31

CUMULATIVE IMPACTS

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31 Cumulative Impacts

31.1 Introduction

31.1.1 Overview

The Project ToR requires that the EIS *Describe any cumulative impacts on environmental values caused by the project, either in isolation or by combination with other known existing or planned development or sources of contamination*. A cross reference to the locations where each of the requirements of the ToR has been addressed is given in Appendix B which references both the study chapters (Sections 1 through 34) and/or Appendices A (through EE).

There is no standard methodology in Queensland for the assessment of cumulative impacts as part of an EIS and there are no specific requirements in the legislation as to how cumulative impacts should be addressed. For the purposes of this chapter, cumulative impacts are defined as changes to the environment that are caused by an action in combination with other past, present and future human actions (Hegmann *et al.,* 1999). In this cumulative impacts chapter the combined effects of different developments within a similar spatial and temporal scope are considered. Cumulative impacts occur when impacts from individual developments combine to result in an impact which is greater than the individual residual impact of each development when considered in isolation. This impact may be positive or negative. The severity and duration of the cumulative impact will depend on the timing and duration of principally construction activities, as operational activities will over time establish a new equilibrium in supply and demand.

Past and present developments, as well as potential or existing sources of contamination, are considered part of the existing environment described in Sections 8 to 30 of this EIS, hence the cumulative impacts of these developments in combination with the Project has been assessed in the residual impacts of each chapter. This chapter provides an assessment of the environmental impact of the Project in synergy with the environmental impacts from future developments planned within the region. The delineation between past and present developments and future developments for the purposes of the Project EIS is as follows:

Past and Present Developments: Physical development is observable (in the form of operational infrastructure but excluding projects where a financial investment decision has been made and no physical works undertaken).

Future Developments: Documented evidence of a serious intent to develop and sufficient data to conduct a cumulative impact assessment exists (e.g., including an approved EIS, a detailed Initial Advice Statement (IAS) etc., but excluding early studies that do not indicate commitment such as feasibility studies).

The geographic separation of known and proposed developments in the region will reduce the severity of some cumulative impacts, particularly where the impacts are concentrated at or near the Project site. However, in some instances this also serves to increase the severity of cumulative impacts, as activities are concentrated in the larger towns that provide the necessary infrastructure and services.

31.1.2 Objective

The objective of the cumulative impact assessment is to assess the potential for impacts from the Project to have compounding or synergistic interactions with similar impacts from other projects proposed or under development within the sphere of influence on the Project.

31.1.3 Assessment Method

The impacts on the environmental values are presented in Sections 8 to 30 of the EIS with technical reports appended to provide additional detail. Where impact areas have been identified in the EIS, appropriate mitigation is proposed to reduce the impact to an acceptable level. In many cases, the residual impact (or mitigated impact) is reduced to a negligible level. In these cases where the Project is not contributing to the cumulative impact, no further assessment has been carried out.

The mitigated impacts are referred to as residual impacts. It is only these residual impacts which could result in cumulative impacts when considered alongside impacts from other developments. Therefore only residual impacts are discussed in this chapter and are considered to be the starting point of the cumulative impact assessment. The residual impacts are determined through the impact assessments carried out and the mitigation proposed in the EIS chapters (and technical reports). Table 31–1 details the residual impacts concluded in each chapter.

For the purpose of this chapter, environmental and social values that are considered for cumulative impacts are defined within the individual discipline chapters that make up the EIS (i.e. Sections 8 to 30). Those values impacted by the Project but not impacted by future developments within the same spatial and temporal scope, were excluded from the cumulative impact assessment (e.g. climate adaptation and contaminated land).

Additionally, some chapters of the EIS (e.g. health and safety) discuss indirect impacts which affect other environmental values (e.g. dust and particulate generation which impact on air quality values). Where this is the case, these impacts are stated as indirect and are addressed under the values that are affected; this is detailed in Table 31–1.

The cumulative impact assessment has included future developments that are within the same spatial and temporal scope as the Project and:

- Are being assessed under Part 1 of the Chapter 3 of the *Environmental Protection Act 1994* (Qld) with the EHP being the EIS Coordinator. As a minimum an IAS is available on the EHP website.
- Have been declared a ‘state significant project’ by the Coordinator-General under the *State Development Public Works Organisation Act 1971* (Qld) and an EIS for the project is currently being completed or is complete. As a minimum an IAS is available on the website of the Department of State Development, Infrastructure and Planning.
- Are directly associated with the development of CSG projects within the Bowen Basin or (i.e. gas fields and gas pipelines).
- Will, or may, utilise resources located within the region (including materials, groundwater, road networks or workforces) that are the same as the Project.
- Could potentially compound residual impacts that the Project will potentially have on environmental or social values.

Developments that satisfied the above criteria and could reasonably and practically be assessed for impacts at the time of writing were included in the cumulative impact assessment. Section 31.3 outlines the developments assessed.

Table 31-1 Environmental Values with Cumulative Impacts

Environmental Value	Residual Impact	Cumulative Assessment required? (Yes / No)
Climate	Indirect (impacts on other values)	No
Air Quality	Low	Yes
Greenhouse Gas Emissions	Low	Yes
Contaminated Land	Low	No
Soils	Low	No
Geology	Indirect (impacts on other values)	No
Groundwater	Low	Yes
Surface Water	Low	Yes
Aquatic Ecology	Moderate / Low	Yes
Terrestrial Ecology	Low	Yes
Environmentally Sensitive Areas	See Terrestrial Ecology	See Terrestrial Ecology
Land Use and Tenure	Moderate / Low	Yes
Landscape and Visual Amenity	Low	Yes
Roads and Transport[1]	Negligible	No
Noise and Vibration	Low	Yes
Economics	Moderate / Low	Yes
Social	Moderate / Low	Yes
Indigenous Cultural Heritage	Low	Yes
Non-Indigenous Cultural Heritage	Low	Yes
Preliminary Hazard and Risk	Low	Yes
Waste Management	Negligible	No
Decommissioning and Rehabilitation	Negligible	No
Health and Safety	Indirect (impacts on other values)	No

The Project is expected to operate over a 40 year period with construction operations ongoing over this period and peak construction activities are predicted to occur from late 2015 through to the end of 2016 when the initial Project facilities are established. This period is expected to have a peak construction workforce of approximately 1,760. Two smaller peaks are expected to occur in December

[1] Though cumulative assessment has not been performed of the road and transport impacts by virtue of the negligible residual environmental impact, the Roads and Transport chapter (Section 21) of this EIS does consider the cumulative impacts from significant committed projects. This assessment concludes that the residual cumulative impacts are also considered to be negligible.

2019 with 1,342 personnel and in May / June 2046 with 1,300 personnel. Other total Project workforce peaks are represented in Table 31–2 and generally coincide with the construction of facilities.

The EIS reference case for the Project has been split into 17 development areas with the first stage of the Project most likely to involve development areas at Red Hill, South Walker, Coxendean and Saraji, (to be confirmed). Further detail is provided in the Project Description chapter (Section 4) of this EIS.

31.2 Legislative Context

The following legislation and policy are relevant to assessing and managing cumulative impacts.

Water Act 2000 (Qld)

This Act provides the framework to deliver sustainable water planning, allocation management and supply processes to ensure the improved security of water resources. Under the Act, a Cumulative Management Area can be declared if an area contains two or more petroleum tenures, including tenures on which CSG activities operate and where there may be cumulative impacts on groundwater resulting from water extraction by the tenure holders. A section of the Project area towards the south falls within the Surat Cumulative Management Area.

Surat Cumulative Management Area

The southern half of ATP 1025 (around the Blackwater area) is the only part of the Project area that overlaps with the Surat Cumulative Management Area. The declaration of the Surat Cumulative Management Area, which is inclusive of the Southern Bowen Basin, means that the Queensland Water Commission will be preparing a groundwater impact report for this area, which will identify likely future impacts on groundwater from the water extraction associated with the petroleum tenures, and provide appropriate strategies for managing these impacts.

Sustainable Resources Community Policy

This policy focuses on communities being impacted by rapid development driven by the resource industry and works to foster equitable and sustainable resource communities. One of the four key themes under the policy is “Fostering partnerships with local government, industry and community”. These partnerships will aim to establish local leadership groups to focus on regional planning issues and key projects that will address cumulative or regional issues arising from resource development.

