SCIENTIFIC INQUIRY INTO
HYDRAULIC FRACTURING
IN THE NORTHERN TERRITORY

FINAL REPORT APPENDICES

MARCH 2018

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These Appendices of the Final Report support and refer to the *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory Final Report*. There is also an Executive Summary of the Final Report. Each document has been published separately, but together they form the totality of the Final Report.

The Scientific Inquiry into Hydraulic Fracturing in the Northern Territory
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Image: Mick Wallangkarri Tjakamarra, Water Dreaming with bushtucker, 1972, acrylic on board, 65 x 45.5 cm (irregular). Araluen Art Collection. Winner of the 1972 Caltex Art Award. Acquired by the Central Australian Art Society. Donated to the Alice Springs Town Council in 1989 for the people of Alice Springs. © the artist licensed by Aboriginal Artists Agency, image courtesy of Araluen Arts Centre

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Appendix 1 Terms of Reference

Background

On 14 September the Northern Territory Government announced a scientific inquiry into hydraulic fracturing of onshore unconventional reservoirs in the Northern Territory (the **Inquiry**) under the *Inquiries Act (NT).*

Definitions

For the purposes of this document:

"Associated Activities" means:

a. the acquisition of ground or surface water for hydraulic fracturing;
b. the mixing of water, chemicals and proppant to create hydraulic fracturing fluid;
c. the return of injected fluid and water produced from the unconventional reservoir to the surface after hydraulic fracturing, and subsequent transport for reuse, treatment or disposal; and
d. the reuse, treatment and release of wastewater generated by hydraulic fracturing.

"environment" means land, air, water, organisms and ecosystems and includes:

a. the well-being of humans;
b. structures made or modified by humans;
c. the amenity values of an area; and
d. economic, cultural and social conditions.

"environmental impact" means any change, or potential change, to the environment.

"environmental risk" means the chance of something happening that will have an environmental impact, measured in terms of the environmental consequences and the likelihood of those consequences occurring.

"hydraulic fracturing" means the injection of fluids under pressures high enough to fracture the gas bearing formation where the fluid is comprised of water, chemicals and proppant.

"unconventional reservoir" is a reservoir where the gas bearing formation is shale.

Terms of Reference

The Inquiry will:

1. assess the scientific evidence to determine the nature and extent of the environmental impacts and risks, including the cumulative impacts and risks, associated with hydraulic fracturing of unconventional reservoirs and the Associated Activities in the Northern Territory;
2. advise on the nature of any knowledge gaps and additional work or research that is required to make the determination in Item 1, including a program for how such work or research should be prioritised and implemented, that includes (but is not limited to);
    a. baseline surface water and groundwater studies,
    b. baseline fugitive emissions data,
    c. geological and fault line mapping, and
    d. focus areas for baseline health impact assessment,
3. for every environmental risk and impact that is identified in Item 1, advise the level of environmental impact and risk that would be considered acceptable in the Northern Territory context;

4. for every environmental risk and impact that is identified in Item 1,
   a. describe methods, standards or strategies that can be used to reduce the impact or risk; and
   b. advise whether such methods, standards or strategies can effectively and efficiently reduce the impact or risk to the levels described in Item 3;
5. identify any scientific, technical, policy or regulatory requirements or resources that are in addition to the reforms being implemented through the existing environmental reform process that are necessary to reduce environmental risks and impacts associated with the hydraulic fracturing of unconventional reservoirs to acceptable levels; and
6. identify priority areas for no go zones.

When the Inquiry makes a determination under Item 1 about whether or not there has been an impact or risk on economic, cultural and social conditions, the Inquiry will not only consider the impacts and risks of hydraulic fracturing and the Associated Activities, it will also consider the impacts and risks of the development of the onshore unconventional gas industry, including exploration activities such as seismic surveys and aerial surveys, land access and costs and benefits of the industry. This may be undertaken through a social impact assessment or similar activity.

Methodology

In the course of delivering the Terms of Reference, the Inquiry will:

1. advise the timeframe for the Inquiry prior to 1 January 2017;
2. develop and implement a stakeholder engagement program, which will be publicly released prior to 1 January 2017 and which will include opportunities for the public to give written submissions and meet with the Inquiry in Darwin, Katherine, Tennant Creek and Alice Springs (and potentially other communities) prior to and following:
   a. the release of an Interim Report on the Findings of the Inquiry; and
   b. the release of a draft Final Report on the Findings of the Inquiry;
3. have regard to issues raised in the course of implementing the stakeholder engagement plan that relate to the Terms of Reference;
4. subject to any request for a submission or any part thereof to be kept confidential, make all submissions to the Inquiry publicly available;
5. have regard to relevant domestic and international reviews and inquiries regarding the environmental impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the Associated Activities; and
6. consider the principles of ecological sustainable development and the precautionary principle.

Appendix 2 Final list of issues

1 Water

Water quality

Groundwater

- There may be a risk of groundwater contamination as a result of:
  - induced connectivity between hydraulically fractured shale formations and overlying or underlying aquifers;
  - surface spills of chemicals, flowback water or produced water into near-surface groundwater;
  - leaky wells as a result of poor design, construction, operation or abandonment practices or as a result of well degradation over the life of the well;
  - reinjection of flowback water, produced water or treatment brines into a groundwater aquifer;
  - induced connectivity between different groundwater systems as a result of seismic activity caused by hydraulic fracturing or reinjection of water; and/or
  - changed groundwater pressure regimes from hydraulic fracturing activities.

Surface water

- There may be a risk of impacts on surface water quality as a result of the following types of incidents:
  - on-site spills, including as a result of extreme weather events such as cyclones and floods;
  - spills that occur during transportation of chemicals to or from the site during the development and production phases;
  - spills of flowback water, produced water or brines produced by water treatment; and/or
  - inputs of sediment from erosion of road and pipeline corridors.

Water supply and distribution (quantity)

- There may be a risk of adverse environmental impacts as a result of reduced water supply due to the large amounts of water being extracted for use in hydraulic fracturing.
- There may be a risk of changes to the timing and/or quantity of surface water flows because of the discharge of produced water, which may be significant particularly in arid to semi-arid landscapes.
- There may be a risk to surface water and groundwater flow processes as the result of possible seismic activity caused by hydraulic fracturing or reinjection of water.
- There may be a risk of surface disturbance affecting surface flow paths and altering infiltration.

Aquatic ecosystems and biodiversity

- There may be a risk of adverse impacts on aquatic ecosystems and biodiversity, including groundwater dependent ecosystems. This may result from changes in the quality and/or quantity of surface and/or groundwater available to them.

Amenity values

- There may be adverse impacts on general amenity values such as in national parks, rangelands and recreational fishing areas. This may result from changes in the quality and/or quantity of water available.

Public health

- There may be adverse impacts on human and livestock health due to changes to water quality, supply and distribution as a result of hydraulic fracturing and the associated activities.

Aboriginal people and their culture

- Natural water bodies are central to traditional land use and many sites of significance to Aboriginal people relate to water. A reduction in either water quantity or quality may impair the traditional use and/or value of the sites.

Economic

- Changes to water quality, supply and distribution may have an adverse impact on industries that may coexist with the onshore unconventional gas industry, such as agriculture, pastoralism, fishing and tourism.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

2 Land

Terrestrial ecosystems and biodiversity

- There may be a risk that hydraulic fracturing and the associated activities will have an adverse impact on terrestrial ecosystems and biodiversity in the Northern Territory. Specifically, there may be a risk of:
  - biodiversity loss on a local and regional scale as a result of areas being cleared for roads, pipelines and drill pads or as a result of spills;
  - biodiversity loss and reduced ecosystem function due to habitat loss and fragmentation;
  - adverse impacts on terrestrial ecosystems, including fauna and flora, as a result of changes to water quality and availability;
  - biodiversity loss and ecosystem function due to the spread of weeds;
  - impacts on biodiversity and greenhouse gas emissions due to changed fire regimes;
  - adverse impacts on fauna as a result of increased noise and light from gas operations;
  - loss of biodiversity due to inadequate knowledge of biodiversity assets leading to inappropriate planning of regional development;
  - disruption of surface water flows at the landscape scale by road and pipeline infrastructure;
  - loss of locally important or sensitive sites due to inappropriate location of infrastructure within a development area; and/or
  - increased human activity, roads and pipelines acting as barriers and corridors for faunal movement and the drinking of wastewater.

Soil health

- There may be a risk that the chemicals used in the drilling and hydraulic fracturing process will have an adverse impact on soil health, including as a result of spills of flowback water.
- There may be a risk that there will be compaction of soils underneath production pads or along pipelines.

Aboriginal people and their culture

- The landscape, terrestrial ecosystems, plants and animals are central to traditional cultural values. Adverse impacts to these things may have an adverse impact on Aboriginal cultural values.

Seismic activity

- There may be a risk of seismic activity caused either by the hydraulic fracturing process or the reinjection of wastewater into the ground.

Subsidence

- There may be a risk that the drilling and hydraulic fracturing process causes land subsidence.

Economic

- An adverse impact on terrestrial ecosystems may be a risk to industries that co-exist with the onshore unconventional gas industry, such as agriculture, pastoralism, fishing and tourism.

Amenity values

- The Panel recognises that the Northern Territory has iconic wilderness values as a core part of the Australian outback. There may be a risk that the development of the unconventional gas industry will have an adverse impact on the outback experience (for example, tourism) through infrastructure development (for example, the construction of pipelines and processing plants) and increased traffic, noise and light (from flaring).
- There may be a risk of solastalgia.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

3 Air

Public health

- The possible health risks associated with the release of gases from the hydraulic fracturing process are discussed below in '1.4 Public health'.

Climate change

- There may be a risk that greenhouse gases, including hydrocarbons (methane and ethane) and carbon dioxide, will be released during hydraulic fracturing and the associated activities. Emissions may be from sources such as wellheads, pipelines, compression stations and final use. The potential contribution of hydraulic fracturing and the associated activities to the burden of greenhouse gas emissions will be assessed by the Panel.

Amenity values

- There may be a risk that there will be adverse impacts on amenity values, such as in national parks and rangelands, due to gaseous emissions and flaring.

Air contamination

- There may be a risk that soil contaminated by spills of fracking fluids or wastewater becomes airborne as dust, causing harm to the environment and to human health.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

4 Public health

Drilling and fracking chemicals

- There may be a risk that chemicals used during the drilling and hydraulic fracturing process are harmful to humans and livestock. Further, there may be a risk that those chemicals come into contact with humans or livestock via groundwater or atmospheric pathways. While the concentrations of potentially harmful chemicals in the water are low, the actual amount of chemicals can be significant and may pose a threat to the water supply if not properly managed.

Hydrocarbons and BTEX

- There may be a risk that hydrocarbons associated with the extracted gas come into contact with humans or livestock via groundwater or atmospheric pathways. This may include aromatic hydrocarbons such as BTEX, which have featured prominently in some risk assessments relating to flowback water from petroleum and unconventional gas extraction activities in the US. The addition of BTEX in drilling and fracking fluids is prohibited in the Northern Territory.

Radioactive substances

- There may be a risk that naturally occurring radioactive materials from underground come into contact with humans or livestock as a result of the drilling or hydraulic fracturing process.

Mental health and wellbeing

- There may be a risk that the mental health and wellbeing of persons could be affected by an unconventional gas project. These factors could include increased costs of living associated with changing property values, access to social services, business failures, increased traffic, effects on the natural environment and concerns about the amenity of the local area, including solastalgia.

Diesel fumes

- There may be a risk of emissions from plant and equipment, such as diesel fumes from drilling equipment and pumps, and from off-site increases in road traffic.

Physical safety

- There may be a risk that physical safety may be compromised by factors associated with hydraulic fracturing, including road transport accidents.

Aboriginal health

- There may be a risk that as a consequence of the possible impacts described above, the physical and mental health of Aboriginal persons and communities, as a group that is especially vulnerable and disadvantaged, is particularly affected (that is, the 'gap' is increased and not decreased).

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

5 Aboriginal people and their culture

Land ownership

- There may be a risk that hydraulic fracturing or the associated activities will disrupt traditional practices that connect Aboriginal landowning groups with their country and underpin recognition of their ownership of that land.
- There may be a risk that there is inadequate or inappropriate consultation with Aboriginal landholders in obtaining access to their lands and/or permission to carrying out any onshore unconventional shale gas development.

Benefits

- There may be a risk that the development of the industry will occur without short and long term benefits flowing to local Aboriginal communities.

Culture, values and traditions

- There may be a risk that the above and/or below ground disturbance associated with drilling and hydraulic fracturing of onshore shale gas formations will have an adverse impact on Aboriginal culture, values and the traditions that connect landowning groups with their country and sustain community cohesion.
- There may be a risk that access to and the use of traditional lands will be denied or restricted by the presence of any onshore unconventional shale gas development.
- There may be a risk that sacred sites and cultural landscapes are degraded and damaged both above and below the ground.

Community wellbeing

- The development of the onshore unconventional shale gas industry may have an adverse impact on the wellbeing of Aboriginal communities.
- There may be a risk of solastalgia caused by any onshore unconventional shale gas development.
- There may be a risk that any onshore unconventional shale gas industry causes community division in respect of those who may benefit from any industry and those who will not.

Aquatic and terrestrial ecosystems

- The development of the unconventional gas industry may have an adverse impact on aquatic and terrestrial ecosystems important to Aboriginal culture.

Aboriginal health

- There is a risk of an exacerbated adverse impact on Aboriginal health, taking into account the particular vulnerabilities and disadvantage of that population.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

6 Social impacts

Housing and rents

- There may be impacts on local housing, which may decrease or increase rents and house prices as a result of an increased population.

Insurance

- There may be a risk that there will be an increase in insurance costs and liabilities of landowners, occupiers, and traditional owners.

Health services

- There may be impacts on the local health system (hospitals, health services and so on) as a result of an increased population, including that there may be increased health services in remote communities as a result of industry's presence.

Education

- There may be an impact on the local education system as a result of an increased population.

Infrastructure

- There may be an impact on infrastructure, such as roads, as a result of increased traffic.

Livelihoods

- There may be an impact on livelihoods.

Long term benefits

- There may be a risk that the development of the industry will occur without short and long term benefits flowing to the local community.

Community cohesion

- There may be an adverse impact on community cohesion and resilience. That is, there may be a risk of social division being created between those who benefit from the development of any onshore unconventional shale gas industry and those who do not.

Crime

- There may be an increase in crime.

Employment

- They may be an impact on local employment and skill levels.
- There may be negative impact caused by an influx of FIFO employees.

Business

- There may be an impact on local business opportunities.

Amenity

- There may be a risk that the amenity of people will be adversely impacted by hydraulic fracturing and its associated activities.

Social licence to operate

- There may be a risk that no social licence to operate an onshore unconventional shale gas industry exists.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

7 Economic impacts

Distribution

- There may be a risk that any economic benefits will not be shared by the regions that are directly affected by the industry and/or will not be shared equitably between the gas companies, the government, and the community.

Property values

- There may be a risk that there will be a decrease or increase in existing property values.

Other industries

- There may be a risk that there will be an adverse impact on other businesses, such as tourism, fishing, agricultural and pastoral businesses.

Energy security

- There may be an impact on the energy security of the Territory.

Employment

- There may be an impact on employment in the Territory.

Net impacts

- There may be a risk that any economic benefits will not outweigh economic detriments.
- There may be an opportunity cost of investing in an onshore unconventional shale gas industry rather than in renewable energy.
- There may be a risk of residents leaving a particular region because of the presence of an onshore unconventional shale gas industry.

Management

- There may be a risk that, if not properly managed, any economic benefits will result in 'boom and bust' economic activity.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

8 Land access

Consultation

- There may be a risk that gas companies do not consult adequately with land owners, occupiers, or traditional owners, in gaining access to the land for exploration and extraction purposes.

Consent

- There may be a risk that gas companies enter the land without obtaining the consent of the landowner, occupier, or traditional owners, causing conflict.

Conditions

- There may be a risk that gas companies and landowners, occupiers, and traditional owners, do not negotiate mutually beneficial conditions associated with any agreement permitting access.

Compensation

- There may be a risk that compensation paid for access and/or disturbance to land will not be adequate.
- There may be a risk that if there is an incident in the exploration, extraction or production of any gas, the land may not be properly remediated or the land owners, occupiers, or traditional owners may not be adequately compensated.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

9 Regulatory framework

Failure to protect the environment

- There may be a risk that the regulatory framework does not adequately protect the environment (water, land, and air) from risks associated with hydraulic fracturing and its associated activities.
- There may be a risk that the regulatory framework does not ensure adequate, or any, remediation and/or rehabilitation of any environmental damage caused by hydraulic fracturing and its associated activities.
- There may be a risk that the cost of any remediation and/ or rehabilitation of environmental damage caused by hydraulic fracturing and its associated activities is not passed on, either in whole or in part, to the entity that caused the harm, but is passed on to the public.

Land access

- There may be a risk the regulatory framework does not appropriately balance the rights of landowners, occupiers, and traditional owners, with those of gas companies.

Public health

- There may be a risk the regulatory framework does not adequately mitigate public health risks associated with the onshore unconventional shale gas industry.

Aboriginal culture and communities

- There may be a risk the regulatory framework does not adequately protect Aboriginal culture, values, traditions and communities from risks associated with the unconventional shale gas industry.

Social impacts

- There may be a risk the regulatory framework does not adequately mitigate the social risks associated with the onshore unconventional shale gas industry.

Economic impacts

- There may be a risk the regulatory framework does not ensure that any economic benefits are appropriately distributed between the gas companies, the Government and the local community.

Compliance and enforcement

- There may be a risk of inadequate monitoring or enforcement of compliance with the regulatory framework. This may arise from, for example, inadequate resourcing of the regulatory agency, inadequate expertise, or inadequate training.
- There may be a risk that sanctions provided for in the regulatory framework are inadequate or are not utilised by the regulator.
- There may be a risk that the cost of complying with the regulatory framework is too high for industry and the industry becomes uneconomic.

Access to justice

- There may be a risk that access to justice by the public is denied or restricted by the regulatory framework.

Complexity

- There may be a risk that the regulatory framework developed is too complex.
- There may be a risk that given its complexity, any regulatory framework that is developed is rushed and inadequate.
- There may be a risk that there is inadequate information about the long term risks associated with hydraulic fracturing and its associated activities to develop a suitably robust regulatory framework.

Regulatory capture

- There may be a risk of 'regulatory capture', whereby the regulatory body becomes inappropriately aligned with industry and becomes reluctant to regulate against the interest of any onshore unconventional shale gas industry.
- There may be a risk of the perception of regulatory capture which may have a tendency to undermine confidence in both the regulatory body and the Government.

Political risks

- There may be a risk that the Government is perceived to be subject to undue influence by the gas industry thereby leading to a loss of public confidence in the Government and the democratic process.
- There may be a risk that, given the short term nature of the political cycle, the long term consequences of any onshore unconventional shale gas industry cannot be appropriately regulated.

Cumulative risks

- There may be cumulative risks associated with some or all of the risks identified above.

Appendix 3 Risk assessment matrix

Chapter 7 Water

Environmental value 1: water quantity

Environmental objective 1: to ensure all surface and groundwater resources are used sustainably

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive extraction from surface water	*Likelihood* - low, lack of permanent surface water in Beetaloo Sub-basin and other semi-arid and arid regions. *Consequence* - medium. *Risk* - low.	• That a SREBA be conducted (***Recommendation 7.5***). • That the use of surface water be prohibited (***Recommendation 7.6***). • That WAPs be developed for the northern and southern regions of the Beetaloo Sub-basin (***Recommendation 7.7***).	Low
Excessive extraction from groundwater - regional impacts	**Northern Beetaloo Sub-basin:** *Likelihood* - low. *Consequence* - medium. *Risk* - low. **Southern Beetaloo Sub-basin:** *Risk* - cannot be assessed, lack of detailed knowledge on recharge rates in the region.	• That a SREBA be conducted (***Recommendation 7.5***). • That the use of surface water be prohibited (***Recommendation 7.6***). • That the Daly-Roper Water Control District (WCD) be extended south to include all of the Beetaloo Sub-basin and that Water Allocation Plans (WAP) be developed for the northern and southern regions of the Beetaloo Sub-basin (***Recommendation 7.7***). • That use of water by the shale gas industry be restricted to less than that which can be sustainably extracted (***Recommendation 7.7***). • That groundwater extraction be prohibited in semi-arid regions until there is sufficient information to demonstrate that there are no adverse impacts (***Recommendation 7.7***).	Low for northern Beetaloo Sub-basin. Not able to be determined for southern Beetaloo Sub-basin.
Excessive extraction from groundwater - local impacts	*Likelihood* - low of an unacceptable aquifer drawdown further than 1 km from the gas company bore fields. *Consequence* - medium, if aquifers are drawn down excessively this could reduce the effectiveness of bores used by pastoralists and communities. *Risk* - low.	• That a SREBA be conducted (***Recommendation 7.5***). • That the extraction of groundwater for hydraulic fracturing be prohibited within at least 1 km of existing or proposed domestic or stock bores. (***Recommendation 7.8***). • That WAPs include provisions to control the rate and volume of water extraction by the gas companies (***Recommendation 7.8***). • That gas companies monitor drawdown in local water supply bores (***Recommendation 7.8***). • That gas companies 'make good' and rectify any problems if the drawdown is found to be excessive (***Recommendation 7.8***). • That groundwater modelling be undertaken to ensure there are no unacceptable impacts on groundwater (***Recommendation 7.16***).	Low
Unacceptable changes to surface or groundwater flows from felt seismic activity caused by hydraulic fracturing	*Likelihood* - low, little evidence for hydraulic fracturing causing felt seismic activity, except in areas of active faults. *Consequence* - low. *Risk* - low.	• That a traffic light system for measured seismic intensity be implemented (***Recommendation 5.7***).	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable changes to surface and groundwater flow from seismic activity caused by reinjection of wastewater	*Likelihood* - low, evidence that this practice has cause seismic activity in US but no evidence for flow changes. *Consequence* - low to medium. *Risk* - medium.	• That the reinjection of wastewater into deep aquifers and conventional reservoirs and the reinjection of treated or untreated wastewaters (including brines) into aquifers be prohibited (***Recommendation 7.9***).	Low
Unacceptable changes to the surface water flow characteristics due to planned or accidental discharge of wastewaters	*Likelihood* - low to medium, based on historical data from the US. *Consequence* - low. *Risk* - low.	• That the discharge of wastewaters (treated or untreated) to any surface water body be prohibited (***Recommendation 7.17***).	Low

Environmental value 2: surface and groundwater quality

Environmental objective 2: to maintain acceptable quality of surface and groundwater

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination from leaky production wells	**Wastewater (salts and chemicals)** *Likelihood* - very low, little evidence of faulty contemporary wells. *Consequence* - medium, will depend upon the behaviour of contaminants in the groundwater (dispersion, transport, degradation). *Risk* - medium. **Methane** *Likelihood* - low to medium, methane leakage more likely than leakage from bores of contaminated flowback or produced water. *Consequence* - low, little evidence that methane contamination of groundwater is harmful. Methane in water is considered non-toxic, but a possible explosion risk in drinking water bores or storage tanks if dissolved concentration exceeds 28 mg/L. *Risk* - low.	• That guidelines be developed for human and environmental risk assessments for all onshore shale gas developments (***Recommendation 7.4***). • That information about hydraulic fracturing fluids, flowback and produced water be publicly disclosed (***Recommendation 7.10***). • That all wells to be hydraulically fractured are constructed to at least Category 9 or equivalent and be tested to ensure well integrity before and after hydraulic fracturing, with the results certified by the regulator (***Recommendation 7.11***). • That there is an offset of 1 km between well pads and water supply bores (***Recommendation 7.11***). • That there is real-time groundwater quality monitoring around each well pad (***Recommendation 7.11*** and ***7.13***). • That well pads are equipped with multilevel observations bores (***Recommendation 7.11***). • That electrical conductivity and other water quality indicators are measured (***Recommendation 7.11***).	Low (wastewater) Low (methane)

