystems as of 2006, depicted on this map is based on rectified 2006 Landsat TM imagery (supplied by the Statewide Landcover and Trees Study (SLATS), Queensland Government).

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All datasets are updated as they become available to provide the most current information as of the date shown on this map.

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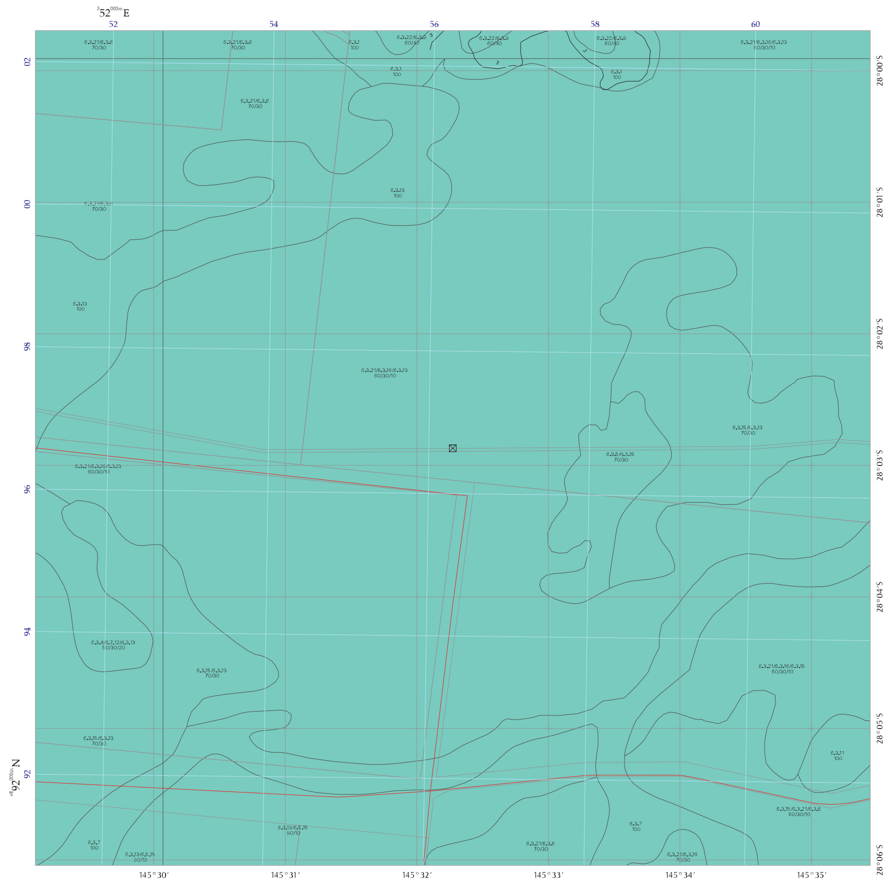
Digital regional ecosystem data is available in shapefile format, for Lot on Plans from www.ehp.qld.gov.au/REDATA or from DNRM for larger areas.

Appendix 6: Regional Ecosystem Map for site 6 (source: DEHP 20130)



Vegetation Management Act Regional Ecosystem and Remnant Map-Version 6.1

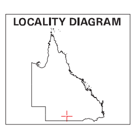
- Remnant vegetation containing endangered regional ecosystems
- Remnant vegetation containing of concern regional ecosystems
- Remnant vegetation that is a least concern regional ecosystem
- Remnant vegetation under Section 20AH of the VMA
- Non-remnant
- Plantation Forest
- Dam or Reservoir
- Remnant Vegetation
- PMAV Category X area
- Great Barrier Reef Wetlands
- Vegetation Management Act Essential Habitat
  For further information on VMA Essential Habitat, please see the attached VMA Essential Habitat map.
- Subject Lot
- Watercourse (Stream order shown as black number against stream where available)
- Bioregion boundary
- Roads
  © Pitney Bowes Software 2012
- National Park, Conservation Area State Forest and other reserves
- Cadastral line
  Property boundaries shown are provided as a locational aid only.
- Towns
- Coordinate entered

Based on 2006 Landsat TM imagery

Requested By: J.STRICKLAND@GRIFFITH.EDU.AU
Date: 15 May 13 Time: 11.31.55

Centered on Coordinate:
Latitude: -28.0478 Longitude: 145.5379 (decimal degrees)
Bioregion: Mulga Lands

Queensland Government



Horizontal Datum: Geocentric Datum of Australia 1994 (GDA94)

A remnant map covers areas not covered by a regional ecosystem map.

Defined map areas are labelled with the regional ecosystem (RE) code along with the percentage breakdown if more than one RE occurs within the area. Detailed definitions of regional ecosystems are available from www.ehp.qld.gov.au/REDD. Defined map areas smaller than 5ha may not be labelled.

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Some watercourse lines are derived from GeoScience Australia 1:250 000 mapping.

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All datasets are updated as they become available to provide the most current information as of the date shown on this map.

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