31.3 Relevant Projects

31.3.1 Selection Criteria

The projects to be considered are those projects which are proposed but which are not currently operating, defined in Section 31.1.1 as “future developments”. Approved projects that are in

construction or operating are assumed to be captured through establishment of the Project environmental value baselines and the impact assessments carried out in the EIS chapters (and technical reports). These projects are defined in Section 31.1.1 as “past and present developments”. Since the list of projects for consideration in this cumulative assessment was developed, a number of projects have been delayed (with revised timescales unavailable) or suspended; however these projects were considered to the extent of information publicly available in the development of this cumulative impact assessment.

Developments that satisfied the above criteria and could reasonably and practically be assessed for impacts were included in this cumulative impact assessment.

31.3.2 Projects Relevant to the Study Area

Based on the assessment methodology listed in Section 31.1.3, the projects included in the cumulative impact assessment for the study area are listed in Table 31–2. Figure 31–1 depicts the developments assessed and their approximate locations in relation to the Project. The developments listed in Table 31–2 range from CSG resource projects, coal resource projects, other energy resource projects, energy infrastructure projects, transport infrastructure projects and water infrastructure projects.

The combination of information across multiple developments is challenging and in some cases, it is not possible to compare between projects due to:

- Inadequacy of available data;
- Variability in impacts assessments, assumptions, reporting and management measures;
- Unclear definitions of the spatial extent of potential residual impacts; and
- Variability in the classification of the residual impact significance or risk.

Of the projects listed in Table 31-2, the following have not yet published an EIS and therefore emissions / impact data are not currently available for and quantitative cumulative impact consideration:

- Red Hill Mine Project;
- Byerwen Coal;
- Ellensfield Coal Mine Project;
- Foxleigh Plains Project;
- Minyango Project;
- Saraji East Coal Mine;
- Goonyella to Abbot Point Rail Project; and
- Moranbah South Project.

Table 31-2 Projects Relevant to the Study Area

Project and Proponent	Description	Location	Project Status	Relationship to Arrow Bowen Gas Project
Caval Ridge Mine – BMA	• New open–cut mine to produce 5.5 mtpa of coking coal for export; • Construction period: 2012 – 2014; • Workforce: 1,200 (construction) and 500 (operational); and • Estimated capital cost $4 billion.	6 km south-west of Moranbah.	Project approved. EIS and Coordinator-General's Report available. Coordinator-General's Report on project change being prepared.	Located ~20 km west of the development area boundary of ATP 1103 (Mavis Downs development region). Construction period may overlap.
Red Hill Mine Project - BMA	• New underground mine to produce 14 mtpa of coking coal for export; and • Workforce: 3,000 (construction) and 1,500 (operational).	30 km north of Moranbah.	Project listed as withdrawn on the EHP website.	Located within ATPA 742 (Suttor Creek development region).
Daunia Mine – BMA	• New open-cut coal mine to produce 4.5 mtpa of coal; • Workforce: 1,000 (construction) and 450 (operational); • Construction period: 2011 – 2013; and • Estimated capital cost $1.6 billion.	30 km south-east of Moranbah.	Project approved. EIS and CG's Report available.	Located within ATP 1103 (just west of Mavis Downs development region). Construction schedules will not overlap.
Byerwen Coal – Joint venture between QCoal and JFE Steel	• New integrated open-cut and underground coal mine with a yield of up to 10 mtpa; • Construction phase: 2012 – 2013; • Workforce: 350-500 (construction) and 1000 (operational); and • Estimated capital cost $1.5 billion.	20 km west of Glenden	IAS available EIS in progress	Located within ATP 742 (Suttor Creek development area). The construction schedule will not overlap.

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Project and Proponent	Description	Location	Project Status	Relationship to Arrow Bowen Gas Project
Connors River Dam and Pipeline - SunWater	• A 373,622 megalitre water supply dam. Includes a 133 km pipeline to Moranbah to service coal mines and associated communities; • Workforce: 620 (construction) and 6 (operations); and • Estimated capital of $1.17 billion.	Dam: on Connors River near Mount Bridgett, 110 km east of Moranbah Pipeline: will run from the dam to Moranbah.	Project approved. EIS, SEIS and CG's Report available. The Queensland Government has recently announced that this dam will not proceed.	Dam is located ~35 km east of the development area boundary of ATP 759 (Mavis Downs development region) with the pipeline passing through the development areas of ATP 759 and ATP 1103 (Mavis Downs development region) to Moranbah.
Ellensfield Coal Mine Project – Vale Australia	• Development of an underground coal mine producing an average of 2.5 mtpa of coking and thermal coal for export; • Construction period: 2012 – 2015; and • Workforce: 250-300 (construction) and 220-240 (operations).	~35 km north-east of Moranbah.	EIS recently updated and not available at the time of assessment.	Located on the southern boundary of ATPA 749 (Kemmis Creek development region). Construction periods may overlap.
Foxleigh Plains Project – Anglo Coal	• Expansion existing Foxleigh open-cut mine to the north of the current operations producing up to 4 mtpa of run of mine; • Open-cut mining will commence by the end of 2013; and • Workforce: additional 90 employees, to existing operations, is required during project operations due to increase in production rate.	~6 km south of Middlemount	IAS available EIS in progress	Located with southern portion of ATP 1031 (German Creek development region). The construction schedule will not overlap.
Minyango Project – Blackwater Coal	• Development of a greenfield underground coal mine with a production rate of up to 7.5 mtpa of product coal for export; • Construction phase is not known; and • Estimated capital of $750 million.	Immediately south of Blackwater.	IAS available. EIS in progress.	Located within ATP 1025.

Project and Proponent	Description	Location	Project Status	Relationship to Arrow Bowen Gas Project
Washpool Coal Mine Project – Washpool Coal subsidiary of Aquila Resources Limited	• Development of a greenfield open-cut coal mine producing up to 2.6 mtpa of product hard coking coal; • Construction period: 2012 – 2013; • Workforce: 307 (construction) and 378 (operation); and • Estimated capital of $396 million.	~24 km north-west of Blackwater.	EIS available.	Located ~18 km west of the development area boundary of ATP 1025. The construction schedule will not overlap.
Eagle Downs Coal Project – Bowen Central Coal Joint Venture (Bowen Central Coal and Aquila Coal)	• Development of a greenfield underground coal mine producing up to 8 mtpa of coking and thermal coal for export; • Construction period: 2012-2014; • Workforce: 360 (construction) and 570 (operations); and • Estimated capital of $1.26 billion.	~20 km south-east of Moranbah	EIS approved. EIS available.	Located ~2 km west of the development area boundary of ATP 1103 (west of Mavis Downs development region). The construction schedule will overlap.
Grosvenor Coal Project – Anglo Coal	• Development of a greenfield underground coal mine to produce 5 mtpa of product coal; • Construction period: 2012 – 2014; • Workforce: 480 (construction) and 480 (operations); and • Estimated capital $1.115 billion.	Immediately north of Moranbah.	EIS is complete. EIS available.	Located ~12 km north-north-west of the development area boundary of ATP 1103. The construction schedule will not overlap.
Middlemount Coal Project (Stage 2) – Middlemount Coal	• Stage 2 is an expansion of the current open cut mine to produce up to 5.4 mtpa of ROM coal; • Stage 2 forms the basis of the project as Stage 1 is approved for production of 1.8 mtpa of ROM coal; • Construction period: 2011 – 2014; and • Workforce: 450 (construction) and 500 (operations).	~6 km south-west of Middlemount	EIS is complete. EIS available.	Located ~3 km west of the development area southern boundary of ATP 1031. The construction schedule will not overlap.

Project and Proponent	Description	Location	Project Status	Relationship to Arrow Bowen Gas Project
Eaglefield Expansion Project - Peabody	• Open-cut expansion and associated infrastructure upgrades to increase production from 5 mtpa to 10.2 mtpa ROM coal; • Construction period: 2012 – 2013; and • Workforce: 700 (construction) and 440 (operations).	~36 km north of Moranbah and 32 km south-west of Glenden	EIS is complete. EIS available.	Located on the south-western boundary of ATPA 742 (Suttor Creek development region). The construction schedule will not overlap.
Codrilla Coal Mine Project – Macarthur Coal	• Development of an open-cut coal mine producing an average of 4 mtpa of ROM coal; • Construction phase: 2012 – 2013; and • Workforce: 170 (construction) and 240 (operations).	~45 km south-south-west of Nebo.	EIS is complete. IAS and SEIS available.	Located with the development boundary of ATP 759 (Mavis Downs development region).
Saraji East Coal Mine - BMA	• Development of a greenfield underground coal mine to produce up to 14 mtpa of product coal for export; and • Workforce: 2,500 (construction) and 1,400 (operations).	~30 km north of Dysart	Project listed as withdrawn on the EHP website	Located within the development boundary of ATP 1103.
Arrow Bowen Pipeline – Arrow	• Construction of an approximate 580 km of pipelines which will convey CSG for subsequent export as LNG and associated above ground infrastructure; • Construction to commence in 2016 with first gas to Gladstone in 2017; • Workforce: 693 (construction), 10 (commissioning and decommissioning) and 15 (operations); and • Capital expenditure $1.2 billion.	Pipeline would commence at Red Hill, ~90 km north of Moranbah and terminate at Gladstone	EIS is complete. EIS available.	Pipeline commences in the northern part of ATPA 742 and runs south-east through the development areas and on to Gladstone. The construction schedule will overlap.