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination due to leaky abandoned wells	*Likelihood* - low, likely to be little produced water present and gas pressure will be greatly reduced at end of production life. *Consequence* (wastewater) - low, since very low volumes of wastewater will be involved. *Risk* (wastewater) - low. *Consequence* (methane) - low. *Risk* (methane) - low.	• That a code of practice for well decommissioning be mandated (***Recommendation 5.1***). • That decommissioned and orphased wells be monitored (***Recommendation 5.2***).	Low (wastewater) Low (methane)
Unacceptable groundwater contamination due to spills of hydraulic fracturing chemicals and wastewater: on-site spills	*Likelihood* - medium, spills are typically small volume; the likelihood of the contaminants penetrating to the aquifer is low for most of the Beetaloo Sub-basin. *Consequence* - medium, contamination could result in health issues for humans and stock using the aquifer for drinking. *Risk* - medium.	• That wastewater management plans and spill management plans be mandated (***Recommendation 7.12***). • That enclosed tanks be used for wastewater (***Recommendation 7.12***). • That well pads be bunded to prevent run off and be treated by a geomembrane to prevent infiltration into the soil (***Recommendations 7.12***). • That groundwater be monitored (***Recommendation 7.13***).	Low
Unacceptable surface and groundwater contamination due to off-site spills of hydraulic fracturing chemicals and wastewater from road and rail transport	*Likelihood* - medium, accidents are likely, particularly for road transport. *Consequence* - medium, contamination of surface waterbodies could occur and result in adverse effects on aquatic ecosystem; in case of groundwater, will depend on where the accident/spill occurs and permeability of overlying soil/rock horizons at that location. *Risk* - medium.	• That a wastewater management framework be developed. The framework must include an auditable chain of custody that enables source-to-delivery tracking (***Recommendation 5.5***). • That restrictions be placed on the transport of fracking fluids and wastewater (***Recommendation 7.14***). • That rail be considered as a mode of transport (***Recommendation 7.14***).	Not able to be determined
Unacceptable groundwater contamination due to off-site leaks of hydraulic fracturing chemicals and wastewater from pipelines	*Likelihood* - low, pipelines will be buried. *Consequence* - medium, will depend on volume of the spill, type of wastewater and potential for contamination of groundwater. *Risk* - low.	• That a wastewater management framework be developed. The framework must include an auditable chain of custody that enables source-to-delivery tracking (***Recommendation 5.5***). • Ensure adequacy of construction guidelines and their enforcement.	Not able to be determined
Unacceptable contamination of groundwater aquifers due to reinjection of treated or untreated wastewater into other aquifers	*Likelihood* - undetermined, cannot be assessed without detailed site-specific information and computer modelling. *Consequence* - medium, if surface aquifer is contaminated. *Risk* - undetermined.	• That reinjection of wastewater into aquifers be prohibited (***Recommendation 7.9***). • That discharge of treated or untreated wastewater into waterways be prohibited (***Recommendation 7.13***).	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable groundwater contamination due to induced connectivity between hydraulically fractured shale rock formation and overlying aquifers	*Likelihood* - remote to very low, provided that the hydraulic fracturing does not intersect with a fault. *Consequence* - medium. *Risk* - low.	• That details of known fault locations that could compromise well integrity be submitted to the regulator (***Recommendation 7.15***).	Low
Unacceptable groundwater contamination due to changed groundwater pressures	*Likelihood* - low due to very large distance between shale formation and aquifers. *Consequence* - medium. *Risk* - low, provided that the fracturing operations avoid the proximity of existing faults.	• That modelling of the groundwater system be undertaken as part of a SREBA (***Recommendation 7.16***).	Low
Unacceptable contamination of surface waters due to the intentional discharge of partially treated or untreated wastewater	*Likelihood* - low, provided that this practice is prohibited. *Consequence* - medium, if during wet season when dilution is available and depending upon the concentrations of contaminants released. *Risk* - low.	• That the discharge of hydraulic fracturing fluids and wastewater (treated or untreated) to drainage lines, waterways or temporary stream systems should not be permitted (***Recommendation 7.17***).	Low
Adverse effects of linear infrastructure (roads, pipelines) on the quality and distribution of surface water across the landscape	*Likelihood* - medium, unlikely there will be problems with pipelines provided they are buried. *Consequence* - low to medium, depending upon how they are designed and constructed. *Risk* - medium.	• That landscape and regional impacts are considered in the planning phase of any development (***Recommendation 7.18***). • That roads and pipeline corridors are constructed to comply with relevant guidelines (***Recommendation 7.19***). • That regional and cumulative impacts be taken into account in decision-making (***Recommendation 14.21*** and ***14.22***).	Low

Environmental value 3: aquatic ecosystems and biodiversity

Environmental objective 3: to adequately protect ecosystems and biodiversity that are dependent on surface water or groundwater

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive extraction from surface waters	*Likelihood* - low, given the lack of permanent surface water in Beetaloo Sub-basin and other semi-arid and arid regions. *Consequence* - medium, if volumes and flow regimes are altered. *Risk* - medium.	• That a SREBA be conducted (***Recommendation 7.5***). • That the use of surface water be prohibited (***Recommendation 7.6***). • That WAPs be developed for the northern and southern regions of the Beetaloo Sub-basin (***Recommendation 7.7***).	Low
Excessive extraction from groundwaters	*Likelihood* - low, for surface GDEs since none known in Beetaloo Sub-basin, undetermined for subterranean ecosystems (stygofauna). *Consequence* - undetermined for subterranean ecosystems. *Risk* - undetermined, lack of detailed knowledge of impact of subterranean fauna (stygofauna).	• That a SREBA be conducted (***Recommendation 7.5***). • That the use of surface water be prohibited (Recommendation 7.6). • That the Daly-Roper Water Control District (WCD) be extended south to include all of the Beetaloo Sub-basin and that Water Allocation Plans (WAP) be developed for the northern and southern regions of the Beetaloo Sub-basin (***Recommendation 7.7***). • That use of water by the shale gas industry be restricted to less than that which can be sustainably extracted (***Recommendation 7.7***). • That groundwater extraction be prohibited in semi-arid regions until there is sufficient information to demonstrate that there are no adverse impacts (***Recommendation 7.7***).	Low for surface GDEs but undetermined for subterranean ecosystems
Unacceptable contamination of surface waters (aquatic ecosystems)	*Likelihood* - low. *Consequence* - medium. *Risk* - low.	• That the discharge of wastewaters (treated or untreated) to any surface water body be prohibited (***Recommendation 7.17***). • That wastewater management plans and spill management plans be mandated (***Recommendation 7.12***). • That enclosed tanks for wastewater be used (***Recommendation 7.12***). • That well pads be bunded to prevent run off and be treated by a geomembrane to prevent infiltration into the soil (***Recommendations 7.12***). • That groundwater be monitored adjacent to each well pad (***Recommendation 7.13***).	Low
Unacceptable contamination of groundwaters (groundwater-dependent ecosystems)	*Likelihood* (leaky wells) - low, little evidence of faulty contemporary wells leaking solutes. *Likelihood* (spills) - medium. *Consequence* -undetermined, impact of contaminants on surface GDEs and subterranean fauna unknown. *Risk* - undetermined.	• That a SREBA be conducted, including a baseline study of surface and subterranean ecosystems (***Recommendations 7.5*** and ***7.19***).	Undetermined

Chapter 8 Land

Environmental value 1: terrestrial biodiversity and ecosystem health

Environmental objective 1: to ensure there is a low risk of impact on the terrestrial biodiversity values of affected bioregions and to ensure that the overall terrestrial ecosystem health, including the provision of ecosystem services, is maintained

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable location of shale gas developments within a region	*Likelihood* - high, due to lack of region-wide biodiversity knowledge. *Consequence* - high, significant threat to species that might occupy highly restricted ranges in development area. *Risk* - high.	• That a SREBA for all affected bioregions prior to any onshore shale gas production be conducted (***Recommendation 8.1***). • That areas with high conservation value be excluded from shale gas development (***Recommendations 8.1*** and ***14.4***).	Low
Unacceptable increase in the spread or impact of weeds	*Likelihood* - high, given experience with onshore gas developments elsewhere. *Consequence* - high, given severe potential impact on conservation and production values. *Risk* - high.	• That a baseline assessment of all weeds is undertaken (***Recommendation 8.2***). • That gas companies employ a dedicated weed management officer (***Recommendation 8.3***). • That gas companies have a weed management plan in place (***Recommendation 8.4***).	Low
Unacceptable increase in the spread or impact of exotic invasive ants	*Likelihood* - medium, given that such species are established elsewhere in northern Australia and are readily spread by vehicles and machinery. *Consequence* - high, major impacts on native species if introduced. *Risk* - high.	• That hygiene measures for vehicles and machinery are implement (see discussion at Section 8.4.2.2 and ***Recommendation 8.4***).	Low
Unacceptable increase in the impact of feral animals	*Likelihood* - low, because onshore gas development is unlikely to have a significant impact on feral animal populations. *Consequence* - low, as any increased impact of feral animals is likely to be local only. *Risk* - low.	• Gas companies must be aware of regional feral animal management obligations and programs (see discussion at Section 8.4.2.3).	Low
Unacceptable changes to fire regimes	*Likelihood* - medium, increased human activity and hence sources of ignition. *Consequence* - high, given the ecological importance of fire and its role in GHG gas emissions. *Risk* - high.	• That gas companies comply with regional fire management plans, which include requirements for baseline data, monitoring for any increase in fire frequency, and implementation of management actions as appropriate (***Recommendation 8.5***).	Low
Unacceptable loss of native vegetation	*Likelihood* - high, given that substantial areas will be cleared of vegetation. *Consequence* - low, because only small proportion of the landscape will be cleared, and fragmentation and edge effects are likely to be limited. *Risk* - medium.	• That a SREBA be conducted to identify any threatened species likely to be affected by cumulative effects of habitat loss and fragmentation and manage accordingly (***Recommendation 8.6***). • That vegetation clearing is minimised (***Recommendation 8.7***). • Progressively rehabilitate cleared areas (***Recommendation 8.8***). • Design and implement offsets to compensate for local vegetation and habitat losses (***Recommendation 8.9***).	Low

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Roads and pipelines as ecological barrier or corridors	*Likelihood* - medium, given impacts of past construction of roads and pipelines. *Consequence* - medium, given ecological importance of run-on/ run-off dynamics in flat, semi-arid landscapes. *Risk* - medium.	• That corridor widths be kept to a minimum, with pipelines and other linear infrastructure buried, except for necessary inspection points, wellpads and other operation areas, and the disturbed ground revegetated (***Recommendation 8.10***). • That directional drilling under stream crossings be used in preference to trenching (***Recommendation 8.12***). • That roads and pipeline surface water flow paths minimise erosion of all exposed surfaces and drains (***Recommendation 8.13***). • That all corridors be constructed to minimise the interference with wet season stream crossings and comply with relevant guidelines (***Recommendation 8.14***).	Low
Other impacts on wildlife	*Likelihood* - low, given management procedures already in place. *Consequence* - low, given that any impacts will be local only. *Risk* - low.	• Implement existing management procedures.	Low

Environmental value 2: landscape amenity

Environmental objective 2: to ensure that the perception by residents and tourists that the NT is a place of largely unspoiled landscapes is not diminished

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable landscape transformation	*Likelihood* - medium, given experiences with onshore gas developments elsewhere. *Consequence* - high, given the extremely high importance of the NT's unspoiled landscapes. *Risk* - high.	• That well pads are spaced a minimum of 2 km apart, and that long-term infrastructure within any development areas has little or no visibility from major public roads (***Recommendation 8.15***).	Low
Unacceptable increase in heavy-vehicle traffic	*Likelihood* - cannot be assessed, lack of predicted traffic information. *Consequence* - uncertain. *Risk* - uncertain.	• That the impact that all heavy-vehicle traffic associated with any onshore shale gas industry will have on the NT's transport system is assessed and managed (***Recommendation 8.16***).	Low to medium

Chapter 9 Greenhouse gases

Environmental value 3: climate change

Environmental objective: to limit the emissions of methane and greenhouse gases to the atmosphere

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Excessive upstream fugitive emissions of methane during upstream extraction, processing, transport and distribution	*Likelihood* - high, given that methane emissions occur mostly on a continuous basis but with some episodic releases. *Consequence* - low, given that upstream methane emissions (from any new shale gas field) will contribute a very low proportion of net global methane emissions. *Risk* - medium.	• That the US EPA New Source Performance Standards of 2012 and 2016 be introduced (***Recommendation 9.1***). • That a code of practice or other guideline for the ongoing monitoring, detection and reporting of emissions from wells be undertaken (***Recommendation 9.2***). • That baseline monitoring of methane concentrations be undertaken for at least six months prior to the grant of any exploration approvals (***Recommendation 9.3***). • That baseline and ongoing monitoring be undertaken (Recommendation 9.4). • Monitoring results should be published on a continuous real-time basis (***Recommendation 9.5***). • That once emission concentration limits are exceeded the problem is rectified (***Recommendations 9.6***).	Methane levels reduced to a level consistent with the acceptability criterion for methane emissions (**Table 9.9**), but the risk remains medium (see GHG mitigation).
Excessive emissions of methane from post production wells	*Likelihood* - high, in the absence of monitoring and appropriate action. *Consequence* - low, given that upstream methane emissions (from any new shale gas field) will contribute a very low proportion of net global methane emissions. *Risk* - medium.	• That a code of practice be developed for decommissioned wells and that wells be implemented (***Recommendation 5.1*** and ***5.2***). • That resources be available in the long term to ensure ongoing monitoring of wells and that problems will be remediated (***Recommendations 14.13*** and ***14.14***).	Methane levels reduced to a level consistent with the acceptability criterion for methane emissions (**Table 9.9**), but the risk remains medium (see GHG mitigation).
Other (supplementary) risks may prevent lower levels of methane emission performance from being achieved	N/A.	• That the action framework in Table 9.10 is implemented to manage and/or mitigate any supplementary risks that may prevent the achievement of lower levels of methane emissions (***Recommendation 9.7***).	Risk is low and acceptable
Excessive emissions of lifecycle greenhouse gases, GHG (including methane)	*Likelihood* - high, given that GHG emissions occur mostly on a continuous basis but with some episodic releases. *Consequence* – low (365 PJ/y production), given that GHG emissions (from any new shale gasfield) will contribute a very low proportion of net global GHG emissions and low/ medium (1,240 PJ/y production) *Risk* – medium (365 PJ/y production) and medium/ high (1,240 PJ/y production)	• After mitigation of methane emissions the residual lifecycle GHG emissions are reduced slightly, but they remain medium or high. • The lifecycle GHG emissions must have a low risk (**Chapter 4**). This can be achieved by fully offsetting the lifecycle GHG emissions. • That the NT and Australian Government seek to ensure there is no net increase of GHG emissions in Australia as the result of any onshore shale gas produced in the NT (***Recommendation 9.8***).	Risk is low and acceptable

Chapter 10 Public health

Environmental value 1: to prevent adverse impacts on public health by exposure to chemicals in contaminated water and air

Environmental objective 1: to assess and manage health risks associated with contaminated surface and groundwater

The risk estimates and risk mitigation measures for this objective are identical to those associated with water quality in Chapter 7.

Environmental objective 2: to assess and manage human health risks associated with the specific chemicals used in, or likely to result from, hydraulic fracturing processes

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable human health effects caused by hydraulic fracturing and geogenic chemicals in flowback water	*Likelihood* - low, for hydraulic fracturing chemicals, unknown (at this time) for geogenic chemicals. *Consequence* - medium, if inadequate knowledge of the concentration or presence of more toxic chemicals compromises the estimation of health risks via a formal HHRA. *Risk* - low.	Require gas companies to prepare a site-specific HHRA that: • uses contemporary knowledge of the chemicals proposed to be used specifically in formulating fracking fluids for operations in the NT; and • provides further details of the chemical composition of flowback and produced water specific to the geological features of the NT sites proposed for shale gas development, along with the proposed methods of treatment and/or disposal of this water (***Recommendation 10.1*** and ***7.10***).	Low - for hydraulic fracturing chemicals Unknown - (at this time) for geogenic chemicals

Environmental objective 3: to ensure human health risks associated with airborne emissions from gas wells and associated infrastructure are acceptable

Risk	Preliminary risk assessment	Mitigation measure	Residual risk
Unacceptable impacts on the health of nearby communities from volatile or gaseous chemicals emitted from well heads, storage ponds, processing facilities or pipelines	*Likelihood* - medium for methane. Low for VOCs but highly dependent on the distance between source and potentially exposed humans. *Consequence* - low for methane (relatively non-toxic gas). Medium for toxic gases and VOCs (such as NOx, BTEX), especially where associated with gas combustion events (flaring). *Risk* - low to medium.	• That wells are constructed and maintained to a high standard to ensure well head assemblies and pipelines are not leaking, coupled with regular monitoring to detect point source leaks (***Recommendations 5.4*** and ***9.4***). • That appropriate setback distances are set to minimise risks identified in HHRA reports, including potential pathways for waterborne and airborne contaminants. In the absence of local information, a default minimum setback distance of 2 km (based on US data) should be used (***Recommendation 10.2***).	Low
Unacceptable impacts on the health of nearby communities from dusts and/or diesel exhaust fumes from shale gas site preparation activities	*Likelihood* - medium, but likely to be of relatively short-term impact during the pre-production phase of well head and facility development. *Consequence* - low to medium, depending on controls over equipment movements and/or dust suppression measures. *Risk* - low to medium.	• That appropriate setback distances (based on scientific evidence) are set to protect landowners and local communities. In the absence of local information, a default minimum setback distance of 2 km (based on US data) should be used (***Recommendation 10.2***).	Low to medium

Environmental objective 4: to ensure the human health risks associated with potential impacts on wellbeing are acceptable

The assessment of this objective is primarily covered in Chapter 9, together with the assessments contained in Chapters 11 and 12.

Appendix 4 Panel meetings

Date	Location
8 December 2016	Sydney, NSW
8-9 February 2017	Sydney, NSW
11 March 2017	Darwin, NT
5 May 2017	By telephone
2 June 2017	Melbourne, Vic
18 July 2017	Canberra, ACT
6 September 2017	Melbourne, Vic
25 September 2017	Melbourne, Vic
9 October 2017	Brisbane, QLD
9 November 2017	Melbourne, Vic
10 February 2018	Darwin, NT
27 February 2018	Melbourne, Vic

Appendix 5 Stakeholder meetings

Location/Date	Organisation	Representatives
DARWIN, NT		
20 February 2017	NT Department of the Chief Minister	Ms Jodie Ryan, Chief Executive Officer Ms Rachel Bacon, Deputy Chief Executive Officer
	Frack Free Alliance, Darwin	Ms Belinda Quinlivian Mr Chris Naden
	Lock the Gate Alliance (NT)	Ms Naomi Hogan, Northern Territory Coordinator
	Environmental Defenders Office (NT) Inc	Mr David Morris, Principal Lawyer and Executive Officer
	Environment Centre Northern Territory	Mr Drew English, Chair Ms Shar Molloy, Director
	Frack Free Alliance, Darwin Rural	Ms Pauline Cass
	Northern Territory Chamber of Commerce	Mr Brian O'Gallagher, Acting Chief Executive Officer Mr Greg Ireland, President
	Australian Petroleum Production and Extraction Association	Mr Matthew Doman, Director, South Australia/Northern Territory
	Origin Energy Limited	Dr David Close, Chief Geologist and Unconventional Exploration Manager Ms Stephanie Stonier, Corporate Affairs Manager (Northern Australia)
	Central Petroleum Limited	Mr Richard Cottee, Managing Director and Chief Executive Officer
	Pangaea Resources Pty Ltd	Mr Todd Hoffman, Geoscientist
	Santos Ltd	Mr Bill Ovenden, Vice President, Exploration and Subsurface Mr Tom Baddeley, Manager, Government and Community Relations Mr Che Cockatoo-Collins, Aboriginal Employment Adviser
KATHERINE, NT		
21 February 2017	NT Department of the Chief Minister	Mr John de Koning, Regional Executive Director
	Amateur Fishermen's Association of the Northern Territory	Mr Warren de With, President
	Katherine Town Council	Mayor Fay Miller Deputy Mayor Toni Tapp-Coutts Alderman Peter Gazey
	Victoria Daly Regional Council	Mayor Brian Pedwell
	Don't Frack Katherine	Ms Kerrie Mott Dr Errol Lawson
	Jawoyn Association Aboriginal Corporation	Mr John Berto, Chief Executive Officer
NHULUNBUY, NT		
22 February 2017	NT Department of the Chief Minister	Mr Jim Rogers, Regional Executive Director
	East Arnhem Regional Economic Development Committee	Representatives from the following organisations: Gumatj Aboriginal Corporation, Miwatj Employment and Participation Ltd, Dhimurru Aboriginal Corporation, Rio Tinto, East Arnhem Regional Council, and the Australian Department of Prime Minister and Cabinet

Location/Date	Organisation	Representatives
TENNANT CREEK, NT		
22 February 2017	Tennant Creek Regional Economic Development Committee	Mr Greg Marlow, Chair Mr Steven Edgington, Regional Executive Director, Barkly Ms Josephine Bethel, Secretariat
ALICE SPRINGS, NT		
23 February 2017	Arid Lands Environment Centre	Mr Jimmy Cocking, Director
	Public Health Association Northern Territory; Doctors for the Environment	Dr Rosalie Schultz
	Alice Springs Town Council	Mayor Damien Ryan Councillor Jade Kudrenko Mr Rex Mooney, Chief Executive Officer
	Chamber of Commerce, Alice Springs/Tennant Creek	Ms Kaye Eade, Executive Officer Mr Martin Glass
	Central Desert Regional Council	Ms Cathryn Hutton, Chief Executive Officer
	Frack Free Northern Territory Alliance	Ms Lauren Mellor, Coordinator Ms Marli Banks
DARWIN, NT		
24 February 2017	Northern Land Council	Mr Murray McLaughlin, Media and Policy Manager Ms Rhonda Yates, Manager, Minerals and Energy Branch Mr Michael O'Donnell, Principal Legal Officer Mr Greg McDonald, Senior Project Coordinator
	Northern Territory Farmers Association	Mr Simon Smith, President Mr Tom Harris, Director
	NT Department of Primary Industry and Resources	Mr Alister Trier, Chief Executive Officer
	NT Department of Environment and Natural Resources	Ms Joanne Townsend, Acting Chief Executive Officer
	Amateur Fishermen's Association of the Northern Territory	Mr David Ciaravolo, Executive Officer
ALICE SPRINGS, NT		
30 March 2017	Aboriginal Areas Protection Authority, Alice Springs	Board meeting
DARWIN, NT		
31 March 2017	Northern Territory Cattlemen's Association	Annual General Meeting and Industry Conference
DARWIN, NT		
2 April 2017	Amateur Fishermen's Association of the Northern Territory	Annual General Meeting
TENNANT CREEK, NT		
11 May 2017	Central Land Council	Full Council meeting
KATHERINE, NT		
31 May 2017	Northern Land Council	Full Council meeting
NEWCASTLE WATERS, NT		
4 July 2017	Traditional Aboriginal owners and Northern Land Council	Ms Gay English, anthropologist Mr Ian Harris, Project Officer Borroloola/Barkly Region, Northern Land Council
MARYFIELD PASTORAL STATION, NT		
5 July 2017	APN Pty Ltd Hayfield-Shenandoah	Mr John Dyer and Mrs Val Dyer Mr Justin Dyer and Mrs Sally Dyer Mr Nick Dyer
HAYFIELD PASTORAL STATION, NT		
6 July 2017	North Star Pastoral Pty Ltd	Mr Colin Ross, Managing Director North Star Pastoral Pty Ltd Mr Warwick Giblin, Managing Director, OzEnvironmental Pty Ltd

Location/Date	Organisation	Representatives
BRISBANE, QUEENSLAND		
17 July 2017	Centre for Coal Seam Gas, University of Queensland	Professor Andrew Garnett, Director Ms Helen Schultz, Project Officer (Research & Strategy), Dr Sue Vink, Principal Research Fellow, Centre for Water in the Minerals Industry Associate Professor Nicole Gillespie, Business School Dr Katherine Witt, Research Fellow, Centre for Social Responsibility in Mining, Sustainable Minerals Institute Associate Professor John Steen, Business School Professor Ray Johnson, Chair, Well Engineering and Production Technology Professor Brian Towler, Chair in Petroleum Engineering Professor Jim Underschultz, Chair in Petroleum Hydrodynamics
	Queensland Gas Company	Mr Spencer Roberts, Smart CSG and Transformation Manager, Shell Australia Ms Lucy McKee, Technology and Planning Manager, Development, Shell Australia
BRISBANE, QUEENSLAND		
24 July 2017	Agforce	Dr Dale Miller, General Manager, Policy Mr Daniel Phipps, CSG Project Leader with Agforce
	Queensland Farmers' Federation	Dr Georgina Davis, Policy Advisor, Resources
DALBY, QUEENSLAND		
25 July 2017	Queensland Gasfields Commission and landholders affected by the CSG industry	Ms Jane Walker, Regional Engagement Officer, Queensland Gasfields Commission Mr Stuart Hayllor Mr Brad Robinson, Feedlot Manager, Mort and Co Mr Tom and Mrs Michelle O'Connor
	Western Downs Regional Council	Mayor Paul McVeigh Mr Ross Musgrove, Chief Executive Officer
	Former Commissioner of the Queensland Gasfields Commission	Mr John Cotter
ROMA, QUEENSLAND		
27 July 2017	Queensland Gasfields Commission	Ms Katrina MacDonald, Regional Engagement Officer
	Former Mayor of Roma	Mr Rob Loughnan
	Former Councillor	Mr Scott Wason
MILES, QUEENSLAND		
27 July 2017	Origin Energy Ltd	Dr David Close, Chief Geologist Mr Tim Ogilvie, Regional Manager (Western Downs) Ms Natasha Patterson, General Manager, Communities and Access
	Miles State High School	Mr Stephen Hardy, Head of Department - Senior
CENTRAL PETROLEUM, PALM VALLEY GASFIELD, NT		
28 August 2017	Central Petroleum	Mr Rolf Schulte, Alice Springs Area Manager
TENNANT CREEK, NT		
15 November 2017	Northern Land Council	Full Council meeting, Tennant Creek
BEETALOO STATION, NT		
13 December 2017	Beetaloo Station	Mrs Jane Armstrong
AMUNGEE MUNGEE STATION, NT		
13 December 2017	Amungee Mungee Station	Mr Adrian Brown
CENTRAL PETROLEUM, MEREENIE OIL AND GASFIELD, NT		
14 December 2017	Central Petroleum	Mr Michael Herrington, Chief Operating Officer Mr Rolf Schulte, Alice Springs Area Manager

Appendix 6 Departmental briefings

Date	Presenters	Description
DARWIN, NT		
8 December 2016	**NT Department of Primary Industry and Resources** Mr Alister Trier, Chief Executive Officer Mr Ian Scrimgeour, Director, Northern Territory Geological Survey	Presentation on Northern Territory gas resources, basins and energy demand.
ADELAIDE, SA		
	Nuclear Fuel Cycle Royal Commission Consultation and Response Agency Ms Madeline Richardson, Chief Executive Mr John Phalen, Director, Engagement **Department of State Development** **South Australian Government** Mr Barry Goldstein, Executive Director, Energy Resources Division Mr Michael Malavazos, Director, Engineering Operations, Energy Resources Division	Overview of the South Australian Nuclear Fuel Cycle Royal Commission Consultation and Response Agency.
DARWIN, NT		
8 February 2017	**NT Department of Environment and Natural Resources** Mr Des Yin Foo, Director, Water Assessment	Presentation on water, focussing on climate change and major aquifers in the Northern Territory.
	Department of the Environment and Energy **Australian Government** Mr Anthony Swirepik, Director, Bioregional Assessments, Office of Water Science	Presentation on bioregional assessments.
	Department of Natural Resources and Mines **Queensland Government** Mr Bill Date, Chief Inspector, Petroleum and Gas Inspectorate Mr Ian Heiner, A/Executive Director, Coal Seam Gas Compliance Unit	Presentation on the Queensland experience with unconventional gas, focussing on land access issues and the Gasfields Commission.
DARWIN, NT		
9 February 2017	**NT Department of Primary Industry and Resources** Mr Jop van Hattum, Senior Director, Petroleum Technology and Operations	Presentation on technical overview of hydraulic fracturing for shale gas.
	NT Department of the Chief Minister Ms Jodie Ryan, Chief Executive Officer	Presentation on the economy of the Northern Territory.
DARWIN, NT		
11 March 2017	**NT Department of Primary Industry and Resources** Mr Jop van Hattum, Senior Director, Petroleum Technology and Operations	Presentation on the Petroleum Act and the Petroleum Environment Regulations.
BRISBANE, QUEENSLAND		
17 July 2017	**Queensland Gasfields Commission** Ms Ruth Wade, Commission Chair Ms Carolyn Collins, General Manager Mr Liam Jeory, Policy and Engagement Director Mr Murray Cornish, Communications Director	Presentation on the Commission's powers and functions.
	Gas Industry Social and Environmental Research Alliance (**GISERA**) and Commonwealth Scientific and Industrial Research Organisation (**CSIRO**) Dr Damian Barrett, Research Director, Onshore Gas (Energy Business Unit) Mr Dan O'Sullivan, Deputy Director Dr Andrea Walton, Research Scientists (Social Science), CSIRO Dr Rod McCrea, Research Scientists (Social Science), CSIRO	Presentations on community wellbeing and resilience.