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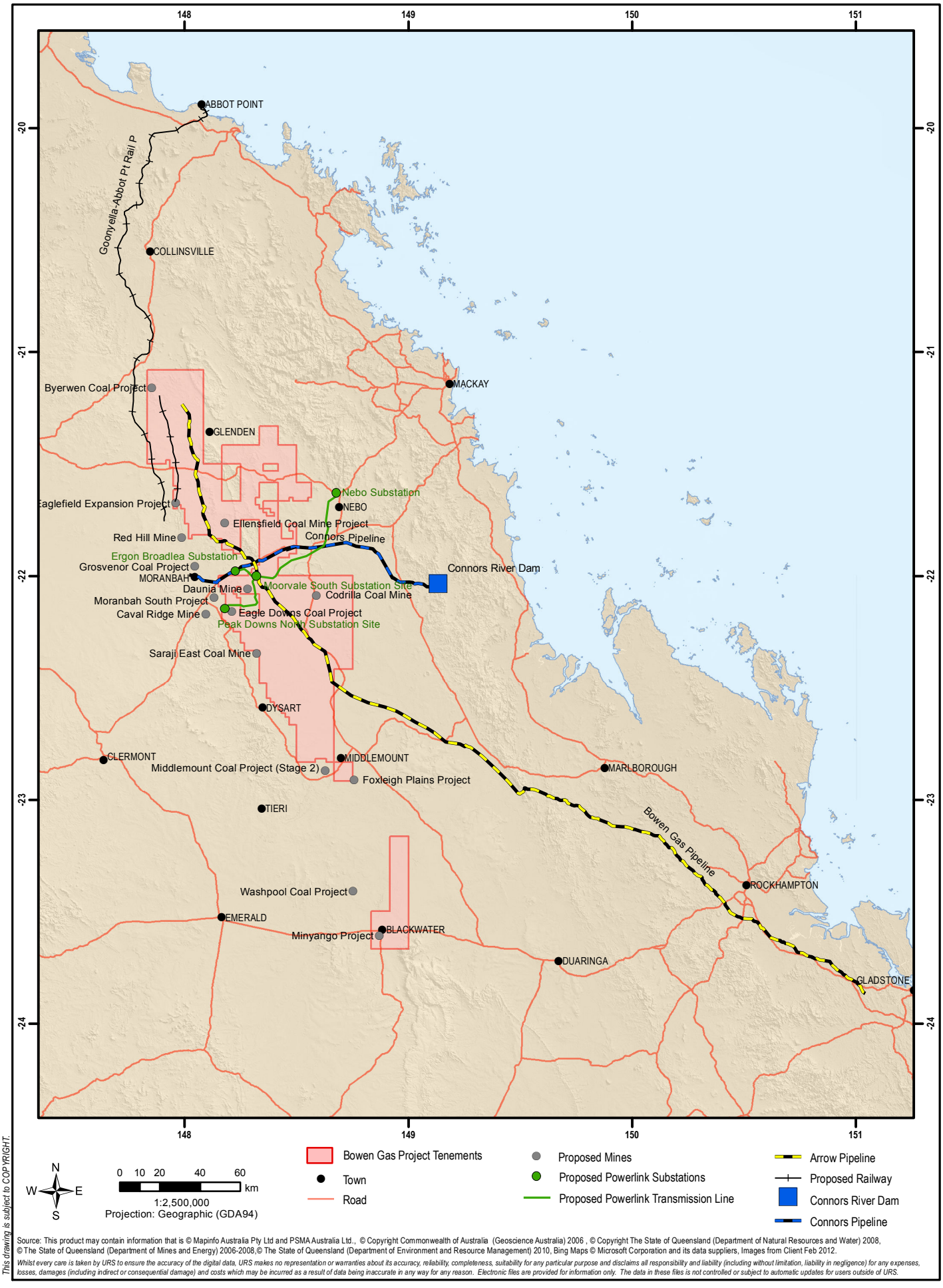
Project and Proponent	Description	Location	Project Status	Relationship to Arrow Bowen Gas Project
Northern Bowen Basin Transmission Network Reinforcement Project – Powerlink Queensland	• Construction of 2 new substations (1 at Moorvale and 1 at Peak Downs); • Construction of 3 transmission lines; between Nebo and Moorvale; between Moorvale and Broadlea; and Moorvale and Peak Downs; • Transmission line between Nebo, Moorvale and Boradlea is proposed to be constructed by late 2014; and • Workforce: 50 (construction).	Substations in the Moorvale area (~26 km east of Moranbah) and Peak Downs (~21 km south east of Moranbah) area. Transmission lines running from; Nebo to Moorvale; Moorvale to Boradlea (~18km east of Moranbah); and Moorvale to Peak Downs.	EIS is complete.	Transmission line to cut through ATP 1103 from Nebo to Broadlea. Not expected to have overlapping construction schedules
Goonyella to Abbot Point Rail Project – BHP Billiton Group	• Construction of a dedicated rail line, approximately 260 km in length, to transport up to 60 MTPA of coal; • 60m wide rail corridor; • Balloon loops at Goonyella Riverside Mine and Port of Abbot Point; • Construction is scheduled to commence by no later than 2015; and • Workforce: 2000 (construction) and 500 (operations).	The line would run from the Goonyella Riverside Mine in the Bowen Basin (~24 km north-west on Moranbah), to the Port of Abbot Point.	EIS in progress. IAS available.	Rail line commencing on the boundary of ATP 1103 and travels north along boundary of ATPA 742 to Collinsville. The construction schedule will overlap.
Moranbah South Project – Anglo American Metallurgical Coal	• Construction and operation of a greenfield underground coal mine; • 14 Mtpa of high quality coking coal for the export market; • Mine life in excess of 30 years; • Construction will commence in 2014; and • First longwall coal production will commence in 2017.	Directly to the south of Moranbah, ~150 km south-west of Mackay	IAS available	Project site is just west of ATP 1103 (near Moranbah) The construction schedule may overlap.



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BOWEN GAS PROJECT EIS

PROJECTS RELEVANT TO THE STUDY AREA

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Figure: 31-1

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In addition, the Connors River Dam and Pipeline project EIS has been withdrawn and therefore the impact assessment data is no longer available. Where information can be used from the IAS' published for these projects, this will be done however this will be in a qualitative style (as the information required for a quantitative assessment will be documented in the EIS). Any quantitative assessment of cumulative impacts from the proposed Project and these projects will need to be assessed in the various project EISs prepared following the publishing of the proposed Project EIS.

In addition, the current economic climate has resulted in a number of the projects listed in Table 31–2 being postponed / halted with resource prices and therefore financial return impacting the decision making processes. In some cases, these delays will mean that some timelines detailed in EIS documentation will no longer be achievable, further complicating the cumulative impact assessment for the proposed Project. This also means that the consideration of these projects' cumulative effects presents the most conservative assessment possible. These challenges preclude a quantitative assessment of cumulative impact significance or risk, but do allow for a subjective assessment of whether the cumulative impact may be worse (or better, in the case of positive impacts) than the expected residual impacts of the proposed Project. As such, the following assessment of cumulative impacts has been described in terms of a worsening or improvement of the Project's residual impacts.

Table 31–3 presents a matrix of those environmental aspects to be considered in this cumulative assessment and identifies the proposed developments with quantitative data considered likely to have environmental impacts to consider. This is a subjective process with key factors being:

- Are the EISs publically available?
- Are developments on or close to the Project area?
- Will there be significant local social or economic change (e.g. additional employment or industry)?

It is assumed in this cumulative impact assessment that the projects under development that are considered will be operating within the scope of their EHP Environmental Authority (once granted); accidental or emergency conditions are not considered.

Table 31-3 Projects with EIS' and Potential Cumulative Impacts

Project	Air Quality	Greenhouse Gas	Groundwater	Surface Water	Aquatic Ecology	Terrestrial Ecology	Land Use and Tenure	Land and Visual Amenity	Economics	Social	Noise and Vibration	Cultural Heritage	Preliminary Hazard and Risk
Caval Ridge Mine		✓	✓	✓					✓	✓			
Daunia Mine	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Washpool Coal Mine Project		✓	✓						✓	✓			

Project	Air Quality	Greenhouse Gas	Groundwater	Surface Water	Aquatic Ecology	Terrestrial Ecology	Land Use and Tenure	Land and Visual Amenity	Economics	Social	Noise and Vibration	Cultural Heritage	Preliminary Hazard and Risk
Eagle Downs Coal Project		✓	✓	✓				✓	✓	✓			
Grosvenor Coal Project		✓							✓	✓			
Middlemount Coal Project (Stage 2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Eaglefield Expansion Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Codrilla Coal Mine Project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Arrow Bowen Pipeline		✓				✓	✓	✓	✓	✓		✓	✓
Northern Bowen Basin Transmission Network		✓				✓	✓	✓	✓			✓	✓

31.4 Cumulative Impact Assessment

The outcomes of the cumulative impact assessments conducted for the proposed Project are summarised below.

31.4.1 Air Quality

31.4.1.1 Project Impact Summary

The air quality impact assessment (detailed in the Air Quality chapter (Section 9) and the Air Quality Technical Report (Appendix H) of this EIS) shows that the environmental values for local air quality are not predicted to be materially impacted by emissions from the Project. The detailed air dispersion modelling carried out predicts a single exceedance for the nitrogen dioxide (NO_2) 1-hour average. This exceedance relates only to operation of the integrated processing facilities (IPF) and centralised gas processing facilities (CGPF) up to a maximum of 1,000 and 1,400 m from the respective facilities. However, for 1-hour NO_2, constraints in the location of the equipment will be implemented to ensure that air quality values are not unacceptably impacted. With these constraints applied the residual impact of emissions will be minor.

31.4.1.2 Potential Non-Project Impacts

The cumulative releases of NO_2 which have the potential to lead to exceeding the Environmental Protection (Air) Policy 2008 (EPP (Air)) criteria, (particularly the 1-hour averaging period) would have to occur from sources in close proximity to the Project (i.e. within the Project area). As shown in Table 31–3, the following projects are predicted to contribute to cumulative air quality impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).

All four of these projects are open cut coal mines with the main air quality issue being dust emissions. Review of the EIS' for these projects found that the assessments carried out were limited to dust emissions (particulate matter at 2.5 and 10 micron sizes and total particulate).

Other projects (where EIS' are not yet available), with the exception of the Goonyella to Abbot Point Rail Project, are mining projects which will also generate dust releases. The rail project is not considered to impact the NO_2 limit.

31.4.1.3 Cumulative Impact Significance and Conclusion

Particulate releases from the proposed Project are all significantly below the EPP (Air) criteria. This is the only release parameter from the assessed projects that could contribute to the Project air quality cumulative impact assessment. The only release from the Project identified as exceeding the Project criteria is the 1-hour average for NO_2; this occurs within close proximity to specific Project infrastructure and will be managed through the mitigation measures outlined in the Air Quality chapter (Section 9) of this EIS. NO_2 emissions from the assessed projects are not significant and will not contribute to cumulative air quality impacts.

On the basis of the Project air quality impacts assessed and the data provided in the EIS' reviewed, it is concluded that the air quality cumulative impact significance from the development of the Project is low.

31.4.2 Greenhouse Gas Emissions

31.4.2.1 Project Impact Summary

The total predicted Scope 1 and Scope 2 greenhouse gas (GHG) releases from the Project (including construction and ramp-down) over the lifetime of the Project are estimated to be approximately 83 $MtCO_2$-e. Emissions are expected to peak during operation in approximately 2046. Therefore, 2046 has been used as the worst-case operational year on which annual emissions are assessed (see Greenhouse Gas chapter (Section 10) of this EIS). Estimated Project emissions for 2046, of approximately 2.1 $MtCO_2$-e were shown to be equivalent to 0.4% of 2010 Australian total emissions and 0.5% of 2010 Australian emissions from the energy sector. The Project emissions equal approximately 0.007% of global 2009 fossil fuel consumption emissions.

The Queensland Government Gas Scheme objectives include increasing the share of electricity produced in gas-fired generators to 18% by 2020. As a major gas producer that will generate nearly all of its own electricity from gas, Arrow will be assisting Queensland in reaching this objective.

31.4.2.2 Potential Non-Project Impacts

Of the projects considered, all are considered to contribute to the cumulative greenhouse gas impact due to the global nature of this impact. Table 31–4 lists those projects for which GHG release data are available.

Table 31-4 Non Project GHG Releases

Project	Scope 1 and 2 emissions (t $CO_{2\text{-}e}$ / yr)	Comment
Caval Ridge Mine	11,136,003	Life of mine (from EIS)
Daunia Mine	3,876,252	Life of mine (from EIS)
Washpool Coal Mine Project	3,700,000	Life of mine (EIS executive summary)
Eagle Downs Coal Project	44,189,817	Based on average release of 901,833pa and 49 year life of mine
Grosvenor Coal Project	13,019,280	Based on maximum release of 542,470pa and 24 year life of mine
Middlemount Coal Project (Stage 2)	8,794,648	Based on maximum release of 382,376pa and 23 year life of mine
Eaglefield Expansion Project	10,393,000	Life of mine (from EIS)
Codrilla Coal Mine Project	3,123,400	Based on maximum release of 223,100pa and 14 year life of mine
Total	**98,232,400**	**-**

GHG releases will also occur from the other projects considered in the cumulative impact assessment (for which EIS' are not available). Though these releases cannot be quantified, they will further increase the non-Project release.

31.4.2.3 Cumulative Impact Significance and Conclusion

The GHG releases (Scope 1 and 2) from the assessed projects exceeds those from the Project though the Project releases are greater than those from any individual project listed by virtue of its large size and longer Project life.

Though not considered in this assessment, it should also be recognised that Arrow (through the proposed Project) will be working with mining operators within the Project area to assist with the de-gassing of their mines to safely gather the gas to generate electricity. This process results in a significant reduction in GHG release (as vented gas has a GHG impact 21 times high than the equivalent mass of carbon dioxide) over either venting or flaring due to the electricity generated.

The *Clean Energy Act 2011* provides a mechanism for Australian facilities to tackle climate change by encouraging the use of clean energy. The *Clean Energy Act 2011* is implemented through the Australian Governments' Clean Energy Plan (CEP). The CEP incorporates a Carbon Pricing Mechanism (CPM) which is intended to impose a cap on emissions from relevant sectors of the economy which is described in the Greenhouse Gas chapter (Section 10) of this EIS. As part of the stationary energy sector, Arrow is a large supplier of gas and as such will be a direct participant in the CPM, as will the operators of the other projects listed above.

The objective of the carbon price is to change Australia's energy consumption by encouraging investment in abatement, renewable energy and the use of cleaner fuels like CSG. As the cost of permits fluctuate, it may be more economically viable to pursue emission mitigation measures and invest in less carbon intensive technologies than to obtain permits for all emissions. Therefore, the extent of residual impact of the Project will largely be controlled by the availability of increasingly efficient technologies to Arrow and the effectiveness of government initiatives under the CEP in reducing carbon emissions. This effectively assists in the mitigation of the GHG impact of the proposed Project and the other projects. On this basis, it is concluded that the cumulative impact significance of the proposed Project is low.

31.4.3 Groundwater

31.4.3.1 Project Impact Summary

The groundwater assessment of the Project (provided in the Groundwater chapter (Section 14) and the Groundwater and Geology Technical Report (Appendix L) of this EIS) shows that the majority of the proposed Project area is within the Isaac River sub-basin of the Fitzroy Basin as described in Schedule 1 of the Environmental Protection (Water) Policy 2009.

Potential groundwater related impacts resulting from the Project may include:

- Direct impacts caused by coal seam depressurisation;
- Indirect impacts caused by coal seam depressurisation;
- Impacts caused by field and infrastructure development, operation and decommissioning;
- Cumulative impacts caused by this and other projects requiring the dewatering and depressurisation of the Permian coal measures; and
- Impacts post-closure.

CSG production and groundwater depressurisation activities in the Project area will have varying impacts on regional groundwater levels depending on the development schedule and management requirements. Due to the low permeability of the confining Rewan Formation and the low permeability of the interburden layers (aquitards) of the Blackwater Group, the predicted groundwater drawdown is relativity restricted to the coal seams (aquifers) and proximal to the proposed CSG fields.