Date	Presenters	Description
CANBERRA, AUSTRALIAN CAPITAL TERRITORY		
18 July 2017	**CSIRO/GISERA** Dr Damian Barrett, Research Director, Onshore Gas (Energy Business Unit)	Presentation on the Beetaloo Basin Water Study quantifying baseline characteristics of groundwater within the Beetaloo Sub-basin.
	NT Department of Environment and Natural Resources Ms Karen Avery, Executive Director, Environment Policy and Support	Presentation on the Northern Territory environmental reform agenda.
CANBERRA, AUSTRALIAN CAPITAL TERRITORY		
19 July 2017	**Department of Industry, Innovation and Science Australian Government** Mr Bruce McCleary, General Manager, National Radioactive Waste Management Taskforce Mr Angus Cole, Manager, Community Consultation, National Radioactive Management Taskforce	Presentation on the Radioactive Waste Management Project community consultation and engagement.
	Department of the Environment and Energy Australian Government Mr John Higgins, Director, Knowledge and Technology Division Mr Matthew Whitfort, Assistant Secretary, Knowledge and Technology Division Mr Andrew McNee, Assistant Secretary, Environment Standards Division	Presentation on human health risks, environmental exposure conceptualisation and environmental risks of chemicals used in coal seam gas extraction.
	Department of the Environment and Energy Australian Government Mr Anthony Swirepik, Director, Knowledge and Technology Division Mr Matthew Whitfort, Assistant Secretary, Knowledge and Technology Division	Presentation on combined geological and bioregional resource assessments.
	Department of the Environment and Energy Australian Government Ms Gayle Milnes, Assistant Secretary, Domestic Emissions Reduction Division Mr Rob Sturgiss, Assistant Secretary, International Climate Change and Energy Innovation Division	Presentation on Australia's current emissions data, its emissions reductions target and whether the supply of high-quality gas to the east coast could assist in meeting this target.
	Department of the Environment and Energy Australian Government Mr Brenton Philp, Assistant Secretary, Energy Division Mr Dwayne Purdy, Director, Energy Division	Presentation on the National Energy Policy, including energy security issues, the role of gas and the National Electricity Market, the Northern Gas Pipeline and future opportunities.
BRISBANE, QUEENSLAND		
24 July 2017	**Department of Natural Resources and Mines Queensland Government** Mr Warwick Squire, Acting Executive Director, Coal Seam Gas Compliance Unit, Mineral and Energy Resources Mr Lyall Hinrichsen, Acting Executive Director, Resources and Energy Policy Mr David Rynne, Chief Economist Mr David Wiskar, Executive Director, Water Policy Mr Keith Phillipson, Director, Office of Groundwater Management Mr Jon Thomas, Manager, Petroleum Assessment Hub Dr Steven Ward, Acting Manager, Coal Seam Gas Compliance Unit Mr Peter Lee, Executive Petroleum Inspector, Petroleum and Gas Inspectorate Mr Hamish Butler, Director, Petroleum and Gas Unit **Department of Environment and Heritage Protection Queensland Government** Mr Mark Venz, Executive Director, Petroleum, Gas and Compliance	Presentation on recent gas exploration and infrastructure development and its economic contribution to the State. Information was provided on gas sector policy and the legislative framework, particularly with regard to petroleum and gas tenure, land access, water policy and planning and groundwater impact assessment. Presentation by the Department of Environment and Heritage Protection, which administers the *Environmental Protection Act 1994* (Qld) on environmental policy, regulation, compliance and enforcement in Queensland.

Date	Presenters	Description
BRISBANE, QUEENSLAND		
28 July 2017	**CSIRO/GISERA** Dr Damian Barrett, Research Director, Onshore Gas (Energy Business Unit) Mr Dan O'Sullivan, Deputy Director, GISERA Dr Neil Huth, Lead Researcher, Agriculture and Food, CSIRO Dr Sarah Lawson, Senior Research Scientist, Reactive Gases Team Leader, Oceans and Atmosphere, CSIRO Dr Melita Keywood, Research Scientist, Oceans and Atmosphere, CSIRO Dr Cameron Huddlestone-Holmes, Senior Research Scientist, Energy, CSIRO Mr James Kear, Research Team Leader, Hydraulic Fracturing, CSIRO	Presentations on scientific research in respect of communities living in gas development regions. Topics included groundwater and surface water management, biodiversity, land management and socioeconomic impacts. Technical presentations were provided on hydraulic fracturing technologies and well decommissioning.
	Department of Natural Resources and Mines Queensland Government Dr Sanjeev Pandey, Acting General Manager, Office of Groundwater Impact Assessment	Presentation on the role of the Office of Groundwater Impact Assessment.
ADELAIDE, SA		
7 September 2017	**Department of State Development South Australian Government** Barry Goldstein, Executive Director, Energy Resources Division **Department of the Premier and Cabinet South Australian Government** Michael Malavazos, Director, Engineering Operations, Energy Resources Division	Overview of South Australia's approach to best practice for upstream petroleum industry regulation with regard to the *Petroleum and Geothermal Energy Act 2000* (SA). The approach to monitoring compliance of regulated activities and surveillance classifications were discussed.
VICTORIA, CANADA		
22 December 2017	**BC Oil and Gas Commission** Ken Paulson, Executive Vice President, Chief Operating Officer Graham Currie, Executive Director, Public and Corporate Relations Sean Curry, Executive Director, Resource Development and Environment	An overview of various aspects of the regulation of onshore shale gas activities in their jurisdiction, and the structure and functioning of the Commission.
CONFERENCE CALL		
23 February 2018	**Newfoundland & Labrador Hydraulic Fracturing Review Panel** Professor Ray Gosine Chair	Discussion about the content and process of the Newfoundland & Labrador Review, including the timing of the implementation of the recommendations.

Appendix 7 Public hearings

Location/Date	Organisation	Representatives
ALICE SPRINGS, NT		
6 March 2017	Alice Springs Town Council	Mayor Damien Ryan Deputy Mayor Jamie de Brenni Councillor Jade Kudrenko
	Arid Lands Environment Centre	Mr Jimmy Cocking, Director Mr Alex Read, Policy Officer
	Aloha Therapeutic Massage	Mr Jason Trevers
	Central Petroleum Limited	Mr Richard Cottee, Managing Director and Chief Executive Officer Mr Rolf Schulte, Alice Springs Area Manager Mr David Liddle, Public Relations and Communications
	Drill and Complete Pty Ltd	Mr Ash Chawla, Well Engineering and Project Management
	Central Land Council	Mr David Ross, Director Mr James Nugent, General Manager, Legal Ms Julie Ann Stoll, Mining Manager
	Public Health Association NT; Doctors for the Environment; Central Australian Rural Practitioners Association	Dr Rosalie Schultz
	Central Australia Frack Free Alliance	Ms Marli Banks Mr Dalton Dupuy
TENNANT CREEK, NT		
7 March 2017	Barkly Landcare and Conservation Association	Mr Anthony Cox, President Ms Anne Alison Ms Naomi Wilson Mr Michael Anderson
	Cave Creek Station	Mr Rohan Sullivan
	Seed Indigenous Youth Climate Network	Ms Larissa Baldwin, National Co-Director Ms Vanessa Farrelly
KATHERINE, NT		
8 March 2017		Ms June Tapp
	Big River Station	Mr Daniel Tapp
	Katherine Mining Services Association	Mr Geoff Crowhurst, Chair
	Top Didj Cultural Experience and Art Gallery	Ms Petrena Ariston
	Don't Frack Katherine	Dr Errol Lawson
		Ms Annette Raynor
		Ms Teresa Cummings
	Katherine Town Council	Mr Robert Jennings, Chief Executive Officer
DARWIN, NT		
10 March 2017	North Star Pastoral represented by OzEnvironmental Pty Ltd	Mr Warwick Giblin
	Australian Petroleum Production and Exploration Association	Mr Matthew Doman, Director, South Australia/Northern Territory Mr Keld Knudsen, Policy Director, Exploration

Location/Date	Organisation	Representatives
DARWIN, NT		
10 March 2017	Origin Energy Limited	Mr Ross Evans, General Manager, Exploration and New Resources Dr David Close, Chief Geologist and Unconventional Exploration Manager Mr Alexander Cote, Senior Petroleum Engineer Ms Stephanie Stonier, Corporate Affairs Manager (Northern Australia)
	Lock the Gate Alliance (NT)	Ms Naomi Hogan
	Santos Ltd	Mr Bill Ovenden, Vice President Exploration and Subsurface Mr Che Cockatoo-Collins, Advisor Aboriginal Engagement Mr Andrew Snars, Maranoa Regional Manager Mr Rohan Richardson, Manager Design and Construction Onshore
	Armour Energy Limited	Mr Luke Titus, Chief Geologist
	Amateur Fishermen's Association of the Northern Territory	Mr David Ciaravolo, Executive Officer
	Environmental Defenders Office (NT) Inc	Mr David Morris, Principal Lawyer and Executive Officer
	Environment Centre Northern Territory	Ms Shar Molloy, Director Mr Drew English
	Frack Free Alliance, Darwin	Ms Belinda Quinlivian Mr Chris Naden Ms Melissa Burey
	Northern Territory Cattlemen's Association	Ms Tracey Hayes, Chief Executive Officer Mr Tom Stockwell, President
	Consolidated Pastoral Company	Mr Troy Setter, Chief Executive Officer
		Mr Justin Tutty
		Ms Katherine Marchment
		Ms Merrilee Baker
	Pangaea Resources Pty Ltd	Mr Tim Radburn, Executive Director
	Halliburton	Ms Diana Grantham, Senior Technical Professional Production Enhancement Mr Ian Adams
	Climate Action Darwin	Ms Anna Boustead Ms Grusha Leeman
DARWIN, NT		
31 July 2017	Sully Pty Ltd and MS Contracting	Mr Bill Sullivan Mr Mark Sullivan
		Mr Rob Woods
	Institute for Energy Economics and Financial Analysis	Mr Bruce Robertson
		Ms Jo Vandermark
	United Voice	Mr Pat Honan
DARWIN, NT		
1 August 2017	Lock the Gate Alliance (NT)	Ms Naomi Hogan
	Environmental Defenders Office (NT) Inc	Mr David Morris, Principal Lawyer and Executive Officer
		Professor Melissa Haswell
		Mr Jamie Houldsworth
	Frack Free Darwin	Ms Belinda Quinlivian Ms Melissa Bury

Location/Date	Organisation	Representatives
DARWIN, NT		
1 August 2017		Ms Seranna Shutt Mr Ron Chute Ms Ellen Gapany
		Professor Jenny Davis
		Mr Ron Chute Mr David Forsyth
		Mr Nicholas Milyari Fitzpatrick
	Oilfield Connect	Mr Mark Fraser, Manager
	Terrabos Consulting Pty Ltd	Mr David Armstrong
		Mr Carl Brand representing Ms Rikki Saltmarsh
DARWIN, NT		
2 August 2017	Santos Ltd	Mr Bill Ovenden, Vice President Exploration and Subsurface Mr Tom Baddeley, Manger Public Affairs Mr Paul Wybrew, Senior Environmental Officer Mr Geoff Atherton, General Manager of Drilling Operations Mr Che Cockatoo-Collins, Advisor Aboriginal Engagement
		Mr Tim Forcey
		Ms Billee McGinley
		Mr Christland Kovison Yao
		Mr Paul Sharp
	The Australia Institute	Mr Roderick Campbell, Research Director
	Climate Action Darwin	Ms Grusha Leeman
	Maritime Union of Australia	Mr Thomas Mayor, Branch Secretary
		Mr Justin Tutty
		Ms Katherine Marchment
		Ms Pauline Cass
ALICE SPRINGS, NT		
3 August 2017	Arid Lands Environment Centre Inc	Mr Jimmy Cocking, Director Mr Alex Read, Policy Officer
		Ms Lisa Gray Mr Miles Jennings
		Mr Allan O'Keefe Mrs Marilyn O'Keefe Ms Jasmin O'Keefe
		Mr Jason Trevers
	Central Australia Frack Free Alliance	Ms Marli Banks Mr Jesse Hancock
		Mr Domenico Pecorari
	Elkedra Station	Ms Amber McBride
ALICE SPRINGS, NT		
4 August 2017		Mr Christopher Hawke
		Ms Dianna Newham Ms Barbara Molanus Ms Ella Newham-Perry
	Arid Lands Environment Centre Inc	Mr Jimmy Cocking, Director Mr Alex Read, Policy Officer

Location/Date	Organisation	Representatives
ALICE SPRINGS, NT		
4 August 2017		Ms Amber Driver
		Ms Kirsty Robertson
		Mr Mark Swindles
		Ms Esther Nunn Ms Gem Walsh
		Ms Heather McIntyre
	RMIT University	Dr Matthew Currell, Senior Lecturer and Program Manager (Environmental Engineering)
KATHERINE, NT		
8 August 2017	Katherine Mining Services Association	Mr Geoff Crowhurst, Chair
		Dr Errol Lawson
	Environment Centre Northern Territory	Ms Shar Molloy, Director
	Vista Gold	Mr Brent Murdoch, Director/General Manager
KATHERINE, NT		
9 August 2017	North Australian Rural Management Consultants Pty Ltd	Ms Teresa Cummings, Corporate Manager
		Ms Carol Randall Mr Andrew Smith
		Mr Annette Raynor
		Mr Daniel Tapp
		Ms Cheryl Birch
	Gasfield Free Communities	Ms Lauren Mellor Ms Vivienne Soebek Mrs Glenys Somers Ms Petrena Ariston Ms Kerrie Mott
		Mr Michael Somers Mrs Glenys Somers
	Origin Energy Ltd	Dr David Close, Chief Geologist and Unconventional Exploration Manager Ms Stephanie Stonier, Corporate Affairs Manager (Northern Australia) Mr Alexander Cote, Senior Petroleum Engineer
		Ms Samantha Phelan
TENNANT CREEK, NT		
10 August 2017	Australian Petroleum Production and Exploration Association	Mr Matthew Doman, Director, South Australia/ Northern Territory Mr Keld Knudsen, Policy Director, Exploration Mr Adam Welch, Senior Policy Adviser
		Mr Raymond Dixon Ms Eleanor Dixon Ms Jeanie Dixon Mr Shannon Dixon Ms Mary James
		Mr Andrew Munckton (by video and conference call)
MELBOURNE, VICTORIA		
6 September 2017	Schlumberger Australia Pty Ltd	Mr Paul McDougall, Australia Onshore General Manager Mr Joe Lima, Director of Environment Sustainability Mr Daniel Kalinin, Technical Manager, Stimulation

Location/Date	Organisation	Representatives
DARWIN, NT		
5 February 2018	Aboriginal Medical Services Alliance Northern Territory	Mr John Paterson, Chief Executive Ms Margie Cotter, Support Advisor
	Imperial Oil and Gas	Mr Bruce McLeod, Executive Chairman and Chief Executive Officer
	United Voice	Mr Jesse Hancock
		Ms Julian Schuller
		Ms Andrea Finn
	Origin Energy Limited	Dr David Close, Unconventional Exploration Manager Mr Alex Cote, Senior Petroleum Engineer
		Ms Lia Gill
		Mr Sean Ryan
		Ms Pauline Cass
		Ms Jo Vandermark
	The Australia Institute	Mr Mark Ogge, Principal Adviser
	1Territory Party	Mr Braedon Earley, President
		Ms Heidi Jennings
		Ms Louise Becker
		Ms Justine Johnson
DARWIN, NT		
6 February 2018	Santos Ltd	Ms Tracey Winters, Head of Government and Public Affairs Mr Geoff Atherton,General Manager, Drilling and Completions Mr Che Cockatoo-Collins, Advisor Aboriginal Engagement Mr Tom Baddeley, Manager Public Affairs–Offshore & NT
	Lock the Gate Alliance (NT)	Ms Naomi Hogan
		Ms Billee McGinley
		Ms Rachel Tumminello
	Amateur Fishermen's Association of the Northern Territory	Mr David Ciaravolo, Executive Officer
	Northern Territory Cattlemen's Association	Mr Paul Burke, Chief Executive Officer Mr Tom Ryan, Executive Officer
		Mr Andrew Arthur
	Climate Action Darwin	Ms Grusha Leeman
		Mr Justin Tutty
	Environment Centre Northern Territory	Ms Shar Molloy, Director
	Australian Petroleum Production and Exploration Association	Mr Matt Doman, Director South Australia and Northern Territory Mr Adam Welch, Senior Policy Advisor
	Northern Territory Greens	Mr Paul Sharp
	Northern Territory Farmer's Association Inc	Mr Simon Smith, Mr Greg Owens
		Mr Dean Geoffrey
		Ms Janette Hintze
		Ms Katherine Marchment

Location/Date	Organisation	Representatives
KATHERINE, NT		
7 February 2018		Mr Daniel Tapp
		Dr Errol Lawson
		Ms June Tapp
		Ms Annette Raynor
	North Australian Rural Management Consultants and Katherine Mining Services Association	Ms Theresa Cummings, Corporate Manager Mr Geoff Crowhurst, President
		Dr Samantha Phelan
ALICE SPRINGS, NT		
8 February 2018		Ms Heather McIntyre
	Central Australia Frack Free Alliance	Mr Dalton Dupuy
		Mr Ned Jampijinpa Hargraves
		Mr Jason Trevers
		Mr Rosalie Schultz
	Health Professionals Against Fracking	Ms Gem Walsh Ms Esther Nunn Mr Darren Turner
	Arid Lands Environment Centre	Mr Jimmy Cocking, Director Mr Alex Read, Policy Officer
ALICE SPRINGS, NT		
9 February 2018		Ms Dianna Newham Ms Ella Newham-Perry
		Ms Laura Robertson
		Ms Vicki Gordon
TENNANT CREEK, NT		
12 February 2018		Mr Peter Dixon
	Seed Indigenous Youth Climate Network	Ms Larissa Baldwin, National Co-Director Ms Nicole Hutton, Coordinator Mr Jordan Wimbis, Coordinator
	Frack Free Alliance (NT)	Ms Lauren Mellor

Appendix 8 Community forums

Date	Location
6 March 2017	Alice Springs
7 March 2017	Tennant Creek
8 March 2017	Katherine
9 March 2017	Darwin
9 March 2017	Humpty Doo
20 March 2017	Gapuwiyak
20 March 2017	Nhulunbuy
21 March 2017	Ngukurr
21 March 2017	Borroloola
22 March 2017	Daly Waters
23 March 2017	Mataranka
24 March 2017	Timber Creek
27 March 2017	Wadeye
29 March 2017	Hermannsburg
29 May 2017	Yuendumu
30 May 2017	Maningrida
4 July 2017	Elliott
8 August 2017	Katherine
10 August 2017	Tennant Creek
11 August 2017	Alice Springs
11 August 2017	Humpty Doo
12 August 2017	Darwin
22 August 2017	Mataranka
22 August 2017	Jilkminggan
23 August 2017	Daly Waters
23 August 2017	Borroloola
24 August 2017	Ngukurr
25 August 2017	Maningrida
28 August 2017	Hermannsburg
29 August 2017	Yuendumu
30 August 2017	Elliott
30 August 2017	Timber Creek
31 August 2017	Nhulunbuy
1 September 2017	Yirrkala
1 September 2017	Gapuwiyak
30 January 2018	Yirrkala
30 January 2018	Nhulunbuy
31 January 2018	Gapuwiyak
31 January 2018	Borroloola
1 February 2018	Daly Waters
2 February 2018	Maningrida

Date	Location
7 February 2018	Katherine
8 February 2018	Alice Springs
9 February 2018	Humpty Doo
10 February 2018	Darwin
12 February 2018	Tennant Creek
13 February 2018	Hermannsburg
14 February 2018	Yuendumu
14 February 2018	Elliott
15 February 2018	Jilkminggan
15 February 2018	Mataranka
16 February 2018	Ngukurr

Appendix 9 Presentations by the Panel

Date	Organisation	Event	Panel member
30 March 2017	Aboriginal Areas Protection Authority	Board meeting, Alice Springs	Chair and Dr David Ritchie
31 March 2017	Northern Territory Cattlemen's Association	Annual industry conference, Darwin	Chair
2 April 2017	Amateur Fishermen's Association of the Northern Territory	Annual General Meeting, Darwin	Chair
11 May 2017	Central Land Council	Full Council meeting, Tennant Creek	Chair
31 May 2017	Northern Land Council	Full Council meeting, Katherine	Chair
15 November 2017	Northern Land Council	Full Council meeting, Tennant Creek	Dr David Ritchie

Appendix 10 Community updates

Update	Date	Description
1	20 December 2016	The inaugural meeting of the Panel on 8 December 2016, the importance of community consultation and the proposed hearings and consultations.
2	6 February 2017	The visit of the Panel to Moomba, SA, to witness hydraulic fracturing, well drilling and associated infrastructure.
3	13 February 2017	The second meeting of the Panel and the March hearings and community consultation schedule.
4	21 February 2017	The release of the Issues Paper on 20 February 2017, stakeholder meetings and the hearings and community consultation sessions.
5	6 March 2017	The commencement of the first round of consultations.
6	11 March 2017	The completion of the first round of consultations in urban centres.
7	20 March 2017	The postponing of the community forum in Maningrida.
8	27 March 2017	The conclusion of the first round of community forums in regional and remote communities.
9	27 April 2017	A reminder that submissions of the Issues Paper close on 30 April 2017 and discussion of hearings and community forums to hear the views of Territorians. Release of public tender for economic modelling.
10	5 May 2017	Release of public tender for a social impact assessment and management framework.
11	24 May 2017	Award of tender to undertake economic impact modelling to ACIL Allen.
12	28 June 2017	Award of tender for a social impact assessment and management framework to Coffey.
13	5 July 2017	Details of the public hearings to be held across the Northern Territory, in relation to the foreshadowed release of the Interim Report.
14	14 July 2017	Release of the Interim Report and commencement of second round of public consultations.
15	27 July 2017	Announcement that the second round of public hearings are commencing next week.
16	31 July 2017	Announcement of commencement of second round of public hearings.
17	2 August 2017	Release of dates and venues for community forums at Katherine, Tennant Creek, Alice Springs, Humpty Doo and Darwin.
18	4 August 2017	Confirmation by the Chair that the second round of consultations is not the final phase of community consultation by the Inquiry.
19	16 August 2017	Release of dates for community forums at regional and remote communities.
20	21 August 2017	Regional and remote community forum update.
21	6 October 2017	Closing date for submissions is announced for consideration in Interim Report.
22	7 October 2017	Clarification regarding the Australian Broadcasting Corporation's news story on the social impact assessment consultation conducted by Cross Cultural Consultants.
23	16 October 2017	Response to the Australian Broadcasting Corporation's Radio National Story that the Chair *"supported"* calls for an investigation into former Chief Minister Adam Giles's subsequent employment by Hancock Prospecting Pty Ltd.

Update	Date	Description
24	27 October 2017	Release of ACIL Allen's economic impact assessment of a potential onshore unconventional shale gas industry in the Northern Territory, *The Economic Impacts of a Potential Shale Gas Development in the Northern Territory*.
25	7 November 2017	Confirmation of appointment of Indigenous Agreement Solutions by Coffey to undertake on-ground engagement in communities within the Beetaloo Sub-basin and surrounding areas, delaying the release of the draft Final Report, the final round of consultations and the Final Report.
26	12 December 2017	Release of the draft Final Report and announcement of third round community consultations.
27	19 January 2018	Release of Coffey Services Australia Pty Lt's draft Social Impact Assessment Framework.
28	30 January 2018	The commencement of the final round of community forums and consultations, in relation to the draft Final Report.
29	5 February 2018	Details of the final round of public hearings to be held across the Northern Territory, in relation to the draft Final Report.
30	14 February 2018	The conclusion of the final round of community forums and consultations.
31	27 March 2018	Release of the Final Report.

Appendix 11 Media engagements

Date	Activity	Media organisation
3 December 2016	Media event	ABC TV and Radio, Darwin and NT News
7 February 2017	Interview	ABC Radio, NT Country Hour
14 February 2017	Interview	ABC Radio, Darwin
20 February 2017	Media event	ABC Darwin, Channel 9, NT News, Territory FM
21 February 2017	Interview	Territory FM
23 February 2017	Media event	ABC TV; ABC Radio, NT Country Hour; Alice Springs News; Centralian Advocate
28 February 2017	Interview	Territory Q Magazine
6 March 2017	Interview	ABC Radio, Alice Springs
9 March 2017	Written response	Katherine Times
	Written response	Alice Springs News
10 March 2017	Interview	ABC Radio, National AM
	Interview	ABC Radio, Darwin
20 March 2017	Interview	Yolngu Radio
21 March 2017	Written response	NT News
23 March 2017	Interview	ABC TV, Darwin
4 April 2017	Interview	ABC Radio, Darwin
	Interview	ABC Radio, Alice Springs
13 April 2017	Written response	NT News
3 May 2017	Written response	NT News
8 May 2017	Written response	Alice Springs News
25 May 2017	Written response	ABC Darwin
26 May 2017	Written response	Alice Springs News
	Written response	Centralian Advocate
29 May 2017	Interview	PAW Radio
30 May 2017	Written response	Alice Springs News
8 June 2017	Written response	ABC Darwin
14 September 2017	Written response	ABC Darwin
4 October 2017	Written response	ABC Darwin
11 October 2017	Written response	ABC Darwin
13 October 2017	Written response	ABC Radio National
16 October 2017	Written response	ABC Radio, Darwin
31 October 2017	Written response	NT News
8 November 2017	Interview	ABC Radio, Darwin
8 November 2017	Interview	Channel 9
12 December 2017	Media conference	NT News, Channel 9, ABC Darwin, Sky News, The Australian, AAP
13 December 2017	Interview	Mix FM 360 program
22 January 2018	Interview	ABC Radio, Darwin
22 January 2018	Written response	Alice Springs News
1st February	Written response to interview request	ABC Radio, Darwin
10 February 2017	Interview	ABC Darwin
28 February 2018	Written response	ABC Darwin

Appendix 12 Submissions

*confidential submission

Submission number	Name or organisation
1	Mr Barry Nicholson
2	Ms Katherine Marchment
3	Ms Monica O'Connor
4	Mr Terry Baldwin
5	Mr Clinton Dennison
6	Mr Mark Edward
7	Mr Lawrence Lyons, Environics
8	Central Australia Frack Free Alliance
9	Mr Robert Adams
10	Ms Harshini Bartlett
11	Mr Daniel Tapp
12	Mr Daniel Tapp
13	Mr Phil Walcott
14	Mr Denny Migl, Sigma Cubed Inc
15	Coomalie Community Government Council
16	Ms June Tapp
17	Mr Barry Nicholson
18	Mr Rohan Sullivan, Birdum Creek Station
19	Mr Blair McFarland
20	Mr Paul Brant
21	Dr Michael Blockey
22	North Star Pastoral, represented by OzEnvironmental Pty Ltd
23	Armour Energy Ltd
24	Mrs Helen Davison
25	Ms Yolande Doecke
26	North Star Pastoral, represented by OzEnvironmental Pty Ltd
27	Mr Phil Cross
28	North Star Pastoral, represented by OzEnvironmental Pty Ltd
29	Mr Gerry Wood MLA, Member for Nelson
30	Origin Energy Ltd
31	Withdrawn
32	Northern Territory Cattlemen's Association
33	Ms Pauline Cass
34	Ms Merrilee Baker
35	Mr Paul Brant
36	Mr David Jagger
37	Ms Eleanor Wilson
38	Mr Mark Sinclair
39	Mr George Kyreakou

Submission number	Name or organisation
40	Mr Daniel Leather
41	Mr Tony Hayward-Ryan
42	Ardent Group Pty Ltd
43	Mr Colin Mellon
44	Ms Amanda Doyle
45	Mr Thomas Lynch
46	Don't Frack Katherine
47	Central Land Council
48	Ms Helen Armstrong, Gilnockie Station
49	Ms Jenny Knight
50	Withdrawn
51	PLan: The Planning Action Network
52	Ms Kelly-Lee Hickey
53	Dr Geralyn McCarron
54	Mr Tony Hayward-Ryan
55	Withdrawn
56	Lock the Gate Alliance (NT)
57	Santos Ltd
58	Santos Ltd
59	Environment Centre Northern Territory
60	Pangaea Resources Pty Ltd
61	Halliburton Australia Pty Ltd
62	Climate Action Darwin
63	North Star Pastoral, represented by OzEnvironmental Pty Ltd
64	Central Petroleum Limited
65	Don't Frack Katherine
66	Withdrawn
67	Ms Annette Raynor
68	Top Didj Cultural Experience and Art Gallery
69	Mr Paul Brant
70	Mr Paul Brant
71	Mr Paul Brant
72	Mr Greg Reilly
73	Mr Jim Sullivan, Cave Creek Station
74	Mr Jason Trevers
75	Mr Rod Dunbar, Lexcray Pty Ltd
76	Central Desert Regional Council
77	Mr Tom Measham, Commonwealth Scientific and Industrial Research Organisation
78	Ms Jennifer McFarland
79	Falcon Oil and Gas Australia Pty Ltd
80	Ms Julia Siddall
81	Ms Barbara Molanus
82	Ms Gabby Watson-Scotty
83	Ms Jessica Graham
84	Ms Jasmine Sammut

Submission number	Name or organisation
85	Mr Joseph Costelloe
86	Mr Jim Green
87	Mr Andrew Andrejewskis
88	Arid Lands Environment Centre Inc
89	Mr Tim Forcey
90	Ms Harshini Bartlett
91	Ms Nicole Pietsch
92	Mr John Armstrong, Gilnockie Station
93	Central Australia Frack Free Alliance
94	Prof Madelon Finkel
95	Katherine Town Council
96	Doctors for the Environment Australia
97	Halliburton Australia Pty Ltd
98	Sweetpea Petroleum Pty Ltd
99	Central Petroleum Limited
100	Jemena Limited
101	Australian Pipelines and Gas Association and Energy Networks Australia
102	WL Tinapple
103	Mr Lindsay Owler, Argonaut Resources
104	Mr Bruce Beer, BC & M Beer Pty Ltd
105	Dr Matthew Currell
106	Ms Sue Slater
107	Public Health Association of Australia
108	Mr Warwick Smyth, Geoconsult
109	Dr Steve Mackie, Geosim Consulting Pty Ltd
110	Regional Development Australia Northern Territory
111	Mr Rob Ross, Qeye Labs Australia Pty Ltd
112	Mr Mick Curran
113	Mr Luke Marshall
114	The Norwood Resource Incorporated
115	Mr Alexander Belford
116	Prof John Kaldi, Australian School of Petroleum, The University of Adelaide
117	Dr Andrew Kulpecz
118	Mr Andrew Pedler, Matau Advisory Pty Ltd
119	Mr Ryan Taylor-Walshe
120	Mr Greg Carlsen
121	Mr David Warner
122	Dr David King
123	Dr Kris Waddington, Buru Energy Ltd
124	Mr Ralf Oppermann, OPPtimal Resource Solutions Pty Ltd
125	Mr John Wilson
126	Mr Richard Osbon
127	Mr Michael Micenko
128	Mr John Kopcheff
129	Mr Craig Gumley, Gumley Advisory Services

Submission number	Name or organisation
130	Mr John Heugh, PetroAfrique Oil and Gas Ltd
131	Mr Gregory Meldrum
132	Dr Steve Mackie, Petroleum Exploration Society of Australia
133	Mr Eric Streitberg, Buru Energy Ltd
134	Mr David Adderley
135	Blue Energy Limited
136	Mr Griffiths Weste
137	Mr James Groombridge
138	Mr Mark Fabian
139	Mr Darryl Roy Kingsley
140	Mr Anthony Kress
141	Frack Free Darwin
142	Institute for Energy Economics and Financial Analysis
143	Mr Robert Laws
144	Ms Helen Bender
145	Beyond Zero Emissions
146	Mr Chris Carty
147	Ms Liz Howells
148	Mr Miles Ponsonby
149	Mr Greg Kemp
150	Nation Energy (Australia) Pty Ltd
151	Mr Robert Pearson
152	Mr Justin Tutty
153	Origin Energy Ltd
154	D.R Johns
155	North Star Pastoral
156	Mr Chris Harwood
157	Paltar Petroleum Limited
158	The Australia Institute
159	Mr James Wright
160	Mr Bill Sullivan, Sully Pty Ltd
161	Mr Bevan Warris
162	Imperial Oil and Gas Pty Ltd
163	The Desert Fruit Company
164	Ms Sandy Watters
165	Ms Juliet Saltmarsh
166	MS Contracting
167	Ms Andrea Broughton, Groundwater Solutions International
168	Santos Ltd
169	Mr John Geary
170	Mr Stuart Jones, Petroleum Exploration Society of Australia
171	Lock the Gate Alliance (NT)
172	Mr Alex Ross
173	Mr Simon Molyneux
174	Oilfield Connect Pty Ltd

Submission number	Name or organisation
175	Climate Action Darwin
176	Mr Alex Yeadon
177	1 Territory Party
178	Schlumberger Australia Pty Ltd
179	Dr Liz Moore
180	Mr David Armstrong, Terrabos Consulting
181	Roper Resources Pty Ltd
182	Ms Jean McDonald
183	Prof Melissa Haswell
184	Mrs Frederika Saltmarsh
185	Katherine Mining Services Association
186	Northern Australian Rural Management Consultants Pty Ltd
187	Ms Rachel Tumminello
188	Environment Centre Northern Territory
189	Ms Sharyn Bury
190	Amateur Fishermen's Association of the Northern Territory
191	Ms Charmaine Roth
192	Ms Pauline Cass
193	Ms Gypsy Cass
194	Mr Cameron Fink, Bridgeport Energy Ltd
195	Mr Rebel Cass
196	Mr Titan Cass
197	Mr Robert Bates
198	Mr Michael Harcla
199	Mr Steve Vidler
200	Ms Rose Matyr
201	Ms Emma Burkitt
202	Ms Megan Fleming
203	Ms Jeananne Baker
204	Mr Geoff Baker
205	Ms Bianca-Jade Stevanovic
206	Mr Michael Baker
207	Mr Brian Baker
208	Ms Renee Baker
209	Mr James Donley
210	Ms Mandy Hall
211	Dr Peter Dart, School of Agriculture and Food Sciences, The University of Queensland
212	Mr Lachlan Bestic
213	Environment Defenders Office (NT) Inc
214	Northern Land Council
215	Australian Petroleum Production and Exploration Association
216	Dr Errol Lawson
217	Northern Territory Cattlemen's Association
218	Consolidated Pastoral Company Pty Ltd
219	Mr Justyn Wood, Wood Petroleum Exploration Pty Ltd

Submission number	Name or organisation
220	Pangaea Resources Pty Ltd
221	Halliburton Australia Pty Ltd
222	Oilfield Connect Pty Ltd
223	Ms Grusha Leeman
224	NT Department of Environment and Natural Resources
225	Ms Jill Emerson-Smith
226	NT Department of Primary Industry and Resources
227	Ms Yvonne Werner
228	Mr Bryce McLaren, Buru Energy Ltd
229	SG Interest I, Ltd
230	NT Department of Environment and Natural Resources
231	Schlumberger Australia Pty Ltd
232	Santos Ltd
233	Origin Energy Ltd
234	Aboriginal Areas Protection Authority
235	Alice Springs Town Council
236	Mr Jason Trevers
237	Amateur Fishermen's Association of the Northern Territory
238	Arid Lands Environment Centre Inc
239	Australian Petroleum Production and Exploration Association
240	Ms Merrilee Baker
241	Barkly Landcare
242	Mr Daniel Tapp
243	Mr Rohan Sullivan, Cave Creek Station and Birdum Creek Station
244	Central Australia Frack Free Alliance
245	Central Land Council
246	Central Petroleum Limited
247	Climate Action Darwin
248	Consolidated Pastoral Company Pty Ltd
249	Ms Teresa Cummings
250	Don't Frack Katherine
251	Drill and Complete
252	Environment Centre Northern Territory
253	Environmental Defenders Office (NT) Inc
254	Frack Free Darwin
255	Halliburton Australia Pty Ltd
256	Katherine Mining Services Association
257	Katherine Town Council
258	Lock the Gate Alliance (NT)
259	Ms Katherine Marchment
260	North Star Pastoral, represented by OzEnvironmental Pty Ltd
261	Northern Territory Cattlemen's Association
262	Origin Energy Ltd
263	Pangaea Resources Pty Ltd
264	Doctors for the Environment Australia

Submission number	Name or organisation
265	Ms Annette Raynor
266	Santos Ltd
267	Seed Indigenous Youth Climate Network
268	Ms June Tapp
269	Ms Petrena Ariston, Top Didj Cultural Experience and Art Gallery
270	Mr Justin Tutty
271	Withdrawn
272	Origin Energy Ltd
273	Origin Energy Ltd
274	Halliburton Australia Pty Ltd
275	NT Department of Environment and Natural Resources
276	Santos Ltd
277	Withdrawn
278	Withdrawn
* 279	Pangaea Resources Pty Ltd
280	Santos Ltd
* 281	NT Department of Primary Industry and Resources
282	Mr Mark Goldstein
* 283	Origin Energy Ltd
* 284	Origin Energy Ltd
285	Coal and CSG Free Mirboo North – Margaret, Gayle
286	Lock the Gate Alliance (NT)
287	Groundswell Gloucester
288	1Earth Media
289	NT Department of Primary Industry and Resources
290	Tax Justice Network Australia
291	Mr Jason Trevers
292	Ms Barbara Molanus
293	Ms Deidre Olofsson
294	Francis Mendes
* 295	NT Department of Primary Industry and Resources
296	Geoscience Australia
297	Mr Rod Dunbar
298	NT Department of Primary Industry and Resources
299	Australian Government Department of Industry, Innovation and Science
300	Imperial Oil and Gas Pty Ltd
301	Ms Eleanor Dixon
302	Australian Petroleum Production and Exploration Association
303	North Star Pastoral represented by OzEnvironmental Pty Ltd
304	North Star Pastoral represented by OzEnvironmental Pty Ltd
305	Mr Mark Swindells
306	Mr Lawrence Lyons, Environics
307	Mr Anthony Kenny
308	Millwarparra Aboriginal Corporation
309	Ms Linda (no surname provided)

Submission number	Name or organisation
310	Mr Phil Cross
311	Dr Matthew Currell
312	Mr John Jenkyn
313	Mr Rob Woods
314	United Voice Northern Territory Branch
315	Mr Bruce Robertson, Institute for Energy Economics and Financial Analysis
316	Lock the Gate Alliance (NT)
317	Prof Melissa Haswell
318	Oilfield Connect Pty Ltd
319	Mr Carl Brand on behalf of Ms Rikki Saltmarsh
320	Mr Tim Forcey
321	Mr Christland Kovison Yao
322	The Australia Institute
323	Mr David Forsyth
324	NT Department of Primary Industry and Resources
325	MS Contracting and Sully Pty Ltd
326	Mr Rod Woods
327	Mr Bruce Robertson, Institute for Energy Economics and Financial Analysis
328	Ms Jo Vandermark
329	United Voice Northern Territory Branch
330	Lock the Gate Alliance (NT)
331	Environmental Defenders Office (NT) Inc
332	Prof Melissa Haswell
333	Mr Jamie Houldsworth
334	Frack Free Darwin
335	Ms Seranna Shutt, Mr Ron Chute and Ms Ellen Gapany
336	Prof Jenny Davis
337	Mr Ron Chute and Mr David Forsyth
338	Mr Nicholas Milyari Fitzpatrick
339	Oilfield Connect Pty Ltd
340	Mr David Armstrong, Terrabos Consulting
341	Mr Carl Brand on behalf of Ms Rikki Saltmarsh
342	Santos Ltd
343	Mr Tim Forcey
344	Ms Billee McGinley
345	Mr Christland Kovison Yao
346	Mr Paul Sharp
347	The Australia Institute
348	Climate Action Darwin
349	Mr Tom Mayor, Maritime Union of Australia
350	Mr Justin Tutty
351	Ms Katherine Marchment
352	Ms Pauline Cass
353	Arid Lands Environment Centre Inc
354	Ms Lisa Gray and Mr Miles Jennings

Submission number	Name or organisation
355	Mr Allan O'Keefe, Ms Marilyn O'Keefe and Ms Jasmin O'Keefe
356	Mr Jason Trevers
357	Central Australia Frack-Free Alliance
358	Mr Domenico Pecorari
359	Ms Amber McBride
360	Mr Christopher Hawke
361	Ms Dianna Newham, Ms Barbara Molanus and Ms Ella Newham-Perry
362	Ms Amber Driver
363	Ms Kirsty Robertson
364	Mr Mark Swindles
365	Health Professionals Against Fracking
366	Ms Heather McIntyre
367	Dr Matthew Currell
368	Katherine Mining Services Association
369	Dr Errol Lawson
370	Environment Centre Northern Territory
371	Vista Gold
372	North Australian Rural Management Consultants Pty Ltd
373	Ms Carol Randall and Mr Andrew Smith
374	Ms Annette Raynor
375	Mr Daniel Tapp and Ms Cheryl Birch
376	Gasfield Free Communities
377	Mr Michael Somers and Mrs Glenys Somers
378	Origin Energy Ltd
379	Dr Samantha Phelan
380	Australian Petroleum Production and Exploration Association
381	Mr Raymond Dixon, Ms Eleanor Dixon, Ms Jeanie Dixon, Mr Shannon Dixon and Ms Mary James
382	Mr Andrew Munckton
383	Ms Dianna Newham
384	Mr Alex Ariston
385	Dr Matthew Currell
386	Dr Errol Lawson
387	Vista Gold
388	Ms Carol Randall and Mr Andrew Smith
389	Australian Petroleum Production and Exploration Association
390	Ms Annette Raynor
391	Ms Helen Clarke
392	Ms Sharon Powell
393	Withdrawn
394	Ms Jo Vandermark
395	Ms Carol Randall and Mr Andrew Smith
396	Ms Annette Raynor
397	Mr Raymond Dixon
398	Mr Jason Trevers
399	Origin Energy Ltd

Submission number	Name or organisation
400	Ms Amber Driver
401	Terrabos Consulting
402	Prof Jenny Davis
403	Mr Michael Somers and Mrs Glenys Somers
404	Dr Samantha Phelan
405	Mr Daniel Tapp and Ms Cheryl Birch
406	Gasfield Free Communities
407	Stygoecologia Australasia
408	Imperial Oil and Gas Pty Ltd
409	Mr Jason Trevers
410	Ms Esther Nunn
411	Arid Lands Environment Centre Inc
412	Territory Frack Free Alliance
413	Dr Errol Lawson
414	Geoscience Australia
415	Mr Richard Creswick
416	Ms Sue McWhirter
417	Northern Territory Environment Protection Authority
418	Consolidated Pastoral Company Pty Ltd
419	NT Department of Primary Industry and Resources and NT Department of Environment and Natural Resources
420	Santos Ltd
421	Australian Petroleum Production and Exploration Association
422	Ms Pauline Cass
423	Ms Heather McIntyre
*424	NT Department of Primary Industry and Resources
425	Ms Andrea Broughton, Groundwater Solutions International
426	Mr Anthony Knapton
427	Pangaea Resources Pty Ltd
428	NT Department of Environment and Natural Resources
429	NT Department of Environment and Natural Resources
430	Withdrawn
431	Ms Carolyn Carttling
432	Ms Evelyn Alberta Bacala
433	Origin Energy Ltd
434	Que Kenny
435	University of Queensland Centre for Coal Seam Gas
436	Urban Development Institute of Australia (NT)
437	Lock the Gate Alliance (NT)
438	Ms Katherine Marchment
439	Core Energy Group Pty Limited
440	Arnhem Earthmoving and Mechanical
441	Blue Energy Limited
442	Central Petroleum Limited
443	Environment Centre Northern Territory

Submission number	Name or organisation
444	Mr Geoff Farnell
445	Australian Government Department of the Environment and Energy
446	Climate Action Darwin
447	North Star Pastoral represented by OzEnvironmental Pty Ltd
448	Mr Roger Heapy
*449	NT Department of Environment and Natural Resources
450	Commonwealth Scientific and Industrial Research Organisation
451	Commonwealth Scientific and Industrial Research Organisation
452	Commonwealth Scientific and Industrial Research Organisation
453	North Star Pastoral represented by OzEnvironmental Pty Ltd
454	Withdrawn
455	Ms Monica Napper
456	Environmental Defenders Office (NT) Inc
457	Ms Charmaine Roth
458	Climate Council of Australia
459	Australian Government Department of Industry, Innovation and Science
460	Schlumberger Australia Pty Ltd
461	Hancock Prospecting Pty Ltd
462	North Star Pastoral represented by OzEnvironmental Pty Ltd
463	Ms Pauline Cass
464	Schlumberger Australia Pty Ltd
465	Australian Petroleum Production and Exploration Association
466	Origin Energy Ltd
467	North Star Pastoral represented by OzEnvironmental Pty Ltd
468	North Star Pastoral represented by OzEnvironmental Pty Ltd
469	Origin Energy Ltd
470	Elengas
471	Northern Land Council
472	NT Worksafe
473	NT Department of Environment and Natural Resources
474	Hancock Prospecting Pty Ltd
475	Bureau of Meteorology
476	Origin Energy Ltd
477	Doctors for the Environment Australia
478	Mr Gerry Wood MLA, Member for Nelson
479	NT Department of Primary Industry and Resources
480	Northern Territory Environment Protection Authority
481	NT Department of Environment and Natural Resources
*482	Australian Government Department of the Environment and Energy
483	Alberta Energy Regulator
484	NT News
485	Mr John Oakley
486	Paul Josif and Associates
487	Ms Carol Randall
488	Ninti One Limited

Submission number	Name or organisation
489	Top End Imports
490	Ms Jean Lewis
491	Engineers Australia Northern Division
492	NT Department of Primary Industry and Resources and NT Department of Environment and Natural Resources
493	Chamber of Commerce Northern Territory
494	Darwin Major Business Group
495	Mr John Wischusen
496	Mr Gerry Wood MLA, Member for Nelson
497	Mr William Probert
498	Mr Sean Ryan
499	Dr Geralyn McCarron
500	Dr Geralyn McCarron
501	Dr Geralyn McCarron
502	Mr Ben May
503	Mr Gerry Wood MLA, Member for Nelson
504	Ms Marcella Louise Hager
505	Central Australia Frack Free Alliance
506	Jemena Limited
507	Ms Kirsten Duncan
508	Dr Geralyn McCarron
509	Mr Paddy Fordham
510	Mr Terry Baldwin
511	Ms Jenny Knight
512	Mr Christopher Hawke
513	Mr Christopher Horne
514	Doctors for the Environment Australia
515	Mr Christopher Hawke
516	Mr Paddy Fordham
517	Dr Geralyn McCarron
518	Mr Tony Hayward-Ryan
519	Australian Nursing and Midwifery Federation
520	Dr Geralyn McCarron
521	Mr Gerry Wood MLA, Member for Nelson
522	Dr Geralyn McCarron
523	Dr Matthew Bolam
524	Ms Rosie Downing
525	Mr Dennis Venning
526	Institute for Energy Economics and Finance
527	Ms Sheena Caddy
528	Katherine Town Council
529	Mr Ray Baney
530	Dr Errol Lawson
531	British Columbia Oil and Gas Commission
532	Dr Bert Herteleer

Submission number	Name or organisation
533	Mr Lance Cramer
534	Australian Government Department of Environment and Energy
535	North Star Pastoral, represented by OzEnvironmental Pty Ltd
536	Darwin Major Business Group
537	Ms Justine Johnson
538	Ms Karen Lewis
539	The Australia Institute
540	AI Group, Jemena Limited, Business Council of Australia
541	Ms Margaret McHugh
542	Mr Russel Killip and Ms Maree Boyle
543	Australian-German Climate and Energy College, University of Melbourne
544	Origin Energy Ltd
545	Mr Alan Johnson
546	Ricky Hall
547	Ms Stephanie Johnson
548	Mr Tim Forcey
549	Prof Peter Dart
550	Mr Neil Smark
551	Ms Jackie Gould
552	Ms Kirsten Robb
553	Ms Janine Sims
554	Ms Tracy Burns
555	Mr Robert Cowan
556	Ms Susanne Devereux
557	Ms Emma Sharp
558	Ms Carol S
559	G C
560	Ms Melissa Crow
561	Kelly Faulkner
562	Ms Teresa Cunningham
563	Ms Annie Rees
564	Ms Nannette Helder
565	Ms Margaret West
566	Mr Paul Greenslade
567	Ms Anne Taylor
568	Ms Tirzah McKee
569	Ms Hilary Furlong
570	Mr Steven Moller
571	Ms Cyndee Gliddon
572	Mr Barry Pringle
573	Ms Merinda Sharp
574	Mr Brian Lewis
575	Ms Bridget Andrews
576	Mr Jason Murphy