After CSG operations are completed, the groundwater system will re-adjust over a long period. It is expected that due to low rates of diffusive recharge into the coal seams and little or no induced flow potential, the groundwater levels and piezometeric pressures within the coal seam aquifers will, over a long time frame, attain a new equilibrium. The rate of groundwater recovery may be slowed by

ongoing mining and CSG operations within the Bowen Basin. Considering the quality and use of the groundwater along with "make-good" commitments Arrow has made, the residual impacts from the proposed Project are considered to be of low to very low significance.

31.4.3.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative groundwater impacts:

- Caval Ridge Mine (20 km from the Project area);
- Daunia Mine (within the Project area);
- Washpool Coal Mine Project (18 km from the Project area);
- Eagle Downs Coal Project (2 km from the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).

All of these projects are coal mines likely to have groundwater impacts. Of these, Eagle Downs is the only underground mine development. During operations and either as a result of the post mining open cut voids or the underground goafed (mined void) areas, all of the coal mining projects are likely to result in localised depressurisation of the groundwater around the sites. Review of the available EIS' found the zones of depressurisation to be generally limited to a 5 to 10 km radius with varying durations ranging from 50 to 265 years to reach equilibrium quoted. In all cases, the groundwater quality was considered poor; appropriate uses were irrigation or stock water though in many cases the water was not of sufficient quality for these uses. Those projects where EIS' are not yet available are also likely to contribute to the cumulative groundwater impacts however, this is difficult to assess in the absence of technical data.

Most coal mine projects in the Bowen Basin are located on the western limb of the basin, targeting the Permian coal seams. Predictive groundwater modelling from coal mines in the Moranbah area indicate that groundwater drawdown, within the confined target coal seams, could potentially extend 5 to 30 km outwards as a result of mine dewatering and associated depressurisation. Drawdown within the coal seams generally corresponds to the seam floor elevations, approximately 0 to 240 m for open pit mines and between 100 and 400 m for underground mines.

The water table drawdown over longwall mines is typically 1 to 10 m in the surficial aquifers. The impact of underground longwall mining occurs as the mine area collapses into the goaf leading to increased vertical permeability and hydraulic connection between mine voids and overlying units.

31.4.3.3 Cumulative Impact Significance and Conclusion

The groundwater model discussed in the Groundwater chapter (Section 14) of the EIS has addressed the cumulative impacts on groundwater where data was available publicly. It is noted that a review of publicly available mine data within the Project area yielded insufficient information (i.e. geometries, schedules and dewatering rates) to enable inclusion of these mines within the groundwater model. Further to this, a review of existing NRM groundwater database reveals that there are no bore water level records showing distinct mine-related impacts in the northern Bowen Basin.

After CSG operations are completed, the groundwater system will re-adjust over the long-term. However, due to relatively low rates of diffuse recharge into the Permian-Triassic outcrops (including the coal seams), the pre-development conditions appear to involve relatively low rates of regional groundwater flow through the deep aquifers, and effectively 'zero' regional flow through the deep aquitards. Consequently, post-closure recovery is likely to be relatively slow and the natural or base-line conditions are unlikely to be re-established within a time frame less than a thousand years (approximately). This interpretation is confirmed by numerical groundwater modelling which shows that significant recovery occurs over a time-frame measured in millennia. Further, the rate of groundwater recovery may be slowed even more by the mining operations discussed in this section. Considering the Framework Approach, the groundwater environmental values identified in the Project area, the proposed mitigation (to derive the residual Project impact) along with the monitoring and management programs, the significance of the cumulative groundwater impacts is considered to be low.

31.4.4 Surface Water

31.4.4.1 Project Impact Summary

As the infrastructure location details of the Project area have not been defined, a generic assessment of potential impacts on surface water resources has been undertaken in the EIS (refer to the Surface Water chapter (Section 15) and the Surface Water Technical Report (Appendix N) of this EIS). Project activities that have the potential to result in environmental impacts on surface water include:

- Drilling and completion activities;
- Watercourse crossings by roads, tracks and pipelines;
- Construction, operation and decommissioning of Project infrastructure including field compression facilities (FCFs), CGPFs, and IPFs including water treatment facilities and water storage dams;
- Pipeline construction;
- Discharge and storage of hydrotesting water;
- Discharge and storage of treated and untreated coal seam water and brine concentrate; and
- Discharges of treated sewage.

Potential impacts on surface waters from the Project arise from a range of activities including drilling activities, construction, operation and decommissioning of production wells, pipelines, dams, and processing and compression facilities. The surface water assessment concluded that the impacts associated with the development of the Project could be appropriately managed by implementing a range of mitigation measures during construction, operational and decommissioning phases of the Project.

31.4.4.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative surface water impacts:

- Caval Ridge Mine (20 km from the Project area);
- Daunia Mine (within the Project area);

- Eagle Downs Coal Project (2 km from the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).

All of these projects are coal mines, five of which are open-cut with Eagle Downs being the only underground mine development.

Review of the EIS' for these projects found that the assessments carried out concluded that the impacts from the mine developments were all capable of being managed through appropriate design and maintenance of mine water management infrastructure. Though some impacts were identified at a local level, these were not considered significant on a regional basis. Water quality is predicted to be maintained and flood impacts have been considered and mitigation proposed.

The subsidence related impacts (i.e. ponding in subsided areas) from the Eagle Downs Coal Project is not predicted to have a significant impact on the Isaac River catchment due to the relatively small volume of the ponded areas in proportion to the catchment volume (0.1%).

31.4.4.3 Cumulative Impact Significance and Conclusion

Due to the geographical extent of the proposed Project (covering 8,000 km^2), overlap of activities in catchments with other projects is unavoidable.

Generally, data available for the proposed projects concluded that, though there may be local impacts in some cases these were not significant in a regional context. In each assessment, the proponent concluded that the impacts were manageable through appropriate design and mitigation.

As the proposed Project activities will be confined to a relatively minor proportion of the surface area and its surface water impacts will be manageable, and as a result of the framework approach (refer to the Environmental Framework chapter (Section 7) of this EIS) developed by Arrow and application of constraints mapping, the cumulative impacts on surface water are considered to be of low significance.

31.4.5 Aquatic Ecology

31.4.5.1 Project Impact Summary

The aquatic ecology impact assessment (refer to the Aquatic Ecology chapter (Section 16) and the Aquatic Ecology Technical Report (Appendix O) of this EIS) has indicated that aquatic ecosystem values within the Project study area are diverse and intrinsically linked in terms of the availability and quality of aquatic habitat present.

The impact assessment concluded that the potential residual impacts of the Project would be reduced to "moderate to low" (with others being negligible) following the implementation of the specific impact avoidance (constraints) framework and specific mitigation strategies (outlined in the Aquatic Ecology chapter (Section 16.6) of this EIS).

Moderate impacts may occur in the following areas:

- Within permanent waterways as a result of:
  - site clearing and levelling;
  - construction of access tracks;
  - waste generation and management;
  - gathering line/gathering line trenching;
  - gathering lines or access roads creek crossings; and
  - operational and maintenance activities, particularly where these involve excavating the gathering line.
- Within ephemeral waterways if/when emergency releases of treated CSG water occur during dry season conditions.

All other impacts from normal or routine operations are expected to be low.

31.4.5.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative aquatic ecology impacts

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).

All of these developments are open cut coal mines and recognise the aquatic ecology and habitat impacts that will occur as a result of developing an open cut coal mine and propose a range of mitigating measures to minimise these impacts. It is also generally noted that the habitats across the sites are extensively disturbed through historic use and that the aquatic biological values are reduced. Each of the separate studies concluded that there was no endangered, vulnerable or near threatened species likely to be present on the site.

31.4.5.3 Cumulative Impact Significance and Conclusion

The Project operations will only impact a relatively minor proportion of the Project area and potentially impact an even smaller area of aquatic habitat. This impact will be minimised through the implementation of the framework approach (outlined in the Environmental Framework chapter (Section 7) of the EIS) and a range of mitigating measures (detailed in the Aquatic Ecology chapter (Section 16) of the EIS). Where impacts cannot be practicably avoided, they will be negated through the implementation of the Project offsets strategy.

Aquatic ecology impacts from other projects are considered to be minor and with the constraints mapping approach and mitigating measures proposed by the Project, the significant of the cumulative impacts is considered to be low.

31.4.6 Terrestrial Ecology

31.4.6.1 Project Impact Summary

The Framework Approach (outlined in the Environmental Framework chapter (Section 7) of the EIS) will be implemented to minimise the terrestrial ecology environmental impacts of the Project (refer to the Terrestrial Ecology chapter (Section 17) of this EIS). It is proposed to avoid areas of extremely high sensitivity thus eliminating impacts to these areas.