Submission number	Name or organisation
577	Ms Anna Cadden
578	Ms Alice Thorn
579	Ms Susan O'Keefe
580	Ms Helen De Campo
581	Ms Rosemary Jacob
582	Ms Sharon Wallent
583	Ms Sue McWhirter
584	Mr Gordon Canning
585	Mr Christopher Brandon
586	Ms Renee Vincent
587	Mr Graham Mantle
588	Ms Ilona Kanaris
589	Mr Richard and Ms Patsy Creswick
590	Ms Fiona Scott
591	Ms Sue D'Arcy
592	Ms Leticia Ashley
593	Mr Harry Jennings
594	Ms Susan Lowry
595	Ms Gypsy Cass
596	Mr Will Steffen
597	Mr Steve Vidler
598	Ms May Briggs
599	Mr Thomas Higgs
600	Ms Catherine Bloomfield
601	Ms Katarzyna Poticka
602	Ms Debbie Boakes
603	Mr Charles Sowden
604	Ms Margaret Bloor
605	Mr William Pullar
606	Ms Michele Grant
607	Mr Geoff Baker
608	Ms Jeananne Baker
609	Ms Lesley Reilly
610	Mr Thomas Whalley
611	Ms Jocelyn Lawry
612	Ms Suzanne Peel
613	Ms Barb Mason
614	Ms Jenny McFarland
615	Mr Greg Chapman and Ms Diana Rickard
616	Ms Lucy Rogers
617	Ms Julie Corbett
618	Ms Yvonne Andrews
619	Mr David Kelly
620	Ms Gillian Thompson

Submission number	Name or organisation
621	Mr Mark Sinclair
622	Dr Geralyn McCarron
623	Australian Petroleum Production and Exploration Association
624	Origin Energy Ltd
625	Imperial Oil and Gas
626	Ms Heidi Jennings
627	The Australia Institute
628	Mr Jasper Vader
629	Santos Ltd
630	Doctors for the Environment Australia
631	Ms Jane Taylor
632	Ms Helen Bender
633	Mr Ian Dunlop
634	Chamber of Commerce Northern Territory
635	Environmental Defenders Office (NT) Inc
636	Ms Mandy Webb
637	Aboriginal Medical Services Alliance Northern Territory
638	The Australia Institute
639	Northern Territory Cattlemen's Association
640	Ms Angela Carpenter
641	Mr Tony Pasons
642	Ms Amanda Jones
643	Oilfield Connect Pty Ltd
644	Mrs Frederika Saltmarsh
645	Hancock Prospecting Pty Ltd
646	Mr Peter Dixon
647	Northern Land Council
648	Mr Paddy Fordham
649	Mr Warwick Morris
650	Climate Action Darwin
651	Ms Billee McGinley
652	Northern Territory Farmers Association Inc
653	Lock the Gate Alliance (NT)
654	Queensland Government Department of Health
655	Mr Darren Boyce
656	Ms Elisabeth Graham
657	Ms Liz Howells
658	Ms Renee Sartori
659	Ms Carmel Sealy
660	Ms Leanne Johnston
661	Emanate Legal
662	Ms Rosemary Sullivan, Cave Creek Station
663	Ms Gai Anderson
664	Mr Andrew Beattie

Submission number	Name or organisation
665	Ms Ana Cussinet
666	Ms Jessica Williams
667	Mr Greg Rogers
668	Mr Gregory Wodetzki
669	Ms Lauren Woodfield
670	Mr Philip Crockford
671	Ms Sharyn Munro
672	Macel Isherwood
673	Coal and CSG Free Mirboo North
674	Ms Marlise Bendel
675	Ms Carolyn Gregurke
676	Ms Bronwyn Schulz
677	Ms Susan Elfert
678	Lesley Boocker
679	Ms Mary Willis
680	Ms Lianne Toohey
681	Mr Andy Cianchi
682	Ms Cindy Ryan
683	Ms Sarah Kendall
684	Mr Ralph Stern
685	Mr Leon Brooks
686	Mr Jayson Crayford
687	Mr David Palmer
688	Mr Garry White
689	Mr Jock Smith
690	Ms Julie Taylor
691	Ms Linda Orgill
692	Mr Dennis Pitchard
693	Ms Audrey Collins
694	Ms Annette Almond
695	Ms Alison Copley
696	Ms Mavis Wright
697	Ania Von Rudzinsky
698	Mr Gareth Cameron
699	Ms Nathalie Grassi
700	Ms Ruth Nielsen
701	Kerry Harrison
702	Mr Bob Robinson
703	Ms MaryBeth Gundrum
704	Ms Sally Moir
705	Ms Lucy Fisher
706	Ms Kellie Fisher
707	Ms Greg Fisher
708	Ms Annabel Fisher

Submission number	Name or organisation
709	Ms Simone Van Hattem
710	Ms Michele Alberth
711	Ms Sienna Jones
712	Mr David Cosgrove
713	Ms Heleen Hoek
714	Ms Grace Field
715	Mr Bastiaan Van Dalen
716	Mr Michael Field
717	Mr Scott Loudoun-Shand
718	Mr Robert Skappel
719	Mr Kieran Hutton
720	Ms Carinne Visschers
721	Mr Rod Green
722	Mr Bruce McQueen
723	Ms June Chin
724	Ms Jennifer Elliot
725	Mr Neil Adsett
726	Mr Greg Strickland
727	Ms Ingrid Srubjan
728	Ms Rebecca Cox
729	Ms Carmel Vandermolen
730	Withdrawn
731	Mr Norman Smith
732	Ms Carla Whitmore
733	Alex Solonec
734	Ms Sharon Clarke
735	Ms Jenny Moore
736	Ms Annette Schneider
737	Ms Diane Pike
738	Ms Bronwyn Grieves
739	Mr Trevor Rhodes
740	Mr Simon Connell
741	Ms Penni Tastula
742	Mr Burl Doble
743	Mr Dennis Nickell
744	Ms Nicole Ross
745	Ms Bronwyn Nash
746	Mr Nick Jones
747	Mr Daniel Wood
748	Mr Peter Stackhouse
749	Ms Jade Rogers
750	Ms Katrin Massmann
751	Ms Rachel Rogers-Whitlock
752	Mr Ken Hardwick

Submission number	Name or organisation
753	Ms Merilyn Cox
754	Ms Simone Young
755	Ms Chantelle Johnson
756	Ms Susan Flavell
757	Ms Anna Denson
758	Ms Thea McDiarmid
759	Mr Thorsten Krause
760	Mr Andre Munckton
761	Ms Hannah Mulholland
762	Ms Lori Martin
763	Ms Lauren Roberts
764	Ms Mandy Rutherford
765	Ms Leonie Norrington
766	Ms Marjorie Janz
767	Mr Henning Hintze
768	Mr Stephen Bellamy
769	Ms Mikaila Mangohig
770	Ms Joyce Maden
771	Ms Angela Parrish
772	Ms Glenda Murrin
773	Ms Judyanne Kent
774	Mr Shane Mitchell
775	Ms Megan Flint
776	Ms Janice McEwen
777	Ms Janelle Sommerville
778	Chris Skinner
779	Ms Tam Tartaglia
780	Ms Lucy Palmer
781	Ms Laura Bachman
782	Ms Amanda La Rosa
783	Ms Heather Pedrotti
784	Mr Steve De Kretser
785	Mr Dan Dunlop
786	Ms Lisa Stefanoff
787	Ms Alison Laherty
788	Mr Jonathan Pilbrow
789	Ms Nicola Rae
790	Ms Janelle Denny
791	Ms Jenny Lynch
792	Ms Karin Traub
793	Ms Kay Buckland
794	Mr Peter Blackadder
795	Ms Erin Caroll
796	Mr Eugene Navarra

Submission number	Name or organisation
797	Ms Alison Hoy
798	Ms Alice Crooman
799	Mr Bruce Hocking
800	Ms Kylie Scott
801	Ms Gabrielle Kaostos
802	Ms Lisa Buchanan
803	Mr Stewart Baillie
804	Ms Leah White
805	Mr James Cohen
806	Mr Jonathon Buckingham
807	Ms Eva Straulino
808	Mr Rob Gib
809	Ms Sheldron Adams
810	Ms Melody Wehipeihana
811	Mr Joel Helmore
812	Ms Elizabeth Cohen
813	Ms Beverley Grant
814	Ms Leanne Pratt
815	Ms Katrina Bryant
816	Ms Emma Chessell
817	Ms Huni Bolliger
818	Mr Richard Stanford
819	Ms Robyn Boyle
820	Ms Renae Kirkham
821	Mr Derek Cooper
822	Ms Kathy Bannister
823	Alex Richmond
824	Mr Rodney Jones
825	Ms Mary Jane Warfield
826	Ms Elizabeth Sangcap
827	S Bartlett
828	Ms Danielle Crosby
829	Ms Wendy Gardner
830	J Cummings
831	Ms Heidi Jennnings
832	Ms Nola Pearmain
833	Ms Sylvia Gregory
834	Mr John Lisle
835	Ms Sandra Bowden
836	Ms Karen Gotts
837	Ms Tania Collins
838	Ms Liz Logan
839	Ms Catherine Reynolds
840	Mr Haydn Whitty

Submission number	Name or organisation
841	Ms Tamara Johnson
842	Shannon Vries
843	Ms Tamara Boehme
844	Mr Andrew Cook
845	Ms Vanessa Spinelli
846	Ms Jasmine Wilkie
847	Ms Deborah Rolfe
848	Ms Lorraine Gibson Napalijari
849	Mr Harry Van Rossum
850	Ms Jill Emerson-Smith
851	Ms Rhonda Bock
852	Ms Sarah Cooper
853	Mr Trevor Bendle
854	Ms Caroline Morrissy
855	Mr Tim Bretten
856	Jo Lucas
857	Mr Duncan Stitfold
858	Shannah Lundon
859	Mr James Bortoli
860	Ms Ruth Gledhill
861	Ms Geraldine Pettig
862	Mr Mitchell Ford
863	Ms Elaine McDonald
864	Ms Helen Philippe
865	Ms Kimberlee Hall
866	Ms Amy I H
867	Ms Jayne Roworth
868	Ms Anne Dowbina
869	Mr Brian Thetford
870	Ms Sheena Caddy
871	Garnet Meldum
872	Ms Dani Stanley
873	Ms Sharon Leach
874	Mr Robert Newland
875	Ms Michelle Leach
876	Ms Fern Davis
877	Ms Sarah Mitchell
878	Cohen Somerville
879	Ms Coral Franklin
880	Mr Mat Field
881	Ms Tabby Fudge
882	Kfir Pronkhorst
883	Mr Russell Craig
884	Mr Zane Billing

Submission number	Name or organisation
885	Sotiris Tzelios
886	Ms Penny Osterhaus
887	Sam Bragg
888	Ms Christina Bawden
889	Mr Gary Lucas
890	Ms Mary Rogers
891	Mr Tom Clarke
892	Mr Doug Corby
893	Ms Katrina Carter
894	Ms Eloise Hutchinson
895	Mr Garth Drake
896	Ms Janine Chambers
897	Ms Bev Dearle
898	Ms Deborah McArthur
899	Ms Anne Handley
900	Mr Mark Paterson
901	Mr Peter Atherton
902	Ms Jodie Dunning
903	Robin Cawthorn
904	Mr John Kelly
905	Ms Jill Mumme
906	Ms Angela Pattison
907	Ms Julie Walton
908	Valentine Flood
909	Ms Beverley Hollins
910	Mr Bryan Jordan
911	Ms Tess McGilp
912	Ms Carolyn Masel
913	Ms Ingrid Schreiner
914	Ms Tara Bouwman
915	Ms Kerri Darby
916	Ms Melissa Bolliger
917	Kahla Maclean
918	Mr Rene Ventura
919	Mr Des Gellert
920	Ms Pamela Dawes
921	Ms Katalina Mindszenty
922	Ms Noeletta McKenzie
923	Ms Kristin Volkmer
924	Ms Sharron Wallace
925	Mr Tony Gintz
926	Ms Margaret Genever
927	Hel Reynolds
928	Ms Ronda Gawley

Submission number	Name or organisation
929	Mr Donovan Fantasia
930	Mr Shaun Spain
931	Mr Phill Robinson
932	Mr Keith Bale
933	Ms Dee Taminiau
934	Mr Jean-Claude Nemorin
935	Ms Vicki Hariss
936	Ms Gia Holman
937	Mr Colin Lawson
938	Ms Chelsie Davies
939	Ms Sue Farnall
940	L P
941	Ms Rowena Salmon
942	Ms Coleen Brown
943	Ms Felicity Cahill
944	Ms Rebecca Humphreys
945	Mr Norman Looker
946	Mr Matt Tierney
947	Dom Ryan
948	Ms Isabella Pagnozzi
949	Ms Jodie Duncan
950	Ms Chelsea Zaicew
951	Ms Alice Scheid
952	Ms Brontie Zaicew
953	Ms Gabrielle Zaicew
954	Mr Nick Collins
955	Ms Vicki Cameron
956	Ms Leanne Groen
957	Mr Zachary Zaicew
958	Ms Alexandra Zaicew
959	Mr Greg Dunn
960	Ms Linda Maxwell
961	Ms Patricia Kahler
962	Mr Craig Andrews
963	Mr William Kennedy
964	Ms Helen Taylor
965	Sam Stockdale
966	Mr Clarence Oliver
967	Mr John Pengilly
968	Leigh Furner
969	Ms Adrienne Rowell
970	Mr Daryl Little
971	Milyika Scales
972	Ms Rachel Allen

Submission number	Name or organisation
973	Ms Beatrice Dodd
974	Mr Bruce Cowell
975	Nerys Lewis
976	Ms Jade Morris
977	Ms Katelijn Hullegie
978	Ms Angela Pattison
979	Ms Rachael Pickering
980	Ms Katia Falco
981	Ms Jackie McCormack
982	Ms Nicole Mutimer
983	Ms Tanja Hawker
984	Ms Jan van der Bij
985	Ms Alisha Mercer
986	Ms Dannielle Townsend
987	Ms Ann Walsh
988	Ms Marie Rancon
989	Ms Carolyn Pickering
990	Lesley Agar
991	Ms Sarina Kelly
992	Ms Sylvia Ashcroft
993	Ms Karen Schoen
994	Ms Carolena Grayson
995	Sollai Cartwright
996	Mr Bill Newell
997	Mr Clayton Ellis
998	Ms Jennifer Clark
999	Ms Janine Schneider
1000	Ms Rosie Paijmans
1001	Mr Maurice Nicholson
1002	Ms Helen Kvelde
1003	Mr Mark Rich
1004	Mr Graham Kirby
1005	Ms Kaye Greenhalgh
1006	Ms Katherine Crawshaw
1007	Ms Chelsea Herman
1008	Ms Deborah Hall
1009	Ms Amanda Amenta
1010	Mr Wade Benn
1011	Eytan Lenko
1012	Ms Karlene Beahan
1013	Ms Tanya Saltau
1014	Ms Gabrielle Conescu
1015	Ms Kathleen Powell
1016	Ms Carolyn Hampson

Submission number	Name or organisation
1017	Ms Jayne Craig
1018	Ms Teresa Woodland
1019	Mr Martin Oliver
1020	Leigh Webber
1021	Ms Rosemary Sargeant
1022	Ms Judith Lay
1023	Ms Estelle Gilmore
1024	Ms Gael Nash
1025	Ms Sue Kruger
1026	Ms Audrey McLean
1027	Ms Jill Fowler
1028	Ms Andrea Jones
1029	Ms Louise Harrison
1030	Sandy May
1031	Ms Melanie Barker
1032	Ms Shez Donald
1033	Ms Veronica Webber
1034	Ms Kathy Donnelly
1035	Ms Anastasia Arbis
1036	Ms Maureen Sladdin
1037	Ms Marlene Schmidt
1038	Ms Jasmina Avdic-Sahovic
1039	Ms Julie Droguett
1040	Ms Glen Durrington
1041	Kym Turnbull
1042	Ms Roz Poulton
1043	Ms Marilyn Schroeder
1044	Chris Jobe
1045	Ms Valerie Elliot
1046	Mr Michael Crowe
1047	Kelley Chapman
1048	Ms Jenelle Saunders
1049	Ms Andrea H
1050	Ms Mary McDonald
1051	Ms Lyn Bayfield
1052	Ms Deborah Sharp
1053	Mr Troy Martin
1054	Ms Jan Archibald
1055	Ms Lyn Muller
1056	Mr Adrian Pearce
1057	Dallas Mckeown
1058	Candida van Rood
1059	Ms Geraldine Milton
1060	Ms Adelaide Torrens

Submission number	Name or organisation
1061	Mr Fergus Lefebvre
1062	Ms Heather Cooper
1063	Ms Maureen Simpson
1064	Ms Fay Bannah
1065	Ms Catrine Sjaardema
1066	Ms Charissa Broad
1067	Mr Geoff McNamara
1068	Ms Lola Farkas
1069	Mr Gerald Harris
1070	Ms Ellen O'Gallagher
1071	Ms Clare Brereton
1072	Ms Lyndall Fuller
1073	Ms Lyn Stannard
1074	Lock the Gate Alliance (NT)
1075	Lock the Gate Alliance (NT) and Origin Energy Ltd
1076	Ms Margaret Pritchard
1077	Ms Helen Pendlebury
1078	Ms Mandy Johns
1079	Ms Di & Mr Stefan Koser
1080	Ms Ben Tyler
1081	Ms Chantal Ross
1082	Ms Ellen Pocock
1083	Mr Gerhard Weihermann
1084	Mr James Rooney
1085	Ms Janette Carter
1086	Ms Kathy Bannister
1087	Ms Kristina Hewer
1088	Ms Linda Booth
1089	Ms Lisa Peters
1090	Ms Louise Brown
1091	Ms Lyn Jones
1092	Ms Casey Townsend
1093	Mr Graeme Parsons
1094	Ms Carol Phayer
1095	Min Gaulai
1096	Ms Danielle Scott
1097	Ms Mandy Hall
1098	Ms Robyn Bacon
1099	Ms Sue Clarke
1100	Ms Tess Wallace
1101	Ms Rhanii Lee
1102	Ms Ema Trnka
1103	Ms Justine Johnson
1104	Mr Lloyd Beck

Submission number	Name or organisation
1105	Mr Antonio Cusati
1106	Ms Sharon Scurr
1107	Ms Emma Burkitt
1108	Ms Marianne Haverkort
1109	Ms Ryleigh Hunt
1110	Mr Josh McShanag
1111	Ms Venessa Porter
1112	Ms Joanne Kaissis
1113	Mr Ray Sheppard
1114	Mr Michael Kelly
1115	Ms Rose Baartz
1116	Kym Rodell
1117	Ms Jessica Fletcher
1118	Ms Elizabeth Case
1119	Mr David Hood
1120	Ms Liz Togni
1121	Ms Jade Boakes
1122	Ms Penni Tastula
1123	Ms Leonie Chester
1124	Lock Barker
1125	Ms Kate Irwin
1126	Ms Learne Enson
1127	Ms Laura M
1128	Mr Raymond Johnston
1129	Ms Laura Roser
1130	Linda Sayers
1131	Ms JoAnne Scott
1132	Ms Lia Gill
1133	Northern Territory Greens
1134	Ms Kate Rogers
1135	Ms Michelle Brown
1136	Shilo McNamee
1137	Ms Faith Taylore
1138	Ms Lana Howitt
1139	Ms Melanie Reid
1140	Mr Phil O'Brien
1141	Mr Mark Sammy
1142	Mr Mark Head
1143	Mr Jeremy Garnett
1144	Ms Annette Ranynor
1145	Mr Jason Trevers
1146	Ms Laura Robertson
1147	Pangaea Resources Pty Ltd
1148	Withdrawn

Submission number	Name or organisation
1149	Dr Errol Lawson
1150	Aboriginal Areas Protection Authority
1151	Central Land Council
1152	Ms Pauline Cass
1153	Ms Janette Hintze
1154	Mr Sean Ryan
1155	Mr Kim Wilson
1156	Ms Patsy Hickey
1157	Ms Justine Johnson
1158	Ms Barbara Molanus, Dianna Newham, Ella Newham-Perry
1159	Climate Action Darwin
1160	Jean McDonald
1161	Mr Jason Trevers
1162	Ms Pauline Cass
1163	Imperial Oil and Gas
1164	Oilfield Connect Pty Ltd
1165	Jemena Limited
1166	Mr Denis Coburn
1167	Bores NT Pty Ltd
1168	Imperial Oil and Gas
1169	Dr Wayne Somerville
1170	Dr Wayne Somerville
1171	Ms Pauline Cass
1172	Ms Lia Gill
1173	Ms Katherine Marchment
1174	Ms Julian Schuller
1175	Ms Jo Vandermark
1176	Ms Andrea Finn
1177	Environment Centre Northern Territory
1178	Australian Petroleum Production and Exploration Association
1179	Health Professionals Against Fracking
1180	Doctors for the Environment Australia
1181	Seed Indigenous Youth Climate Network
1182	Aboriginal Medical Services Alliance Northern Territory
1183	Imperial Oil and Gas
1184	United Voice Northern Territory Branch
1185	Ms Julian Schuller
1186	Ms Andrea Finn
1187	Origin Energy Ltd
1188	Ms Carolyn Carttling
1189	Ms Lia Gill
1190	Mr Sean Ryan
1191	Department of Primary Industry and Resources
1192	Ms Jo Vandermark

Submission number	Name or organisation
1193	The Australia Institute
1194	1 Territory Party
1195	Ms Heidi Jennings
1196	Ms Louise Becker
1197	Ms Justine Johnson
1198	Santos Ltd
1199	Northern Territory Cattlemen's Association
1200	Ms Billee McGinley
1201	Ms Rachel Tumminello
1202	Amateur Fishermen's Association of the Northern Territory
1203	Northern Territory Cattlemen's Association
1204	Mr Andrew Arthur
1205	Climate Action Darwin
1206	Mr Justin Tutty
1207	Environment Centre Northern Territory
1208	Australian Petroleum Production and Exploration Association
1209	Northern Territory Greens
1210	Northern Territory Farmers Association Inc
1211	Mr Dean Geoffrey
1212	Ms Janette Hintze
1213	Ms Katherine Marchment
1214	Mr Daniel Tapp
1215	Dr Errol Lawson
1216	Ms June Tapp
1217	Ms Annette Raynor
1218	North Australian Rural Management Consultants Pty Ltd
1219	Dr Samantha Phelan
1220	Ms Heather McIntyre
1221	Central Australia Frack Free Alliance
1222	Mr Ned Jampijinpa Hargraves
1223	Mr Jason Trevers
1224	Doctors for the Environment Australia
1225	Health Professionals Against Fracking
1226	Arid Lands Environment Centre Inc
1227	Dianna Newham and Ella Newhan-Perry
1228	Ms Laura Robertson
1229	Ms Vicki Gordon
1230	Mr Peter Dixon
1231	Seed Indigenous Youth Climate Network
1232	Territory Frack Free Alliance
1233	Lock the Gate Alliance (NT)
1234	Mr Luke Playford
1235	Gas Energy Worldwide
1236	Ms Alisha Mercer

Submission number	Name or organisation
1237	Ms Annemarie
1238	MS Contracting
1239	Mr Christopher Hawke
1240	Que Kenny
1241	Mr Richard Creswick
1242	Australian Government Department of Environment and Energy
1243	Ms Shirley Crane
1244	Associate Professor Tim Cohen, University of Woollongong
1245	Mrs Frederika Saltmarsh
1246	Gasfield Free Communities
1247	Dr Geralyn McCarron
1248	Origin Energy Ltd
1249	Santos Ltd
1250	Lock the Gate Alliance (NT)
1251	Australian Petroleum Production and Exploration Association Submission
1252	The Australia Institute
1253	Territory Frack Free Alliance
1254	The Environment Centre Northern Territory
1255	Katherine Mining Services Association
1256	Mr Peter Jolly
1257	1 Territory Party
1258	Ms Lia Gill
1259	Mr Oliver Crowder
1260	Dr Samantha Phelan
1261	Mr Stuart McGill
1262	Ms Billee McGinley
1263	Ms Sonya McKay
1264	Northern Australian Rural Management Consultants Pty Ltd
1265	Barkly Regional Council
1266	Ms Margaret Clinch
1267	Ms Margaret Cotter
1268	Ms Max Bowden
1269	Origin Energy Ltd

Submissions containing confidential information

Submission number	Name or organisation	
* 279	Pangaea Resources Pty Ltd	Appendices 1, 3 and 6 are commercial-in-confidence
* 281	NT Department of Primary Industry and Resources	Attachments are confidential under s 61 of the *Petroleum Act 1984* (NT)
* 283	Origin Energy Ltd	Attachment is partially redacted and considered commercial in confidence
* 284	Origin Energy Ltd	Attachment does not meet the level of reporting certainty required by the ASX
* 295	NT Department of Primary Industry and Resources	Attachment C is confidential due to the non-disclosure of environmental security bonds
* 424	NT Department of Primary Industry and Resources	Attachment D is confidential under s 61 of the *Petroleum Act 1984* (NT)
* 449	NT Department of Environment and Natural Resources	Submission provided in confidence (content not yet publicly available. Awaiting publication)
* 482	Australian Government Department of the Environment and Energy	Submission provided in confidence (content not yet publicly available).