The avoidance, mitigation and management measures proposed for the Project will avoid or reduce the potential impacts to terrestrial ecology values within the Project area. This will result in two levels of residual impact for each activity (depending on whether an area is of extremely high sensitivity and therefore avoided, or not). This risk-based approach protects the most sensitive areas and will be underpinned by a program of monitoring and inspection to ensure compliance and to determine the efficacy of the mitigation applied. A risk-based approach will also be applied to the monitoring to protect the highest risk species.

In addition, an offsets strategy will be implemented to meet the requirements of the state and federal governments.

31.4.6.2 Potential Non-Project Impacts

As shown in Table 31-3, the following projects are predicted to contribute to cumulative terrestrial ecology impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area);
- Codrilla Coal Mine Project (within the Project area);
- Arrow Bowen Pipeline (traverses the northern Project area); and
- Northern Bowen Basin Transmission Network (crosses ATP 1103 east of Moranbah).

Four of these developments are coal mines with the other two linear infrastructure developments. For the linear projects, clearing is required along the route which inevitably results in ecological impacts; in both of these projects, minimising the impact to the ecology of the area was a consideration in determining the final routes.

Coal mines have less flexibility in location, particularly open cut mines (the only options being the location of the surface infrastructure). Rehabilitation and decommissioning is therefore a large factor in planning these developments.

All of these projects recognise the terrestrial ecology impacts that will occur and propose a range of mitigating measures to minimise these impacts.

31.4.6.3 Cumulative Impact Significance and Conclusion

The six projects identified above all have impacts to the terrestrial ecology and are located either fully or partially within the Project area. All projects propose a range of mitigating measures to minimise impacts and rehabilitation plans to return the land nearer to its original state.

An offset package will be developed in consultation with EHP and DSEWPaC to address both State and Commonwealth offsetting requirements for the Project. This will effectively negate the impacts to areas of high biodiversity value from the Project but this is not the case for all of the other projects (some of which were approved prior to the development of the offsetting approach). Given the unavoidable impact from the development of these projects, the significance of the cumulative residual impacts to terrestrial ecology is considered to be moderate, however, considering the offsets that will be required by the Project, use of risk based constraints mapping, the routing options considered and the proposed rehabilitation plans, the extent to which the Project contributes to this cumulative impact is minor.

31.4.7 Land Use and Tenure

31.4.7.1 Project Impact Summary

Potential impacts of the Project on the environmental values of agricultural activities, urban development and homesteads, mining and resource activities, conservation, tourism and recreational areas and infrastructure have been identified (see the Landuse and Tenure chapter (Section 19) of the EIS).

Potential impacts on the agricultural environmental values are:

- Disturbance of the soil profile;
- Disruption to machinery operations;
- Impediments to farm workability;
- Increased or new management overheads (including integration with farm plans); and
- Loss of amenity and ground contamination.

Potential operation impacts will be mitigated through development planning and modifying construction practices and rehabilitation methods to suit individual land holder needs, whilst ensuring appropriate controls are in place to protect the Project infrastructure (e.g. fire breaks).

Potential operational impacts on the rural landscape resulting from venting and flaring associated with the operation of the wells and gas compression stations include:

- Noise;
- Vibration; and
- Air quality.

Relevant mitigation and management measures include consultation with affected landowners to locate infrastructure and stage construction to better minimise effects on landowners where possible.

Potential impacts on mining and resource activities may arise as the Project area overlies existing mining lease and mineral development lease tenements. In accordance with the provisions of the

Petroleum and Gas (Production and Safety) Act 2004, Arrow will seek to establish agreements with third party overlapping tenure holders to minimise any restriction of the Project on the mining of mineral resources within the fields for the timeframe of the Project.

Potential impacts on conservation, tourism and recreation are not predicted. The potential impact to infrastructure (all of which are common across the Project area) includes disruption to:

- Roads;
- Rail;
- Stock routes; and
- Utilities and other services,

Potential impacts of the Project on roads are anticipated to be minor. Where state controlled roads or local roads are required to be crossed or intersected by the construction of Project infrastructure, all works will be carried out in consultation with the relevant stakeholders to minimise disturbance to the operation of the road. The residual impacts to land use and tenure are considered to be moderate to low.

31.4.7.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative land use and tenure impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area)
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).
- Arrow Bowen Pipeline (traverses the northern Project area); and
- Northern Bowen Basin Transmission Network (crosses ATP 1103 east of Moranbah).

Of the six projects considered relevant for land use and tenure cumulative impacts, four are open cut coal mines and two are linear infrastructure projects.

Land use in the coal mine areas is generally grazing and mining with some cropping. The land use impacts during construction and operation are generally localised and these sites will implement rehabilitation plans to return the land to as close as the original land use as practicable. This will inevitably result in some reduction in land use capability with two of the four mines comprising significant areas of (Class A / B) good quality agricultural land. Other projects identified (where EIS' are not yet available), will also have land use impacts however, with the exception of the rail project, they are all mining projects the Bowen Basin, an area when mining is considered as normal land use.

Impacts from land contamination are generally highlighted as an issue for all of the projects with mitigation being applied to prevent and/or remediate contamination.

31.4.7.3 Cumulative Impact Significance and Conclusion

With the number and scale of developments in the Bowen Basin and specifically in or in close proximity to the Project, it is likely that there is a cumulative impact to land use and tenure values,

particularly during the operations phase of the mining projects and construction phase of the Project and linear infrastructure projects.

A range of mitigation measures will be employed by the different projects to minimise the impacts at all stages of development however, due the scale of development, the reduction in land use classification and the potential for contamination to occur, it is considered that a moderate cumulative impact to land use will occur.

31.4.8 Landscape and Visual Amenity

31.4.8.1 Project Impact Summary

Given the extensive Project area and unknown location of key Project infrastructure, it has not been possible to apply a standard land and visual impact assessment (LVIA) technique to each potential visual receptor location within the Project area. In consideration of the framework approach (outlined in the Environmental Framework chapter (Section 7) of this EIS), a significance based approach has been adopted to develop detailed knowledge of landscape and visual characteristics and key Project processes (see Landscape and Visual Amenity chapter (Section 20) of this EIS).

The LVIA has determined the overall landscape and visual significance of the Project area to be low, although some characteristics of the landscape within the Project area will be altered in a localised context by some Project activities and the construction and operation of Project infrastructure.

Whilst the 'framework assessment' has determined that the majority of Project infrastructure would be subject to low to moderate landscape and visual constraints, the LVIA has assumed that Project infrastructure elements with a medium to high magnitude of landscape or visual effect will be located a minimum 1 km from high sensitive visual receptor locations, including homesteads and other residential dwellings. The LVIA has determined that the Project would have a potential low visual impact on a large number of people residing in rural areas within and surrounding the Project area as well as people living in consolidated urban development or travelling along highways and local roads within the immediate Project area.

31.4.8.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative landscape and visual amenity impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area)
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).
- Arrow Bowen Pipeline (traverses the northern Project area); and
- Northern Bowen Basin Transmission Network (crosses ATP 1103 east of Moranbah).

Of the six projects considered relevant for land use and tenure cumulative impacts, four are open cut coal mines and two are linear infrastructure projects.

The landscape in the project areas and surrounds is generally flat with gently undulating plains. The Bowen Basin land use includes a high number of operating or proposed mining projects and as such, these are part of the landscape.

The mine projects will have a visual impact during the operational and construction phases however, this is limited to a small number of residences who are able to see the developments. Open cut mine developments generally result in large volumes of spoil which, post remediation, form the dominant landform. Residual impacts from these projects are generally stated as low to moderate.

The visual impacts from the linear infrastructure projects are significantly lower with the main impact occurring during the construction phase (generally accommodation camps, clearing and construction equipment). Visual impacts are considered during the routing process to minimise impacts.

31.4.8.3 Cumulative Impact Significance and Conclusion

Implementation of the framework approach by the Project will avoid those areas where the greatest impacts would be realised however the scale of the Project is such that there will still be some landscape and visual impact.

The construction requirements of the projects proposed for the area and the final landforms left by the proposed open-cut mines will also result in changes to the landscape and cumulative visual impact.

However, mitigation is achieved through design processes and rehabilitation work and this, coupled with the low population density of the region, reduces the cumulative landscape and visual impact to a low level.

31.4.9 Economics

31.4.9.1 Project Impact Summary

As detailed in the Economics chapter (Section 23) of this EIS, there are potentially both beneficial and adverse economic impacts from the Project. The beneficial impacts are expected to be impacts on gross regional, state and national product, increased employment, positive impact on wages and increased tax revenues and local business boosts.