Appendix 13 Table of correspondence requesting further information

*confidential submission (see Appendix 12)

Date	Recipient	Details	Submission reference
28 April 2017	Origin Energy Ltd	Request for data in relation to petroleum resources, water use and land access and disturbance.	272
28 April 2017	Pangaea Resources Pty Ltd	Request for data in relation to petroleum resources, water use and land access and disturbance.	*279
28 April 2017	Santos Ltd	Request for data in relation to petroleum resources, water use and land access and disturbance.	232
28 April 2017	Schlumberger Australia Pty Ltd	Request for data in relation to water use and chemical toxicity.	231
28 April 2017	NT Department of Environment and Natural Resources	Request for data in relation to water resources and ecosystems.	224
28 April 2017	NT Department of Tourism and Culture	Request for data in relation to tourism areas, cultural sites, recreational sites and national parks.	No formal response submitted.
28 April 2017	NT Department of Primary Industry and Resources	Request for data in relation to petroleum resources and water use.	*281
28 April 2017	Halliburton Australia Pty Ltd	Request for data in relation to water use and chemical toxicity.	274
22 May 2017	NT Department of Environment and Natural Resources	Request for data in relation to water resources.	271
24 May 2017	NT Department of Environment and Natural Resources	Request for data in relation to water resources.	278
26 May 2017	Origin Energy Ltd	Request for information in relation to fluid ecotoxicity.	Addressed in Submission 272.
26 May 2017	Santos Ltd	Request for information in relation to fluid ecotoxicity.	280
7 June 2017	Senator the Hon. Nigel Scullion	Request for information in relation to Amendments to Pt IV of the *Aboriginal Land Rights (Northern Territory)* Act 1976 (Cth).	No response received.
13 June 2017	Department of Primary Industry and Resources	Request for information in relation to environmental rehabilitation securities.	*295
6 July 2017	Department of Primary Industry and Resources	Request for information in relation to the management of weeds on and around petroleum exploration permits.	419
6 July 2017	Department of Environment and Natural Resources	Request for information in relation to the management of weeds on and around petroleum exploration permits.	419
25 July 2017	Arid Lands Environment Centre Inc	Request for information on greenhouse gas emissions and methane emissions.	No written response received. But see submission 353.
25 July 2017	Australian Petroleum Production and Exploration Association	Request for information regarding issues identified in the Interim Report: 1. flowback and produced water; 2. spills; 3. deep groundwater systems; 4. solid waste management; 5. health assessment; 6. traffic; and 7. greenhouse gas emissions.	421

Date	Recipient	Details	Submission reference
25 July 2017	The Australia Institute	Request for information on greenhouse gas emissions and methane emissions.	No response received.
25 July 2017	Climate Action Darwin	Request for information on greenhouse gas emissions and methane emissions.	No written response received. But see submission 446.
25 July 2017	Environment Centre Northern Territory	Request for information on greenhouse gas emissions and methane emissions.	No written response received. But see submission 370.
25 July 2017	Environmental Defenders Office (NT) Inc	Request for information on greenhouse gas emissions and methane emissions.	See submission 456.
25 July 2017	Northern Territory Environment Protection Authority	Request for information on greenhouse gas emissions and methane emissions.	417
25 July 2017	Imperial Oil and Gas Pty Ltd	Request for information on flow back and produced water, spills, deep groundwater systems, solid waste management, health assessment and greenhouse gas emissions.	No written response received. But see submission 408.
25 July 2017	Lock the Gate Alliance (NT)	Request for information on well integrity and greenhouse gas emissions.	See submissions 370 and 437.
25 July 2017	Origin Energy Ltd	Request for information regarding: 1. flooding; 2. well integrity; 3. flowback and produced water; 4. spills; 5. deep groundwater systems; 6. solid waste management; 7. health assessment; 8. infrastructure requirements; 9. baseline data; 10. traffic; 11. greenhouse gas emissions; and 12. comments on Section 9.8 of the Interim Report regarding Preliminary Risk Assessment.	433
25 July 2017	Pangaea Resources Pty Ltd	Request for information on greenhouse gas emissions, and methane emissions.	427
25 July 2017	Santos Ltd	Request for information on greenhouse gas emissions and methane emissions.	420
25 July 2017	Schlumberger Australia Pty Ltd	Request for information on well integrity, flowback and produced water, spills, solid waste management, health assessment, and greenhouse gas emissions.	See submissions 460 and 464
31 July 2017	Commonwealth Scientific and Industrial Research Organisation	Request for information on greenhouse gas emissions and methane emissions.	450
1 August 2017	NT Department of Primary Industry and Resources	Request for information regarding further input regarding the below matters: 1. well integrity; 2. flowback and produced water; 3. solid waste management; 4. infrastructure requirements; 5. disposal of wastewater into aquifers; 6. storage; 7. discharge into waterways; 8. Amungee well data; 9. greenhouse gas emissions; 10. minimum standards; 11. regulatory capture; 12. cost recovery; 13. compensation; and 14. strategic development.	*424

Date	Recipient	Details	Submission reference
2 August 2017	Consolidated Pastoral Company Pty Ltd	Request for information regarding claims made by Lock the Gate Alliance (NT) that there were water studies around the Beetaloo Sub-basin commissioned.	418
2 August 2017	Geoscience Australia	Request for information regarding: 1. future development of each basin; 2. groundwater studies; and 3. recharge rates of the Tindall limestone aquifer.	414
2 August 2017	Australian Government Department of Industry, Innovation and Science	Request for information regarding the objectives of the Royalty Return Scheme.	459
8 August 2017	NT Department of Environment and Natural Resources	Request for information regarding the Department of Environment and Natural Resources *Environmental Regulatory Reform Discussion Paper.*	*449
11 August 2017	Australian Government Department of the Environment and Energy	Request for information on greenhouse gas emissions and methane emissions.	445
14 August 2017	Commonwealth Scientific and Industrial Research Organisation	Request for information regarding research being undertaken by GISERA on groundwater in the Hutton Sandstone aquifer in the Surat Basin.	451
18 August 2017	Commonwealth Scientific and Industrial Research Organisation	Request for information regarding groundwater dependent ecosystems.	452
18 August 2017	NT Department of Environment and Natural Resources	Request for information regarding flow rate estimates.	429
31 August 2017	Australian Government Department of the Environment and Energy	Request for research commissioned in relation to chemicals used in hydraulic fracturing.	*482
11 September 2017	NT Department of Environment and Natural Resources	Request for information regarding surface spills and groundwater contamination, and oxygen.	481
13 September 2017	Alberta Energy Regulator	Request to discuss the Alberta Energy Regulator's experience with shale gas development and understanding of the regulatory framework within which the regulator operates and which governs onshore shale gas development in Alberta.	483
19 September 2017	NT Department of Environment and Natural Resources	Request for an indicative Fire Management Zone Risk and Hazard Map and to provide the outcomes of public consultation administered by Bushfires NT regarding changed fire regimes in the NT.	473
20 September 2017	Northern Territory Environment Protection Authority	Request for information regarding the regulatory framework for the management of spills of chemicals and wastewater associated with hydraulic fracturing.	480
20 September 2017	NT Department of Primary Industry and Resources	Request for information regarding the regulatory framework for the management of spills of chemicals and wastewater associated with hydraulic fracturing.	492
20 September 2017	NT Department of Environment and Natural Resources	Request for information regarding the regulatory framework for the management of spills of chemicals and wastewater associated with hydraulic fracturing.	492
20 September 2017	NT Worksafe	Request for information regarding the regulatory framework for the management of spills of chemicals and wastewater associated with hydraulic fracturing.	472
20 September 2017	Hancock Prospecting Pty Ltd	Request for information related to buffer zones regarding Exploration Permit 154 and evidence of compliance with regulation and no significant environmental incidents indicated in a submission to the Inquiry.	474

Date	Recipient	Details	Submission reference
22 September 2017	NT News	Request for information regarding associated research gathered from the MediaReach poll referenced in the NT News article *Fracking to Divide Territory Labor* published 31 August 2017.	484
24 October 2017	BC Oil and Gas Commission	Request for information in relation to the regulation of the onshore unconventional gas industry in British Columbia.	Response received. Submission 531 was a result of the correspond-ence.
24 January 2018	Queensland Government Department of Health	Allegations of adverse health effects associated with CSG operations in south east Queensland.	654
29 January 2018	Australian Government Department of the Environment and Energy	The estimated total fugitive emissions rate of methane and carbon dioxide for Australia.	1242
22 February 2018	Department of Primary Industry and Resources	Request for information regarding allegations of leaky and failed wells in the Beetaloo Sub-basin.	1191
22 February 2018	Origin Energy	Request for high-resolution image on the Amungee NW-1H schematic cross-section.	1269

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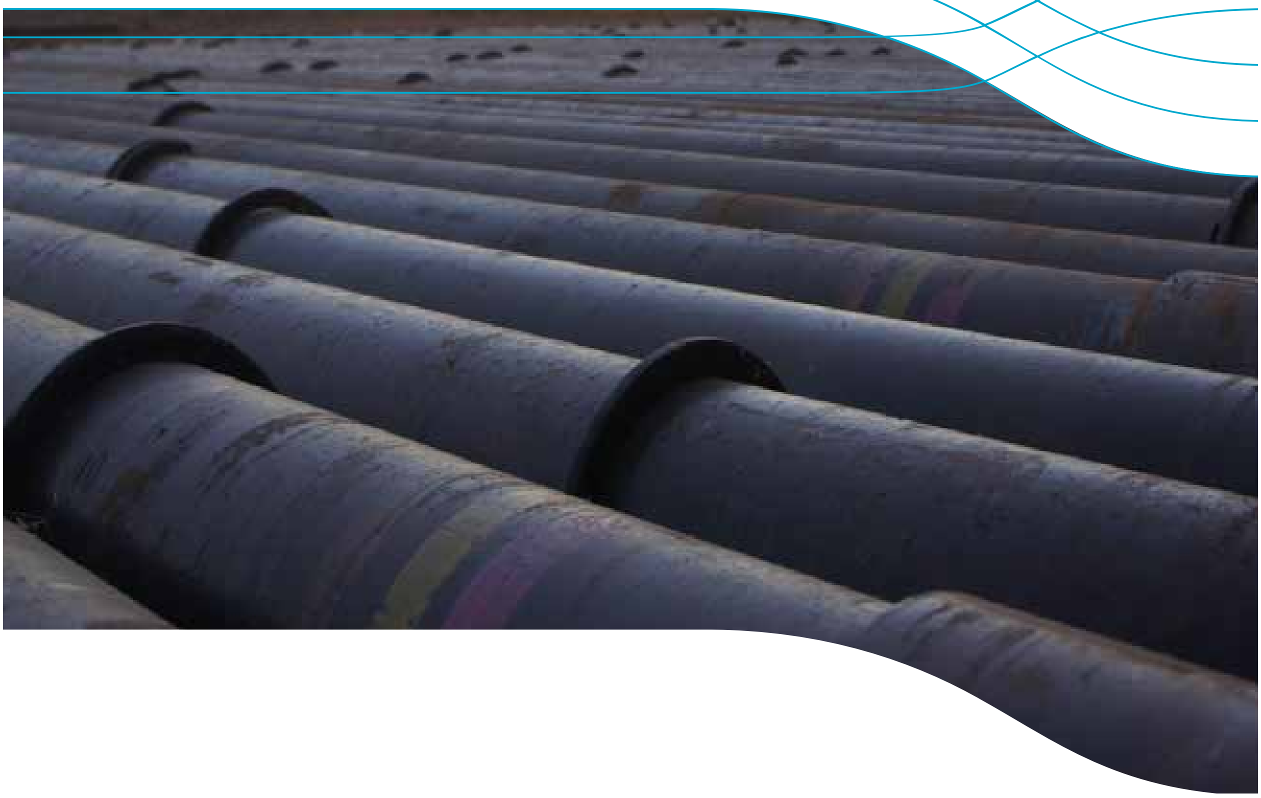
Report into
The shale gas well life cycle and well integrity

Prepared for the Northern Territory Hydraulic Fracturing Inquiry

Cameron Huddlestone-Holmes, Bailin Wu, James Kear and Raman Pandurangan
EP179028
December 2017



Citation

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Important disclaimer

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Acknowledgments

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We acknowledge the Northern Territory Hydraulic Fracturing Inquiry for commissioning this work.

Executive summary

Shale gas resources are attracting increased attention globally, given their potential as an energy resource. The Northern Territory holds significant shale gas resource potential and, to date, these resources have seen only limited exploration. In December 2016, the Northern Territory Government established the Northern Territory Hydraulic Fracturing Inquiry (**the Inquiry**), an independent scientific inquiry to investigate the environmental, social and economic risks and impacts of hydraulic fracturing of onshore unconventional gas reservoirs and associated activities in the Northern Territory. This report has been prepared for the Inquiry, to provide an overview of the drilling and hydraulic fracturing process employed in the development of shale gas resources. It has a focus on well integrity and the potential for impacts related to well integrity.

This report is based on a review of the literature on well integrity issues and well integrity failure rates for oil and gas wells. The available literature specific to shale gas well integrity failure rates is not extensive; however, the well construction and operation methods used in other oil and gas developments provide an indicator of potential well integrity issues in shale gas development. The well integrity hazards for any shale development will depend on the characteristics of the resource.

The report first provides an overview of concepts around well integrity, and an overview of the drilling life cycle from design to construction, operation and subsequent abandonment, and the associated hydraulic fracturing processes. It then discusses well integrity in more detail, with a review of the potential mechanisms for well integrity issues and the rates of well integrity failure as reported in the literature. Potential pathways for hydraulic fracturing to cause subsurface contamination and to affect well integrity are also discussed. The report outlines the regulatory regime that applies to well integrity and hydraulic fracturing in the Northern Territory, and summarises the regulations in other Australian jurisdictions. It concludes with policy options for managing well integrity risks in the Northern Territory.

Well integrity is the quality of a well that prevents the unintended flow of fluid (gas, oil or water) into or out of the well, to the surface or between rock layers in the subsurface. Well integrity is established through the use of barriers that prevent these unintended fluid flows. For shale gas wells, a two-barrier principle is applied, in which at least two independent and verified barriers are in place. Only if both barriers fail will there be a well integrity failure that results in unintended or uncontrolled fluid flow.

The key findings of this study are as follows:

- Well integrity in shale gas wells is a risk that needs active management throughout the well life cycle for the safe, efficient and environmentally sustainable operation of wells.
- The scale of the risk depends on the characteristics of the resource being developed, as for other types of oil and gas wells (shale gas wells are a subcategory of oil and gas well).
- The low permeability and limited overpressures in shale gas resources mean that they are likely to have lower well integrity risks than conventional resources, and this is supported by the limited amount of data available.
- The most plausible pathway for environmental impact over the life of a well is by migration of methane gas up the outside of the well, caused by a loss of integrity of the bond between cement and casing or cement and formation. The rates of gas leakage on a per well basis are likely to be small; however, the cumulative flux of gas from a large number of wells may be significant in terms of greenhouse gas emissions.

- The residual risk is low when risks are actively managed using current leading industry practice based on hazard identification, risk assessment and risk management.

Other findings of this study are as follows:

- Industry and regulators have a focus on maintaining well integrity, and the industry follows several international standards on well integrity management.
- Current leading practice involves the use of well integrity management systems to manage integrity risks across the well life cycle.
- The two-barrier principle is critical to maintaining good well integrity and is standard practice in the industry.
- Gas migration along the outside of the well does not necessarily indicate the movement of other fluids. Methane migration is driven by buoyancy, whereas migration of fluids will require pressure gradients to drive fluid flow.
- Plausible pathways for hydraulic fracturing operations (as opposed to during the rest of the well life cycle) to lead to contamination of shallow aquifers are primarily through impacts on well integrity that may contribute to the migration of fluid along the outside of the well. Casing failures during hydraulic fracturing activities are also plausible, although there is a low likelihood of this occurring in wells that have been properly engineered.
- Catastrophic well integrity failures during shale gas drilling operations are unlikely in a shale gas development because of the low permeability and limited overpressures in shale resources.
- Baseline studies to characterise the environment before shale gas activities commence in an area will provide important data to assist in any future evaluation of possible environmental impacts.
- There has been limited development of onshore gas resources in the Northern Territory; therefore, there is currently a lack of data for well integrity hazard identification and risk assessment. To reduce well integrity risks, it may be useful to have a basin-wide approach to identifying hazards and effective risk management approaches, with collaboration between operators, regulators and other stakeholders, should an onshore gas industry develop. This approach may assist in providing the broader community with transparency about the process for managing well integrity.
- In the Commonwealth, South Australia and Western Australia, the regulations related to well integrity for offshore wells are objective based, and use the 'as low as reasonable practical' principle for managing well integrity risks. These jurisdictions have no or limited prescriptive requirements around well construction, although they do have guidelines for well integrity assessment.
- Codes of practice for coal seam gas well construction and abandonment are mandated in New South Wales and Queensland. Queensland also has a code of practice for other petroleum wells. The establishment of a code of practice or guidelines in the Northern Territory will need to balance a prescriptive approach with the ability to adapt as risks are understood and new technologies become available.
- The long-term integrity of shale wells that have been abandoned using current industry practices is not well covered in the literature. The main risk for abandoned wells is gas migration along the outside of the casing. Gas leakage on a per well basis is likely to be small, but the cumulative flux of gas from a large number of wells may be significant in terms of greenhouse gas emissions. Understanding the risks associated with abandoned wells within the context of the Northern Territory's shale gas resources could lead to the establishment of leading practices, should an onshore gas industry develop.

1 Introduction

This report has been prepared for the Northern Territory Hydraulic Fracturing Inquiry (**the Inquiry**) to provide an overview of the drilling and hydraulic fracturing process employed in the development of shale gas resources. It has a focus on **well integrity**[1] and the potential for **impacts** related to well integrity. During exploration, wells provide access to allow the resource to be characterised, and during production they provide a means for gas to be brought to the surface. As the interface to the subsurface environment, wells are also a possible pathway for unintended release of fluids to the environment, and concerns have been raised about well integrity.[2] Hydraulic fracturing is necessary to allow economic production rates from shale gas resources, because of the low permeability of these resources. The potential for impacts on shallow aquifers from the migration of **hydraulic fracturing fluids** has also been raised as a concern.[3]

The drilling and hydraulic fracturing technologies used in shale gas projects have evolved from those used for conventional petroleum resources, with a great deal of innovation over the past two decades.[4] Drilling for shale gas now typically involves the drilling of multiple wells from a single-well pad, with horizontal extensions increasing the exposure to the target shale formation.[5] To produce shale gas, multiple hydraulic fractures are placed along the horizontal section of the well. The most common hydraulic fracture design in shale gas wells in the United States uses water-based hydraulic fracturing fluids pumped at a high flow rate.[6] The adoption of this technology has been important in the rapid growth of shale gas and oil production in the United States.[7]

This report first provides an overview of some of the key concepts around well integrity, and of drilling and hydraulic fracturing processes. It then discusses well integrity in more detail, with a review of the potential mechanisms for well integrity issues and the rates of well integrity failure that have been reported in the literature. It also discusses potential pathways for hydraulic fracturing that lead to subsurface contamination. The regulatory regime that applies to well integrity and hydraulic fracturing in the Northern Territory is outlined, together with a summary of regulations in other Australian jurisdictions. The report concludes with a summary of the issues and policy options for managing **risks** related to well integrity.

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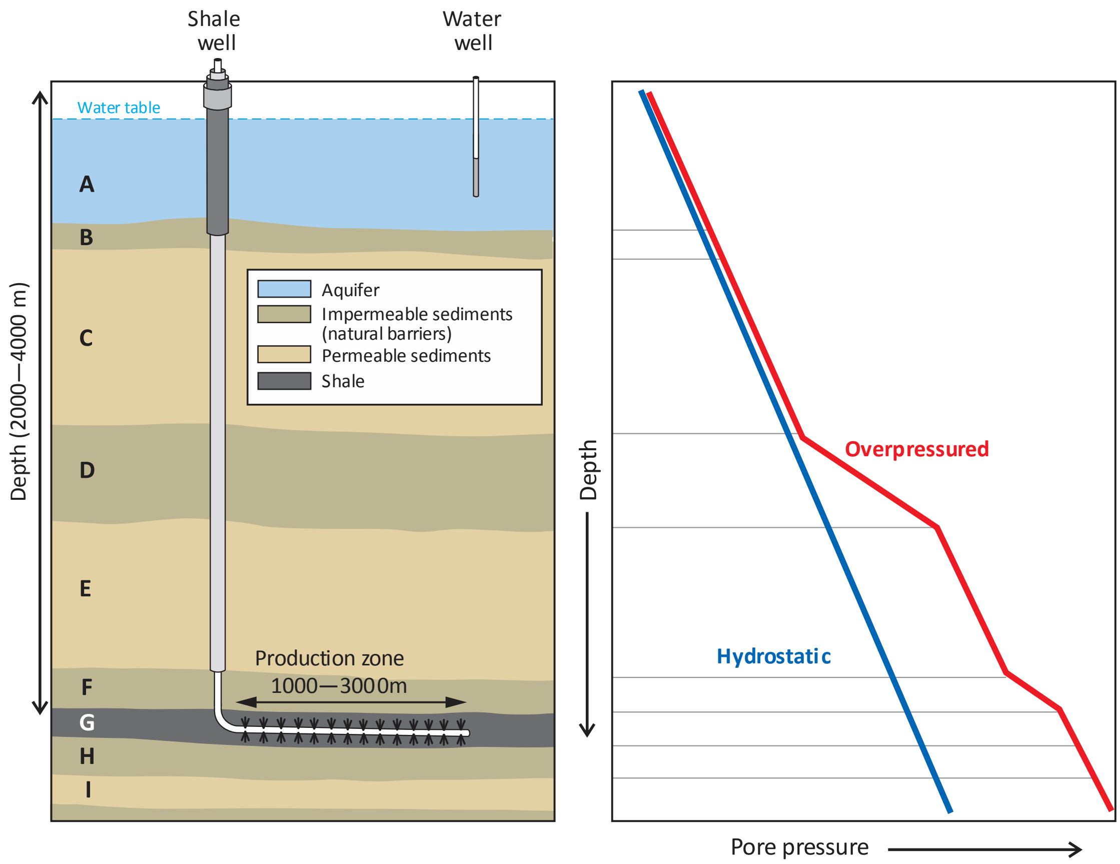
[1] Terms given in bold in the text are included in the Glossary
[2] Davies et al. 2014; Ingraffea et al. 2014; Jackson 2014.
[3] US EPA Report. Chapter 6.
[4] Golden and Wiseman 2015. p968-974.
[5] Cook et al. 2013. p54-56
[6] Gallegos et al. 2015.
[7] Cook et al. 2013; Golden and Wiseman 2015.

2 Why is well integrity important?

Concerns around well integrity are often raised in regard to shale gas developments. These concerns relate to the potential for the unintended flow of fluid out of, or into, the well, between layers of rock or to the surface via the well. To understand well integrity, it is important to consider how fluids and gases move in the subsurface. **Figure 1** shows a simplified shale gas resource, consisting of the shale layer at the base, with overlying layers of various sedimentary rocks referred to as the **overburden.** This overburden will include layers of different **permeability**; broadly the layers can be classified as permeable (which allow fluid to flow through them) or impermeable (which form a barrier to fluid movement). Some of the permeable layers may be **aquifers**, containing water that is used for agriculture or domestic purposes, whereas others may contain salty water. Hydrocarbons (oil or gas) may also be present in some rock layers.

Figure 1: Simplified shale gas resource. Rock layers A-F are overburden that cover the shale resource (layer G). The graph on the right shows the pore pressures in the rock; the gradient in blue is the hydrostatic gradient. The gradient in red shows the pore pressures in an overpressured scenario, with layers D and F trapping higher pressures below them. Not to scale**.**



Subsurface vertical water flow

The pressure of the fluids in the rock is called the **pore pressure**, and at hydrostatic pressure, the pore pressure is equal to the weight of the column of fluid above it. The pore pressure increases with depth, as it does in any body of water. When water in rock layers is at hydrostatic pressure, there is no driving force for the water to flow vertically.

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In some geological settings, the pore pressure is higher than the hydrostatic pressure. These **overpressures** can occur when there is an increase in the amount of fluid or gas in the rock, or when there are changes to the rock such that the amount of pore space is reduced. If the fluid cannot escape, the result is an increase in pore pressure. Overpressures can only occur where there are impermeable layers preventing the vertical flow of water, otherwise the water would flow upwards to equalise back to hydrostatic pressure. In **Figure 1**, layer A contains an aquifer that is connected to the surface. Overpressures cannot form in this layer because the pressure can escape at the surface. The pore pressures in layer E are overpressured, as shown in the graph in **Figure 1**, but the fluid and pressures are held in place by layer D, which is impermeable.

If a well is drilled into a water-bearing layer that is at hydrostatic pressure (layers A, B and C in **Figure 1**), water would only flow up the well with the aid of a pump. This scenario is analogous to drinking a glass of water through a straw – suction has to be applied. If a well is drilled into an overpressured layer (layer E in **Figure 1**), the water will flow up the well unassisted. A common example of this scenario is the artesian water wells drilled into the Great Artesian Basin.

Fluids will not move in the subsurface unless there is a driving force, so an overpressure zone would be required for a fluid to move unassisted vertically up the well.