Adverse impacts are considered to potentially include; increased labour costs for local businesses, reduction in agricultural land production, increased housing prices, increased industrial / commercial land prices, reduced rural property values, restrictions on future coal mine development and impact on local infrastructure and service capacity.

31.4.9.2 Potential Non-Project Impacts

Projects with the potential for cumulative economic impacts are generally those where on-going employment is required; i.e. the resource intensive mining projects. Of the projects with EIS' that have been considered, the following operational staff numbers and capital cost estimates are available:

- Caval Ridge Mine (500 operational staff, estimated capital cost of $4 billion);
- Daunia Mine (450 operational staff, estimated capital cost of $1.6 billion);

- Washpool Coal Mine Project (378 operational staff, estimated capital cost of $378 million);
- Eagle Downs Coal Project (570 operational staff, estimated capital cost of $1.26 billion);
- Grosvenor Coal Project (480 operational staff, estimated capital cost of $1.15 billion);
- Middlemount Coal Project (Stage 2) (500 operational staff, estimated capital cost of $300 million);
- Eaglefield Expansion Project (440 operational staff, estimated capital cost of $1 billion);
- Codrilla Coal Mine Project (240 operational staff, estimated capital cost of $250 million); and
- Arrow Bowen Pipeline (15 operational staff, estimated capital cost of $1.2 billion).

These projects alone equate to over 3,500 long term operations jobs and an estimated capital investment of over $11.2 billion; a partial data set for other projects contribute a further 3,330 jobs and $2.25 billion in capital spend taking the total figures to 6,830 jobs and almost $13.5 billion

The following points provide a summary of key economic conditions within the region or “catchment area” (Isaac, Mackay and Central Highlands local government areas) which are a result of the existing projects and developments (additional data supporting these points are presented in the Economic Technical Report (Appendix T) of this EIS).

- Mining (including energy resources) is the largest contributor to the catchment area’s 2010 – 2011 Gross Value Added;
- Business attraction has led to significant Gross Regional Product growth, particularly in Mackay, which is the catchment area’s urban centre;
- Mining and construction dominate employment, which is expected to continue. However, as major projects come online, the proportion of construction work is expected to decrease while the proportion of mining workforce is expected to increase;
- The catchment area has a tight labour market with lower unemployment than Queensland overall;
- The low unemployment rate is a symptom of high labour demand and limited local supply;
- The dominance of the resources sector means the regional economy and many businesses are highly exposed to commodity prices;
- The Minerals Resource Rent Tax, the extended Petroleum Resource Rent Tax, and carbon price will add financial pressure to resource companies operating in the catchment area;
- Access to improved social and community infrastructure is required to make towns more liveable and is likely to improve residents’ quality of life;
- The catchment area is now largely viewed as a mining region, compared to an agricultural region historically;
- The catchment area’s property market has tightened significantly in recent years, driven largely by increased demands from resource companies and their employees. This is likely to intensify as more projects are developed; and
- Rental prices have also increased significantly in the last five years, which is likely to be the result of a high transient workforce.

31.4.9.3 Cumulative Impact Significance and Conclusion

The economic impact assessment indicates that the Project will generate a positive economic benefit for the regional, state and national economies. These include increases in industry output, Gross Regional Product, employment, business activity skills development and government tax revenues. A cost benefit analysis of the Project outlined in the Economic Technical Report (Appendix T) of this EIS

indicates the benefits generated by the Project outweigh the costs and is economically desirable for Queensland. Considering the historical economic trends witnessed in the region, the positive cumulative impact of the Project and existing and new projects is expected to continue.

31.4.10 Social

31.4.10.1 Project Impact Summary

Positive social impacts that may result from the Project include employment, education and recreation opportunities. These impacts are anticipated to have benefits locally, regionally and nationally for the duration of the Project.

Potential adverse impacts related to cumulative community perceptions and anxiety regarding continued development is likely mainly in Moranbah and Dysart within the study area and would be felt by low income and disadvantaged sections of the community. This may also occur in Blackwater, though according to the current Project development timeline, much could change in the southern area before development commences in 2035.

31.4.10.2 Potential Non-Project Impacts

As with the economics assessment, those projects with the potential for cumulative economic impacts are generally those where on-going employment is required; i.e. the resource intensive mining projects. The projects identified are estimated to generate 6,830 long term operations jobs plus thousands of additional construction jobs; an estimated capital spend of $13.5 billion will also create thousands of indirect opportunities across the region. Negative aspects from these developments will be the impacts on local residents: the availability of housing, influx of people, increases in cost of living and fly in, fly out (FIFO) workers. Many of the negative impacts identified in the project assessments also have positive aspects depending on perspective. Positive impacts include the significant investments the projects make in the local area (e.g. infrastructure such as road networks), the opportunity for well-paying local employment and the effect this has in reducing the efflux of people from rural areas, the flow down effects of local spending (shops, hotels etc.) and the royalties paid to the government.

31.4.10.3 Cumulative Impact Significance and Conclusion

Cumulative impacts for communities are inherently difficult to identify or assess because they are based on assumptions of assessments made by other projects which may be difficult or impossible to ascertain. The cumulative effect of more than one resource project in the Bowen Basin is likely to manifest as an amplification or exacerbation of the Project impacts assessed in the social impact assessment (see the Social chapter (Section 24) and the Social Technical Report (Appendix U) of this EIS). Further, existing operations in the region have already produced a cumulative impact, such as increased demand on social infrastructure and housing in Moranbah and Dysart, and were considered as part of the baseline for the proposed Project.

Table 31–5 below lists key cumulative social aspects in the Project regional area and identifies specific planning and consultation mechanisms for mitigating cumulative impacts should they occur.

Table 31-5 Key Consideration for the Regional Area Regarding Cumulative Impacts

Aspect	Key Considerations
History and Settlement	• Reduction in farming efficiency and productivity; • Heightened landholder anxiety; and • Further temporary worker accommodation facility (TWAF) development in region, away from communities large and productive farming areas to CSG use.
Governance, Planning and Primary Infrastructure	• Decreased capacity of existing utilities to meet further demand; • Reduced road amenity and access for local graziers; • Increased road maintenance costs for local governments; • Increased volume of traffic; • Reduced capacity of local governments to fulfill community aspirations; and • Reduced residential passenger capacity through Moranbah Airport.
Demographic Profile	• Increased population growth from other project workforces and the workforce for the service and other industries; • Increased cultural diversity; • Decreased median age; • Increase in non-residential males in region; and • Greater increase in non-resident workers against residential population numbers
Social Capital	• Potential for conflict within communities over new divisions caused by perceived CSG impacts; • Increased community anxiety and concern regarding influx of NRW into region; • Potential for industrial action / social movements / greater media scrutiny over increased TWAF development and limited residential workforce employment arrangements; • Increased cost of living; and • Reduction in family oriented values in communities.
Community Services and Facilities	• Increased demand on community infrastructure and services; • Need for additional services for disadvantaged and marginalised groups; and • Need for FIFO key service workers.
Health and Emergency Services	• Increased likelihood of traffic accidents and road safety issues along Peak Downs Highway; • Heightened concern of potential impact of CSG on groundwater; • Increased difficulty in planning for health services; • Reduced capacity at regional hospitals to deal with additional workload; and • Compounding of men's long term health issues as a consequence of TWAF lifestyle.
Housing and Accommodation	• Increased residential house purchase and rental prices; • Reduction in housing affordability; • Increased demand for hotel/motel accommodation; and • Increased movements of people to areas of more affordable housing.
Education and Training	• Increased number of apprenticeship and training opportunities; • Reduction in number of senior students completing year 12 in region; and

Aspect	Key Considerations
	• Provision of alternative pathways for senior students in the region.
Employment, Enterprise and Economy	• Increased pressure on local and regional labour markets; • Further decrease in low level of regional unemployment; • Increased difficulty for local businesses to attract and retain staff; and • Demand for skilled labour likely to exceed supply nationally.

The key to managing cumulative impacts is to have various projects' proponents considering more than their own project in the development and implementation of their strategies, policies and programs. This is best achieved through a high level, strategic forum which will enable key stakeholders to better understand the requirements and outcomes of multiple projects. There are several opportunities available to achieve this, such as membership of regional community consultative committees, and Arrow will explore opportunities for effective cumulative impacts management in consultation with the Queensland Government Social Impact Assessment Unit, State and local governments, industry and communities. Through early engagement with key stakeholders, Arrow can supply vital information on workforce projections and housing requirements which can inform better planning for infrastructure and services. The Social Impact Management Plan (Appendix V of this EIS) includes a number of planning and consultation mechanisms which Arrow will consider in mitigating potential cumulative impacts of the Project.