Subsurface vertical gas flow

Natural gas is predominantly methane, and has a much lower density than water; this buoyancy will drive natural gas to move upwards through the rock unless there is an impermeable barrier in place. Gas resources can only exist if the gas is trapped in the subsurface, otherwise it would have leaked out through geological time. To extract the gas, a well must be drilled to provide a pathway for the gas to flow to the surface. Gas can flow under its own buoyancy, and any overpressure will increase the rate of flow.

Rate of fluid and gas flow

The rate at which fluids or gas move in the subsurface is affected by the size of the flow pathway. The larger the pathway, the greater the rate of flow for a given driving force (overpressure or buoyancy). Friction and surface roughness of the pathway reduce the flow rate; therefore, fluid and gas flow rate will be lower over longer pathways. Another factor is the size of the **reservoir** of fluid or gas, and the permeability within that reservoir. For example, the Great Artesian Basin is a large reservoir with high permeability, and wells drilled into this reservoir have had artesian flows for decades. In contrast, in a small reservoir, the pressures would be quickly depleted and flows would decline. Similarly, in a reservoir with low permeability, the effective fluid or gas flow would be restricted and pressures would drop quickly. Shale gas reservoirs have low permeability by definition, which is why **hydraulic fracturing** is required. The hydraulic fractures increase the volume of the reservoir accessed by a well (the fractures are extensions of the well for practical purposes), overcoming the low permeability.

The role of drilling fluids

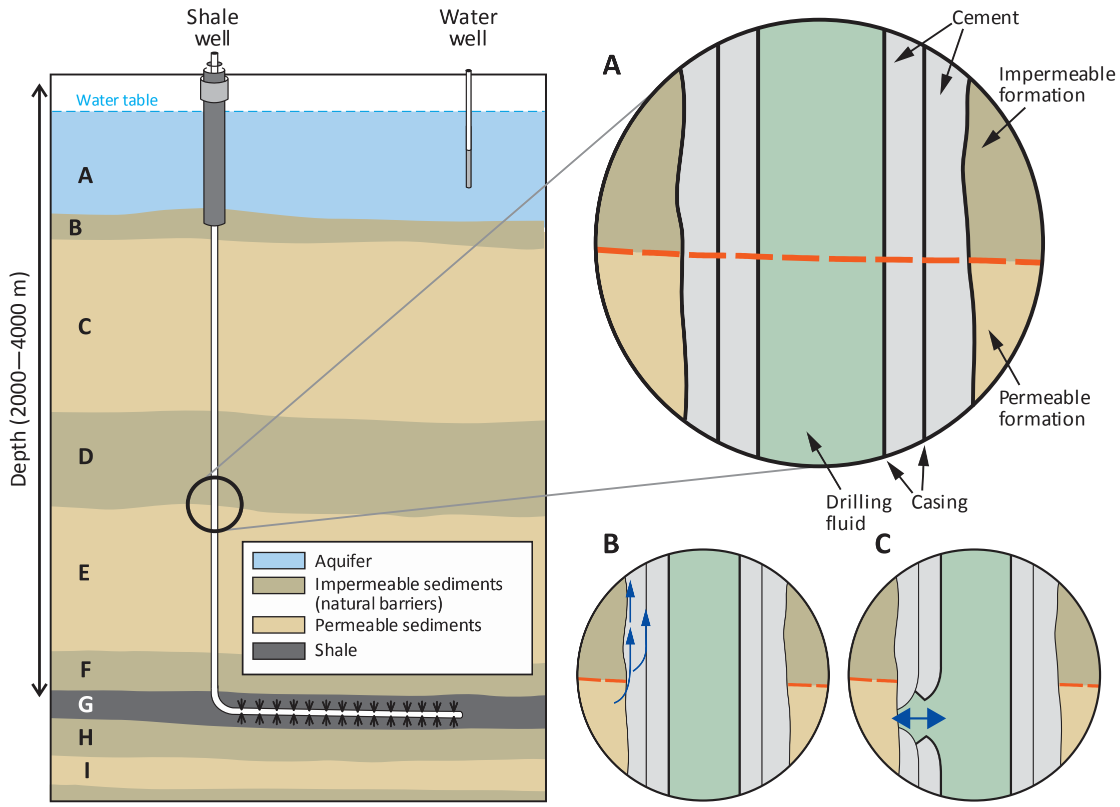
Drilling fluids are usually designed to have a density that balances the pore pressure in the surrounding rock, to prevent formation fluid from entering the well and drilling fluid from being lost to the formation. Drilling fluids also need to lift drill cuttings from the well, prevent **borehole** breakout and lubricate the drill bit. If the drilling fluid density results in pressures greater than the formation pressure, drilling fluid may be lost to the formation. Faults and fractures may also result in losses of drilling fluid. These possible scenarios are well known and are readily identified during drilling operations. A range of engineering practices can be used to manage these losses, including changing the drilling fluid density, using additives that prevent losses and setting **casing** across loss zones.

Well barriers

When a well is drilled, well integrity is established by maintaining the integrity of the natural barriers (the impermeable rock layers) through which the well is drilled. The primary methods of creating well integrity are cementing steel casing into the well, as shown in Figure 2, and controlling the density and pressure of fluids (including drilling fluids during drilling operations) or gas within the well. Problems with well integrity can generally be considered in two broad categories:

- unintended flow of fluids or gases between rock layers or to the surface along the outside of the well (see **Figure 2B**); and
- unintended flow of drilling fluids or hydraulic fracturing fluid from inside the well into the surrounding rock, or from formation fluid or gas into the well (see **Figure 2C**).

Figure 2: Shale gas wells cut through geological layers that form barriers to vertical flow. The casing, cement and management of pressures within the well reinstate this barrier (red dashed line in A). Well integrity problems can occur when the well becomes a pathway for vertical movement or gas or fluid (B), or when the well is breached, allowing fluid to flow in to or out of the well (C). Not to scale.



When considering fluid movement, overpressures contribute significantly to well integrity issues and their consequences. However, high overpressures that would drive vertical fluid movement are not a common feature of shale resources, and the limited data collected in the Beetaloo Basin indicates that this basin has low overpressures.[8] In contrast, the buoyancy and low viscosity of gas means that it is more likely to be able to move along these pathways. In addition, gas may be present in shallower layers of rock as well as the target shale gas reservoir. Gas from any of these sources may move upwards along the well if a pathway is present. The rate at which fluid or gas could flow up a pathway

[8] Close et al. 2016.

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will be limited by the aperture of the opening through which it flows. Where the **annulus** between the well casing and the rock is cemented, the size of any opening will be limited.

A loss of well control can result in the unintended flow of fluid into or out of a well. Where there are high overpressures, the risk of fluid or gas flow into the well is higher. An inrush of gas or **formation fluid** into the well can lead to a well **blowout** at the surface. Large overpressures can be a factor in conventional oil and gas resources, and were a contributing factor to the blowout of the Macondo well that led to the loss of the Deepwater Horizon drilling rig.[9] The Macondo well was drilled offshore in water over 1,500 m deep. The well extended around 4,000 m below the sea floor, where it intersected four distinct hydrocarbon reservoirs. These reservoirs were highly overpressured, with pore pressures close to exceeding the tensile strength of the rock, and contained large volumes of gas and oil. The eventual blowout of the Macondo well is believed to have been caused by a chain of failures, starting with a failure of the cement around the casing, followed by a failure of the **blowout prevention** (**BOP**) system and other secondary safety systems. In contrast, shale gas wells are drilled onshore and into resources at a relatively shallow depth below the surface (2,000-4,000 m). High overpressures are uncommon in shale gas resources, and the low permeability in shale resources will limit the volume of any inrush into the well, meaning that blowouts are unlikely.[10] The operational complexity of onshore shale gas wells is also lower than for offshore drilling in conventional reservoirs, particularly those with high overpressures. This comparison highlights the importance of the geology and characteristics such as pore pressure, permeability and reservoir volume in determining the potential consequences of a failure of well integrity.

Hydraulic fracturing fluid movement

Hydraulic fracturing fluid will migrate into the formation when fluid pressures are higher than the pore pressures in the surrounding rock. During hydraulic fracturing operations, a specific zone of the surrounding rock formation is exposed to the high-pressure hydraulic fracturing fluid in order to propagate hydraulic fracture into the formation. The design of the well controls where the hydraulic fracturing fluid can enter the formation. If the well integrity is compromised, hydraulic fracturing fluids may breach the well and flow into other rock layers. Designing a well to withstand hydraulic fracturing pressures is a routine engineering task, and the designs typically incorporate multiple barriers; also, **pressure testing** of the well before hydraulic fracturing ensures that the well is strong enough to withstand hydraulic fracturing pressures.

Hydraulic fracturing injects fluid under pressure into the reservoir rock. Some of this fluid will hold open the fractures, and the rest will flow into the pore space in the reservoir rock. When the hydraulic fracturing operation is complete, the fluid pressures will dissipate quickly and a portion of the injected hydraulic fracturing fluid will flow back up the well. Some hydraulic fracturing fluid will remain in the pores of the reservoir rock layer due to the low permeability. Migration of the hydraulic fracturing fluid left behind in the pore space of the reservoir rock is governed by the same processes as the migration of other pore fluids; therefore, it is unlikely that the fluid will be strongly driven to flow vertically between rock layers.

Summary of the importance of well integrity

This discussion highlights some of the basic geologic and engineering factors that influence well integrity, and the impact of these factors in shale gas resources. High overpressures are uncommon in

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[9] National Academy of Sciences, 2012.
[10] Royal Society & Royal Academy of Engineering 2012. p25

shale gas resources, and the low permeabilities in these resources will limit the potential for a blowout and the potential drive for cross formation flow. In addition, the low permeabilities will continue to influence the impacts of well integrity after the well has been abandoned. Pressures within the reservoir will be depleted by production. Restoration of pore pressure in the reservoir is likely to be slow because the low permeability will prevent migration of any high-pressure fluids from outside the reservoir, and processes that might increase pressures from within the shale are subject to a geological timescale. However, some gas will remain in the reservoir and its buoyancy will continue to provide drive for upward flow, should pathways be available.

3 Well life cycle

All wells follow a similar life cycle, regardless of their purpose, with some variations in their design and operational aspects. The well life cycle, as outlined in *ISO 16530-1 Petroleum and natural gas industries - Well integrity - Part 1: Life cycle governance* (**ISO 16530-1**), has the following phases:[11]

- basis of design phase;
- design phase;
- construction phase;
- operational phase;
- intervention phase; and
- abandonment phase.

Figure 1 shows the basic layout of a shale gas well and identifies its key components. The layout and components of a well will vary according to its purpose in the local geology. It is impossible to draw a shale gas well in a way that shows how narrow the well is compared to its length. The diameter of a well is only about 15-25 cm, whereas the length is several kilometres. A useful way of visualising this ratio of diameter to length is to think of the edge marking (around 10-12 cm wide) on a several kilometre stretch of highway.

3.1 Basis of design phase

The basis of well design phase is where the objectives of the well are set and the full life cycle operational requirements are determined, to allow for detailed design of the well in the next phase. Some of the information that is required at this phase includes:[12]

- the location;
- targets – formations and depths;
- well type (that is, **exploration**, production or monitoring);
- well subsurface architecture (vertical, deviated or horizontal);
- geological information, including expected formations, aquifers, faulting and temperatures;
- geomechanical information, including pore pressures, rock strength, in situ **stresses**, **porosity**, permeability and temperatures;
- for an exploration well, data acquisition requirements;
- for a production well, production parameters such as production rates, the composition of the fluids and gasses that will be produced, and the stimulation and testing strategies that will be used;
- potential for planned re-completion or conversion of the well for other purposes (converting an exploration well to a monitor well, for example); and
- the expected operating life of the well.

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[11] ISO 16530-1:2017.
[12] ISO 16530-1:2017.

The geology of the resource and the overlying strata that must be drilled through to reach it are important because they determine the depth, thickness and gas content of the target shale horizon. Although shale resources are typically made up of flat lying layers of rock, geological features such as folds and faults are important in determining the geometry of the resource. Igneous intrusions may also cut through the resource, and the design of the well trajectory will need to take these features into account.

Geomechanical properties are important because they describe how rock will respond mechanically (deform or break) as it is drilled through. An open well will fail if the stress concentrations around its circumference exceed the strength of the rock.[13] Geomechanical parameters such as in situ stress, rock strength and pore pressures are important for the design of the casing in the well. These parameters are also important for hydraulic fracture design.

Overpressures in formation fluids are an important consideration for well design and well integrity. [14] If the pore pressure is at the hydrostatic gradient, there is no driving force for fluids to move vertically between layers of rock at different depths, or to the surface. If the pore pressures are above the hydrostatic gradient, they are said to be overpressured and those pressures can drive the flow of fluids vertically between formations to the surface, should a pathway be available. A well with good integrity will be able to control these overpressures. Overpressures develop naturally as a result of a range of mechanisms through geological time, and low to moderate overpressures are present in many shale resources, including the Beetaloo Basin in the Northern Territory.[15] Gas and oil can move vertically owing to their buoyancy and expansion, even without overpressure, but water cannot move vertically without a driving force.

These geological, geomechanical and operational considerations are all important for well integrity. These factors need to be taken into account so that the design of the well reduces risks to its integrity.

3.2 Design phase

In this phase, all aspects of the well are designed in detail, taking into account the overall life cycle of the well and all future operations, through to its eventual abandonment. The design is based on a detailed analysis of data and requirements collected during the previous phase, and includes the following aspects:[16]

- well design, and specification of materials and equipment (such as casing, cement and completion);
- data acquisition program, including **well logging**, sample collection and well testing;
- well stimulation activities, if required;
- barriers to managing well integrity;
- operating procedures, including risk management and well integrity management; and
- plans for final abandonment of the well.

The design of the casing, cementing and completion are important for long-term well integrity. Casing is steel piping that provides a pressure tight conduit between the shale gas resource and the surface.[17]

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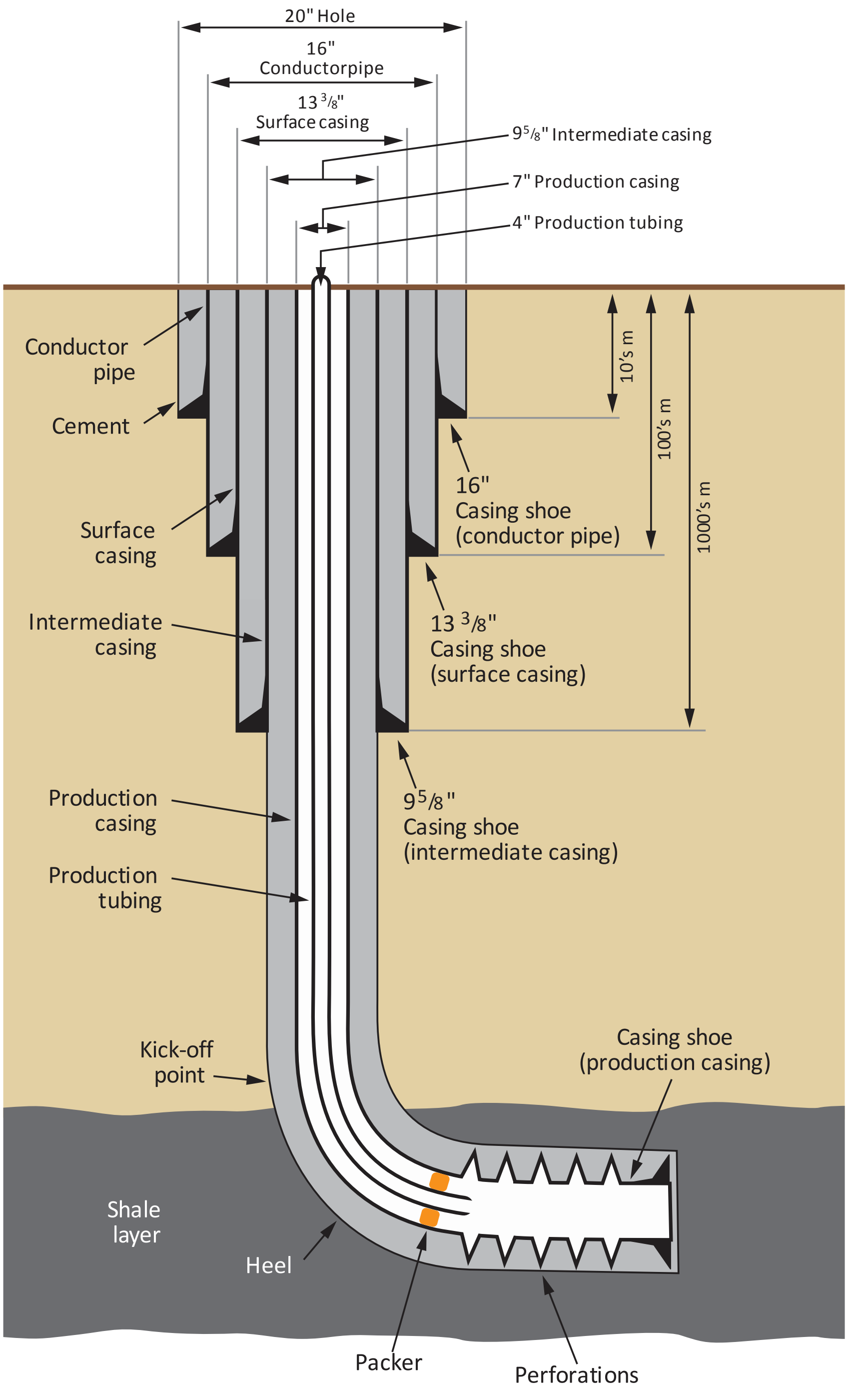
[13] Zoback 2007. p3 and chapters 6 to 9.
[14] Zoback 2007. p3 and chapters 6 to 9.
[15] Close et al. 2016; Jarvie 2014; US EIA 2013.
[16] ISO 16530-1:2017.
[17] Hossain and Al-Majed 2015. p433-501

Wellbore casing is a highly engineered product that is designed to cope with anticipated wellbore conditions. International standards cover the manufacture, testing, engineering specification, mechanical properties and performance of the casing.[18] The casing prevents the unintended flow of drilling and hydraulic fracturing fluids out of the well, keeps the well open through weak or broken rock layers, and prevents formation fluids from entering the well and from moving between layers of rock via the well.

Figure 3: General layout of casing in a shale gas well. Casing sizes are specified in imperial units. Not to scale (width is significantly exaggerated).



Casing/hole sizes

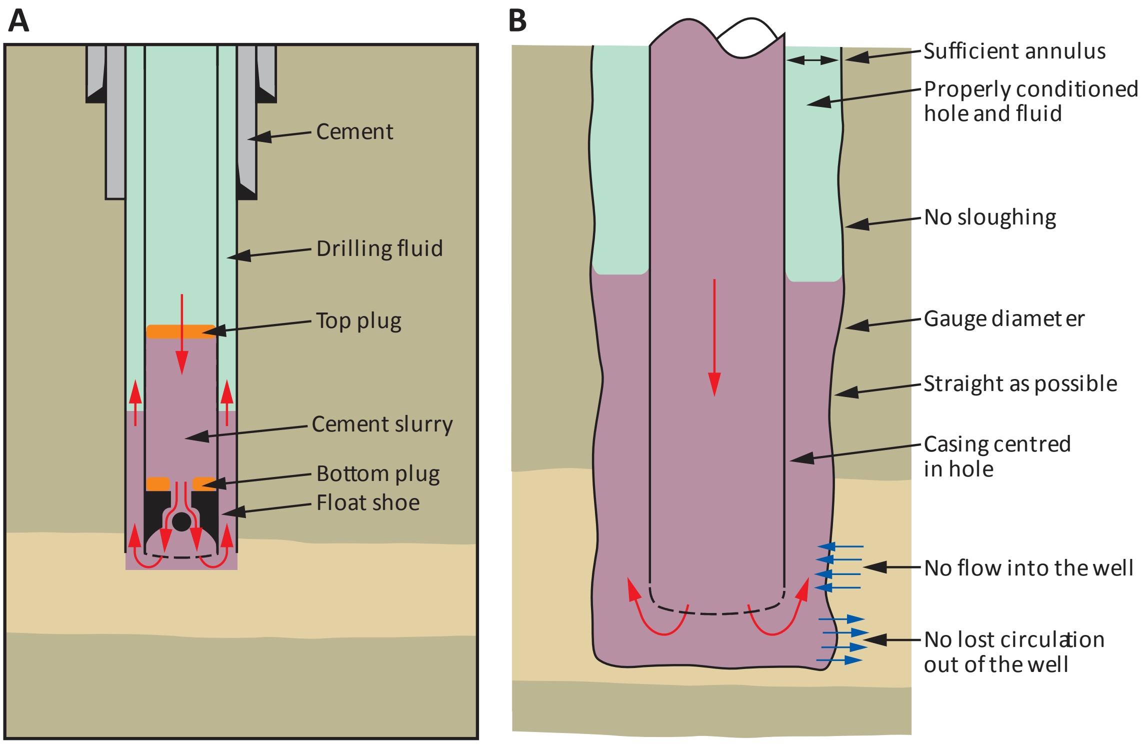
Inches	Centimetres
20	50.8
16	40.6
13 ⅜	34.0
9 ⅝	24.4
7	17.8
4	10.2

[18] ISO 11960:2014.

Wells are drilled in stages, with each stage cased before drilling proceeds to the next stage, using a smaller diameter drill bit. **Figure 3** shows the general layout and nomenclature for casing used in shale gas wells, indicating that the diameter of the well decreases with depth, as successive casing telescopes inside the previous **casing strings**. The design of casing for a well will need to take into account the depths of layers of rock or aquifers that need to be isolated from each other, the corrosive nature of fluids or gases (such as hydrogen sulphide or carbon dioxide) that may be encountered, the stresses that the casing will be subjected to and the operational requirements of the well. The casing layout, casing material and wall thickness are all parameters that can be varied.

Without cementing, the casing alone is not sufficient to ensure wellbore stability. Therefore, the casing is cemented into the well (**Figure 3**), to provide strength to the well and a seal between the casing and the surrounding rock.[19]

Figure 4: The process for cementing casing into a well. The cement is pumped down into the centre of the well and returns up the outside of the well (A). The well requirements for effective cementing are shown in (B). Not to scale. Modified from Smith.[20]



During the cementing process, a cement slurry is pumped down the centre of the well, and flows up the annulus between the rock formation and the most recently placed casing (**Figure 4**). The cement works with the casing to mechanically couple it to the surrounding rock, creating a hydraulic seal and protecting the casing.[21] Shale gas well cements are usually a Portland cement (of slightly different chemical composition to regular Portland cement) mixed with water and other additives. The additives modify certain properties of the cement, such as setting time, viscosity, density and permeability to different fluids. Well cements are designed, tested and prepared using established procedures to meet

[19] Taoutaou 2010.
[20] Smith 1990.
[21] Hossain and Al-Majed 2015. p503-570

relevant specifications, and they have negligible permeability to formation fluids when cured.[22] The casing and cement work together and are critical to well integrity.

In designing the oilfield cementing process, drilling engineers consider factors such as the depth and design of the well, and the properties of the pore fluids and surrounding rock layers. The cementing process is undertaken in a series of steps that are designed to clean and prepare the well for cement, prevent the cement slurry from contamination with drilling fluid (also known as **drilling mud**) and ensure that the cement slurry is positioned at the intended vertical well location.

Various standards cover the design of wells, the specification of materials and equipment used in their construction, and well operations. As at June 2016, the International Association of Oil and Gas Producers listed over 150 primary standards related to well construction and well operations.[23] Some of these standards are mandatory in various jurisdictions; however, they are mostly used for quality control for operations, and the provision of services and materials in the industry.

3.3 Construction phase

The well construction phase involves drilling and completion of the well in accordance with the design. A focus during this phase is managing the risks associated with drilling and maintaining well integrity.[24] Well control refers to the prevention of 'kicks', which are uncontrolled flows of formation fluids or gases into the wellbore that can reach the surface.[25] A severe kick can lead to a blowout, which is the uncontrolled escape of fluid from the well.

Drilling fluids are an essential component of drilling operations, and are distinct from the hydraulic fracturing fluids used during well stimulation (see Section 4). [26] These fluids provide cooling and lubrication to the drill bit and drill string, lift drill cuttings from the well and are a component of well control. The density of the drilling fluid is increased by the use of additives to counteract any overpressures in the formation, preventing kicks and helping to maintain wellbore stability in uncased sections of the well. If the density of the drilling fluid is too high, drilling fluid may be lost in layers of rock. Additives that create a low-permeability skin on the wellbore can be used to limit these losses.

Casing is installed and cemented in place in a number of stages during the construction phase, as shown in **Figure 3**. Initially, a large-diameter surface casing is set sufficiently deep to protect surface aquifers, and is fully cemented in the ground. Once a well is drilled to either the design depth or a depth where a casing string is required, a steel casing string is run into the borehole and cemented (**Figure 3** and **Figure 4**). The cement fills and seals the annulus between the casing strings, or between the casing string and the formation rock. This process is repeated until well construction is complete.

In each stage, the well is prepared (essentially, cleaned by the circulation of drilling fluid) and cement is then pumped down the centre of the well so that it flows around and up the annulus between the casing and the surrounding rock. The well integrity provided by the cement depends on both the cement slurry design and several other aspects of the well cementing process; for example, preparation of the wellbore, and the condition and centralisation of the casing. Ideally, the wellbore and casing would be prepared for cementing as follows (**Figure 4B**):

- the wellbore diameter should be close to the drill bit size (known as the gauge);

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[22] ISO 10426-1:2009.
[23] IOGP 2016.
[24] ISO 16530-1:2017.
[25] Hossain and Al-Majed 2015. p205
[26] Hossain and Al-Majed 2015. p73-139

- the surface of the wellbore should be smooth;
- during drilling, breakouts or **washouts** of the surrounding rock should have been minimised by good design of the drilling mud;
- there should be no formation fluid influx into the wellbore or major loss of drilling mud to the surrounding rock;
- the casing should be centralised, with a sufficiently wide annulus surrounding the casing to allow cement flow; and
- the drilling mud in the hole should be properly conditioned to remove pieces of rock that may slough off the walls of the well.