31.4.11 Noise and Vibration

31.4.11.1 Project Impact Summary

All operational noise from production facilities is required to meet the Environmental Protection (Noise) Policy 2008 limits. As the majority of activities occur on a continuous basis, noise treatment will be designed to achieve the night-time criteria, which will result in noise levels in all other periods being significantly below the criteria.

In remote areas where the noise criteria are set based on the deemed background levels, noise from the project will be greater than 5 dB(A) above the background environment. In these instances, noise will be audible outside of dwellings and may cause some disturbance.

In all instances, noise will comply with the objective environmental values.

Noise from construction activities will at times exceed the long-term noise limit for receptors within 1 km of activities. Where required, mitigation measures are proposed to reduce the impact of construction noise.

During the operation and construction of the Project, drilling is likely to produce the highest levels of vibration of the equipment to be used. Using a conservative assessment, human annoyance and building damage are not expected to occur at distances greater than 70 m from the sites. As Arrow has committed not to drill wells within 200 m from any sensitive receptor, vibration impacts are not anticipated.

31.4.11.2 Potential Non-Project Impacts

As shown in Table 31-3, the following projects are predicted to contribute to cumulative noise impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area); and
- Codrilla Coal Mine Project (within the Project area).

Unlike the Project, the mining projects in the area are not able to alter their impact footprint as easily to mitigate potential noise and vibration impacts on sensitive receptors. The largest noise and vibration impacts from these projects are expected to be from blasting, coal washing and the movement of overburden material (trucks, draglines, etc.).

These four developments have varying numbers of receptors at different distances from the mine areas (generally <5 receptors within a 5 km radius). Different assessment have been carried out in the EIS' with some considering the mitigated noise levels to demonstrate compliance with noise limits and other developments predicting exceedances at different stages as operation move towards nearby receptors or from specific operations such as blasting. Proximity to the developments is also a factor with development predicting impacts to a nearby receptor (1.3 km away) however, another mine is predicting impacts at over 4 km from the mine; this is the greatest range of impact noted.

31.4.11.3 Cumulative Impact Significance and Conclusion

The noise and vibration footprint from the Project infrastructure and operations is expected to be localised around individual project components. It is therefore expected that unless noise or vibration sources from other projects in the region are within close proximity there will not be a cumulative increase in the noise or vibration impact from that activity. It is however expected that there will be a cumulative increase in the amount of noise and vibration in the general environment where the Project is situated due to the increase in development activity. Nevertheless, due to the noise levels from the Project and the proximity in which this occurs, the cumulative impacts are considered to be of low significance.

31.4.12 Indigenous and Non-Indigenous Cultural Heritage

31.4.12.1 Project Impact Summary

The study area has been assessed to constitute a rich and varied cultural landscape that is of particular significance to the local Aboriginal communities as well as containing non–Indigenous cultural heritage values. The management of these values and the attributable sites within the Project area will be through the development of Indigenous Land Use Agreements and Cultural Heritage Management Plan (CHMP) agreements for the Indigenous cultural heritage values and project management plans for the non–Indigenous cultural heritage values. Working under these agreements / plans and with the ability to move locations of project infrastructure, is unlikely that Project activities will adversely affect the value of cultural heritage sites within the Project area.

Arrow is required to meet the Aboriginal cultural heritage duty of care.

31.4.12.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative cultural heritage impacts:

- Daunia Mine (within the Project area);
- Middlemount Coal Project (3 km from the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area);
- Codrilla Coal Mine Project (within the Project area);
- Arrow Bowen Pipeline (traverses the northern Project area); and
- Northern Bowen Basin Transmission Network (crosses ATP 1103 east of Moranbah).

Unlike the proposed Project, the mining projects in the area are not able to alter their impact footprint as easily to avoid cultural heritage sites. The projects are likely to impact on some cultural heritage values, however mitigation includes the removal, relocation and reporting of any Indigenous and non-Indigenous cultural heritage items identified. Though the sites will not physically remain, the Indigenous and historical archaeological material and information on the places will be recorded and preserved for the future.

The projects are expected to agree CHMPs with the aboriginal parties and it is expected that the projects will be working under similar management frameworks and abiding by the legislative duty of care to protect cultural heritage values.

31.4.12.3 Cumulative Impact Significance and Conclusion

Considering that the Project will be implementing mitigation measures as described above to avoid or manage impact on cultural heritage values and any residual impact is considered unlikely, assuming the other developments operate in line with their cultural heritage agreements, any cumulative impact on cultural heritage values in the project area will be of low significance.

31.4.13 Preliminary Hazard and Risk

31.4.13.1 Project Impact Summary

The Preliminary Hazard Analysis (PHA) undertaken for the Project (see the Preliminary Hazard and Risk chapter (Section 27) and the Preliminary Hazard and Risk Technical Report (Appendix Y) of this EIS) includes a quantitative risk analysis that estimates and assesses the risk at offsite land uses.

The main findings of the assessment were:

- Natural hazards present a potential risk to people and assets associated with the Project sites. This risk is minimised by the selection of sites for Project infrastructure which avoid natural hazards, particularly flood risk, bushfire risk and landslide risk.
- Accidental events involving loss of containment at the Project sites have the potential to result in harm to people or property in the vicinity of the sites. The risk calculated in the PHA has been used to determine preliminary separation distances to different land use types from the facilities and pipelines to ensure that risk acceptability criteria are met.

Arrow's integrated risk management plan covers the lifecycle of the Project and ensures that hazard and risk to people and property is systematically managed to a level that is as low as reasonably practicable.

31.4.13.2 Potential Non-Project Impacts

As shown in Table 31–3, the following projects are predicted to contribute to cumulative hazard and risk impacts:

- Daunia Mine (within the Project area);
- Eaglefield Expansion Project (on the boundary of the Project area);
- Codrilla Coal Mine Project (within the Project area);
- Arrow Bowen Pipeline (traverses the northern Project area); and
- Northern Bowen Basin Transmission Network (crosses ATP 1103 east of Moranbah).

The hazard and risks posed by other developments are managed through the techniques and measures outlined in the respective EIS'. Each project has different risks to which location specific mitigation is applied to bring the hazard impact and probability to an acceptable level beyond the project footprint.

31.4.13.3 Cumulative Impact Significance and Conclusion

Due to the nature of the activities being undertaken in and around the project area the potential for a cumulative effect from project hazards is low. The largest risk is the loss of containment from a natural gas project and as described in the PHA chapter of this EIS, the engineering controls along with the separation distances between high risk items will mitigate any potential incident being of a cumulative nature.

31.5 Inspection and Monitoring

Inspection and monitoring programs are developed and incorporated into a project's environmental management plan and by conditions placed on approvals by state and federal governments. Monitoring cumulative impacts is difficult, therefore each of the project proponents will be responsible for their individual inspection and monitoring requirements.

31.6 Summary of Cumulative Impacts

There are potential cumulative impacts to environmental and social values as a result of the multiple developments within the Bowen Basin region. The cumulative impact assessment identified potential positive and adverse cumulative impacts to the following values:

- Groundwater (aquifer depressurisation and loss of water availability) through extraction;
- Surface water through modification of natural catchments (subsided areas and residual voids/ emplacement areas);

- Aquatic ecology through diminished water quality;
- Terrestrial ecology through the areas to be disturbed;
- Land use and tenure, specifically the disturbance and/or loss of agricultural land use;
- Visual amenity due to changes in the nature of the existing landscape;
- Social and economic impacts through industrial growth and population increase:
  - regional, state and national gross product;
  - increased employment;
  - household incomes.
  - businesses;
  - housing prices and availability of affordable housing;
  - industrial / commercial land prices; and
  - community services, infrastructure and amenities;
- Noise and vibration through construction and excavation activities.

This cumulative impact assessment has considered the potential residual impacts to environmental and social values. The residual impacts of the Project by definition are those that remain after taking account of any mitigation and management measures. Therefore mitigation of cumulative impacts is beyond the control of Arrow alone. Mitigation can be achieved with implementation of effective management measures from each of the individual developments and from effective local, regional and national planning. Arrow believe that the mitigation measures that have been proposed by Arrow in Sections 8 to 30 are sufficient to address Arrow's contribution of the cumulative impacts identified in this Section, and that further mitigation is not required

The majority of cumulative effects would occur only if construction of the Project and other developments coincided, which renders the findings of this assessment conservative. As the majority of the projects are progressing through the planning, construction and operation phases, potential cumulative impacts could change or be eliminated altogether. The significance of the cumulative impacts predicted based on the residual Project impacts is generally of low with moderate impacts likely in the areas of terrestrial ecology, and land use and tenure.