During the construction phase, components of the well that contribute to the well's integrity are tested to verify that they are performing as designed. Verification is an important element of well integrity management.[27] The integrity of well casing and cement can be tested by pressurising the well, to verify that it can hold the pressures that it may be exposed to over its life. A variety of downhole logging tools can be used to measure the state of the casing and the integrity of the bond between the casing, cement and rock.

For production wells or wells used for formation testing, hydraulic fracturing (also known as well stimulation) activities are undertaken as part of the construction phase. The hydraulic fracturing process itself is described in Section 4.

The final activity in the construction phase is the 'completion' of the well, preparing it for the production of gas.[28] Completion involves the installation of hardware in the well to allow the safe and efficient production of gas from the well at a controlled rate, and many different completion technologies are available. If the well was drilled for other purposes, or if the well is to be suspended, the completion will be designed accordingly. For example, instruments such as pressure meters or temperature sensors may be installed in a monitoring well during the construction phase.

3.4 Operational phase

For production wells, the operational phase will have the longest duration, with some wells producing hydrocarbons for decades. During this phase, the main activities are monitoring the well's integrity and performance, and maintenance. Abnormal pressures in the annulus between casing strings can indicate integrity issues, as can changes in production rates. Wireline logging, in which measurement tools are lowered down the well on a wireline, is generally the only means of checking the integrity of casing and cement down the well. Observations from a sample of wells can be used to indicate the integrity of wells across a field.[29]

3.5 Intervention phase

In some cases a well must be re-entered to perform maintenance, repairs or replacement of components; for surveillance; or to increase productivity.[30] Such interventions are also referred to as '**workover**'. Interventions can be critical to maintaining well integrity, and a range of technologies are

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[27] ISO 16530-1:2017; NORSOK D-010.
[28] Hossain and Al-Majed 2015. p679-735
[29] ISO 16530-1:2017. p53
[30] ISO 16530-1:2017.

available for repairing casing and cement.[31] Production wells may be hydraulically re-fractured to extend their production, and the design of such activities needs to be commensurate with the design of the well and its current condition, allowing for any corrosion or other deterioration.

3.6 Abandonment phase

The **abandonment** phase is the final phase in the well life cycle; in this phase, the wells are decommissioned, **plugged and abandoned**. The goal of plugging and abandoning the well is to ensure the integrity of the well in perpetuity, effectively re-establishing the natural barriers formed by the impermeable rock layers that were drilled through to reach the resource.[32] Once a well has been abandoned, there is little prospect of re-entering the well for any purpose. Monitoring may be conducted after the well has been abandoned, to confirm that **plugs** have been properly set in the well. The well's ongoing integrity should not be dependent on long-term monitoring,[33] although such monitoring may be conducted to confirm the effectiveness of abandonment practices. The aims of abandonment are to: [34]

- prevent release of formation fluids or well fluids to the environment (including aquifers);
- prevent the flow of **groundwater** or hydrocarbons between different layers of rock; and
- isolate any hazardous materials left in the well.

The method of plugging and abandoning a well involves confirming the well's integrity to ensure that there will be no movement of fluid into or out of the well, and placing barriers in the well to prevent the vertical movement of fluids between rock layers. A schematic of an abandoned well is shown in **Figure 5**. The plugs typically comprise cement with mechanical plugs or retainers. To provide long-term integrity, the cement (or other barrier material) must:[35]

- not shrink;
- be able to withstand the stresses in the wellbore;
- be impermeable;
- be impervious to chemical attack from formation fluids and gases;
- be able to bond with steel casing and rock; and
- not cause damage to the casing.

The design of well abandonment must be considered during the design phase of the well.[36] For example, the casing material that will be left in the well must be compatible with the objectives of abandonment.

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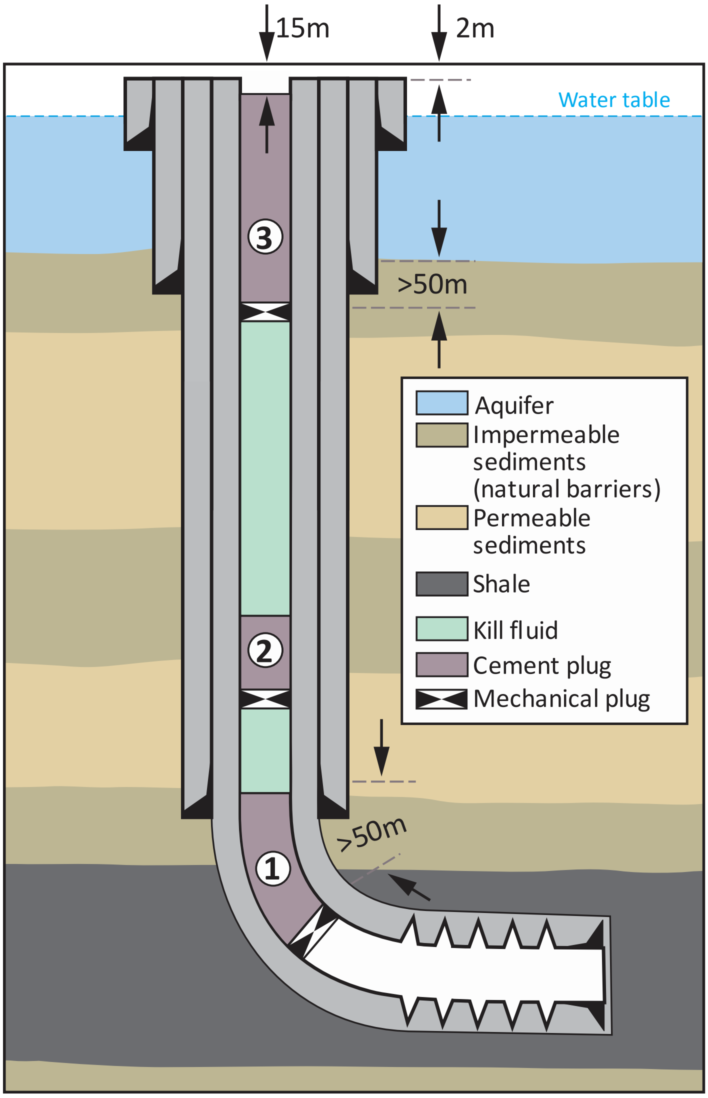
[31] Ansari et al. 2017; Durongwattana et al. 2012; Roth et al. 2008.
[32] ISO 16530-1:2017; Kiran et al. 2017; NORSOK D-010.
[33] ISO 16530-1:2017.
[34] ISO 16530-1:2017.
[35] NORSOK D-010. p96
[36] ISO 16530-1:2017.

Figure 5: An abandoned well, showing the cement plugs that are placed in the well to prevent vertical flow of fluids. Numbers indicate order of placement of the cement plugs. Not to scale.

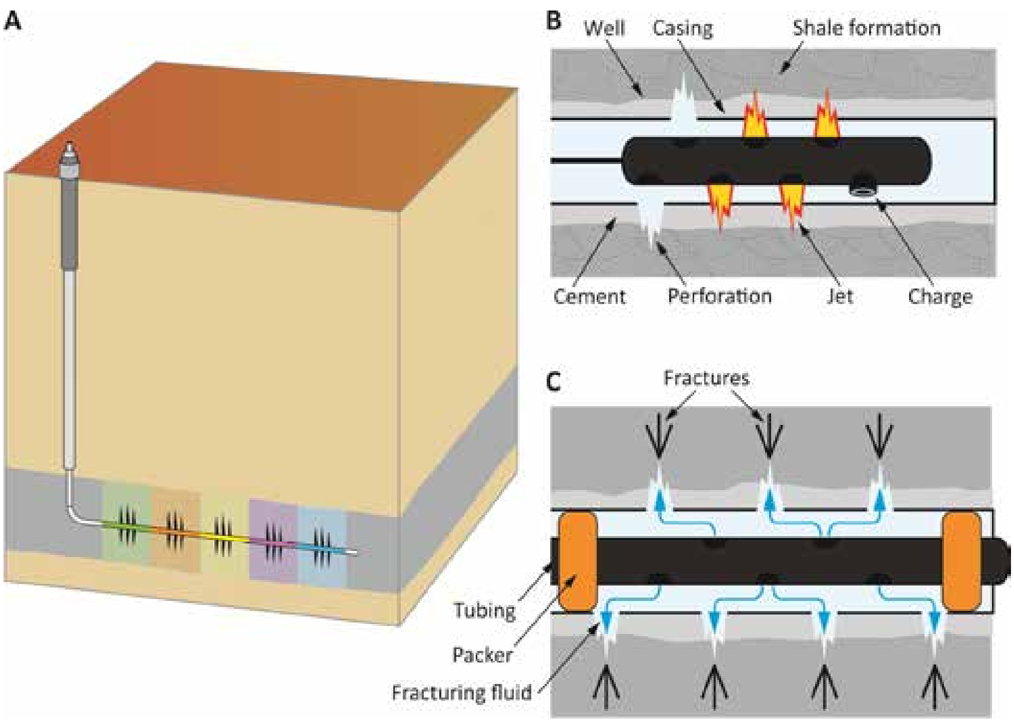


4 Hydraulic fracturing

Hydraulic fracturing is a stimulation technique that is used to increase the production of oil and gas from **unconventional resources** such as oil shales, by the injection of a hydraulic fracturing fluid at high pressure into a cased wellbore. Hydraulic fracturing of a shale gas or shale oil is usually conducted over several intervals (called 'hydraulic fracture stages') along the **production zone** of the well (**Figure 6**). Hydraulic fracturing of each stage treats a discrete volume of the reservoir. This staged approach allows for more control of the hydraulic fracturing process.

It is generally not possible to hydraulically fracture the whole well in one step. Most hydraulic fracturing treatments in shale oil and gas wells take place in the relatively long (up to several km and usually at least 1-2 km long) horizontal or nearly horizontal section of the well that follows the rock layers that contain the most concentrated hydrocarbon resource, and that has mechanical properties that allow for successful fracture treatment. Although vertical wells may be fractured for testing purposes, it is now uncommon to use a large number of vertical production wells to exploit shale gas or tight gas resources, because vertical wells cannot access a large enough volume of the reservoir. The number of fracture stages in a single well has increased over time in unconventional fields in North America. Moreover, a single well may have more than one horizontal branch or 'lateral', and each of these can have a large number of fracture stages. In 2009, 10-12 stages would have been considered typical, with spacing of around 200 m; in contrast, in 2017, it is common for 40-100 fracture stages to be placed in a single lateral, with spacing of about 15-30 m between clusters.

Figure 6: Hydraulic fracture stages. Hydraulic fracturing is typically conducted in stages; each coloured zone in (A) shows a different stage. For each stage, the casing must be perforated (B) to allow the hydraulic fracturing fluid to access the shale formation. Hydraulic fracturing is then conducted in each stage within a short section of the well that has been isolated, in this case using packers (C). Various technologies can be used for staged hydraulic fracturing. Not to scale.



The hydraulic fracturing fluid is predominantly a mixture of water, **proppant** (usually sand) and a small percentage of chemical additives (typically less than 1%). The zone to be fractured is perforated using shaped charges, and isolated using mechanical plugs or other devices before the hydraulic fracturing fluid is injected into the isolated wellbore zone. Because the hydraulic fracturing fluid is contained within the isolated wellbore zone, the pressure builds up until it exceeds a threshold known as the breakdown pressure. Once the hydraulic fracture fluid pressure exceeds the breakdown pressure, it fractures the rock, resulting in 'hydraulic' fractures. The direction in which the hydraulic fracture propagates depends on the orientation of in situ stress in the reservoir, with growth mainly occurring in a direction perpendicular to the minimal **principal stress**. At larger depths, the overburden (vertical) stress due to the weight of the overlying soil or rock is typically greater than the horizontal stress, implying that hydraulic fractures are usually vertically orientated. Once the hydraulic fracture has initiated, further propagation is controlled by the fluid flow. Some of the hydraulic fracturing fluid drives hydraulic fracture growth; the rest is injected or lost into the formation (a process known as 'leak-off'). The surface area of the hydraulic fracture increases as the fracture grows, thereby increasing the fluid loss into the formation. The hydraulic fracturing fluid injection rate is therefore calculated to propagate hydraulic fractures to the desired size, given the expected fluid loss into the formation.

Proppant is added to the hydraulic fracturing fluid to hold the fractures open at the end of the treatment. At the start of the simulation, the hydraulic fracturing fluid is injected without any proppant, to initially open a fracture wide enough to allow the proppant to travel along the hydraulic fracture; this is known as the '**well pad**'. As the hydraulic fracture propagates into the reservoir, proppant is added to the hydraulic fracture fluid in such a way that the correct proppant concentration along the hydraulic fracture is reached at the end of the treatment. Finally, the wellbore is flushed to remove any residual proppant, leaving behind a proppant-filled fracture that acts as a conductive channel through which oil and gas can flow into the wellbore.

After hydraulic fracturing treatment is complete, a portion of the hydraulic fracturing fluid will flow out of the wellbore in a process known as '**flowback**'. The experience in the United States is that the amount of hydraulic fracturing fluid that returns to the surface as flowback water from shale gas reservoirs is typically 10-30%.[37]

The advent of **horizontal drilling**, which exposes the wellbore to a larger part of the reservoir formation, has made it possible to extract oil and gas from reservoirs that were previously considered uneconomical. In the United States in 2015, it is estimated that almost 50% of crude oil production and 70% of natural gas production was from hydraulically fractured wells.[38] Hydraulic fracturing uses a significant volume of water, with a typical shale gas well consuming 13-24 million litres of water during stimulation activities. The Barnett Shale in the United States, for example, used about 243 billion litres of water over its production history, and hydraulic fracturing as a whole used about 116 billion litres water annually in the period 2012-2014. [39] More than 50 million tonnes of proppant (90% is silica sand) are used in the US annually for hydraulic fracturing operations. In 2017, about 4000 tonnes per well is typically used. The trend in the United States is for faster drilling, more hydraulic fractures per well and more wells drilled from each well pad.[40] However, any eventual shale gas well and hydraulic fracture designs in the Northern Territory would be governed by a number of factors including specific geology, available technology, well location and market forces.

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[37] US EPA Report.
[38] US EIA 2016a; US EIA 2016c.
[39] US EPA Report.
[40] US EIA 2016b.

5 Well integrity

Well integrity is a fundamentally important aspect of well operations throughout the life cycle of a well. Maintaining well integrity is critical for the safe and effective operation of wells, and to protect the environment.

Well integrity is defined in several international standards, recommended practices and guidelines:

- Norsok Standard D-010 *Well integrity in drilling and well operations* (**Norsok D-010**) defines well integrity as the "*application of technical, operational and organizational solutions to reduce risk of uncontrolled release of formation fluids and well fluids throughout the life cycle of a well*".[41]
- The Norsok D-010 definition is also used by Oil & Gas UK's *Well life cycle integrity guidelines*.[42]
- **ISO 16530:1 2017** defines well integrity as "*containment and prevention of the escape of fluids to subterranean formations or surface*".[43]
- *Hydraulic fracturing – well integrity and fracture containment, ANSI/API recommended practice 100-1* (**API 100-1**) defines well integrity for onshore wells that will be hydraulically fractured as "*The quality or condition of a well in being structurally sound with competent pressure seals (barriers) by application of technical, operational, and organizational solutions that reduce the risk of unintended subsurface movement or uncontrolled release of formation fluid*".[44]

API 100-1 further describes well integrity as *"the design and installation of well equipment to a standard that:*

- *protects and isolates useable quality groundwater,*
- *delivers and executes a hydraulic fracture treatment, and*
- *contains and isolates the produced fluids"*.[45]

ISO 16530:1 2017 also provides a more complete description of well integrity:

> *"Well integrity refers to maintaining full control of fluids within a well at all times by employing and maintaining one or more well barriers to prevent unintended fluid movement between formations with different pressure regimes or loss of containment to the environment."*

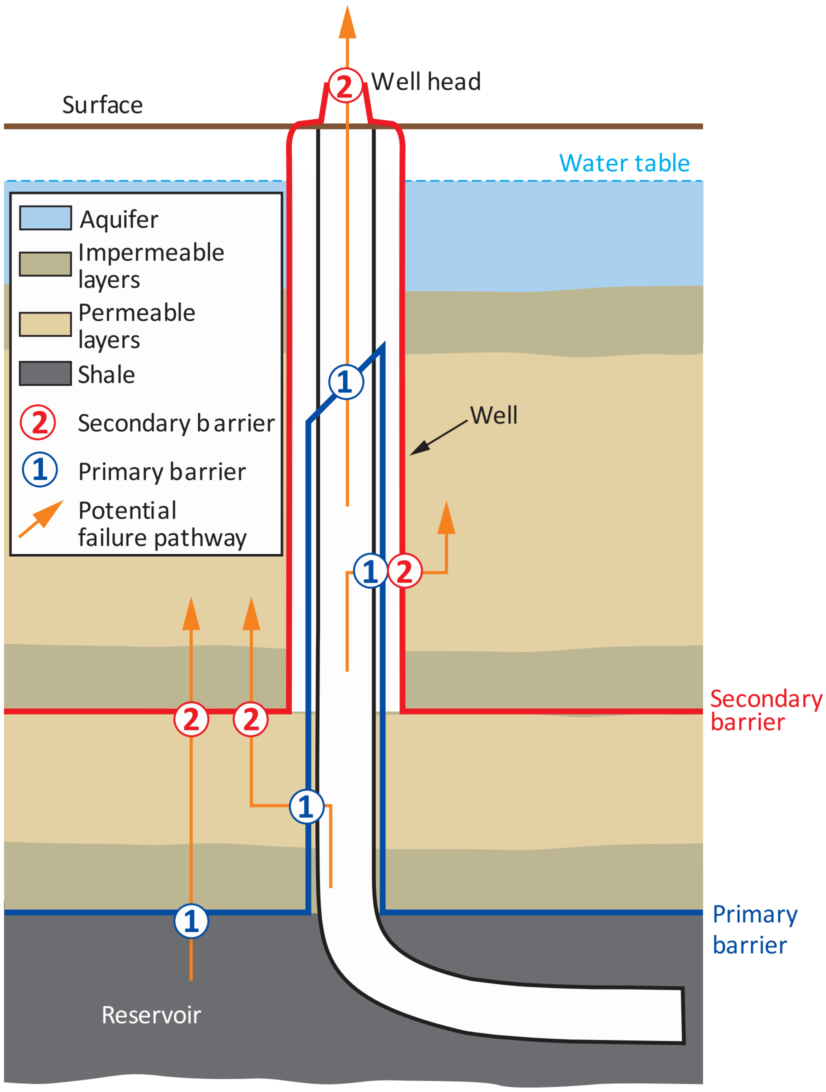
This definition is particularly useful because it introduces the concept of **well barriers**. A fundamental concept in well integrity, well barriers are defined in ISO 16530:1 2017 as a "*system of one or several well barrier elements that contain fluids within a well to prevent uncontrolled flow of fluids within or out of the well*".[46] Well barriers normally comprise several components and practices that work together to contain fluids; they include physical or hardware barriers, operational barriers, human barriers and administrative barriers.

Physical and hardware barriers are the components that are most tangible. They include impermeable formations, drilling fluids, casing cement, casing strings, **packers**, **well heads** and valves, and blowout

[41] NORSOK D-010.
[42] Oil & Gas UK 2016.
[43] ISO 16530-1:2017.
[44] API RP 100-1.
[45] API RP 100-1.
[46] ISO 16530-1:2017.

preventers. **Figure 7** shows the basic principles of the barrier concept, with the elements combining to form a "top hat" barrier that separates fluid in the reservoir and the well from the external environment and the surface. In this figure there are two barriers: a primary barrier in blue and a secondary barrier in red. The use of a two-barrier system, with two independently verifiable well barriers, is common practice in the industry. The second barrier gives a level of redundancy, providing protection should the primary barrier be compromised.

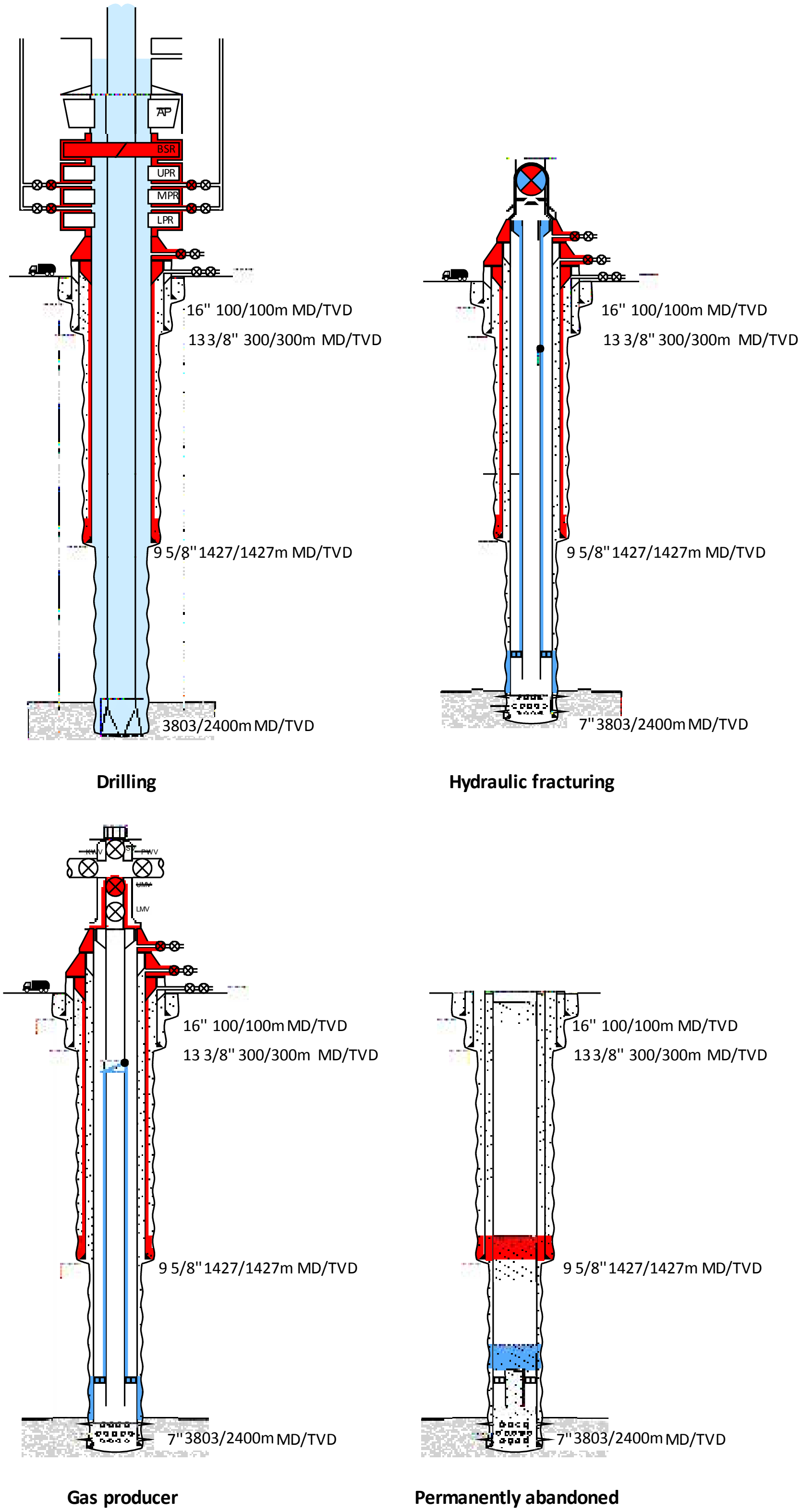
Figure 7: The two-barrier concept, showing the two barriers to various pathways for fluid flow out of the well.



Many different elements make up a well barrier, all of which need to be verified to confirm well integrity. **Figure 8** shows examples of the two-barrier system throughout the well life cycle. The principle is maintained; however, the barriers and barrier elements vary to suit the risks and operational requirements of each phase. Well barrier design will vary between wells, influenced by the design of the well, the characteristics of the resource being drilled and the risks identified.

A **well integrity failure** occurs if all barriers have failed and there is a pathway for fluid to flow into or out of the well. In a two-barrier design, both barriers need to fail for a well integrity failure to occur. A barrier failure will not result in a loss of fluids to or from the environment provided that the second barrier is intact.

Figure 8: Examples of the two-barrier system during different phases of the well lifecycle. The primary barrier is shown in blue and the secondary barrier in red.[47]



[47] Supplied by Wellbarrier AS, Norway, https://www.wellbarrier.com/.

Well integrity issues can be caused by any of the following:

- a **well breach**, including failure of **cement sheaths**, plugs, bonds, casing, and downhole and surface sealing components;
- a hydrological breach, fluid movement between geological formations – including formations not targeted for exploitation; and
- an environmental breach. contamination of or water balance impact on water resources – fluid leaks at surface and causes contamination of water sources.

Various potential impacts on environments can result from poor oil and gas well integrity, such as:[48]

- **impact on groundwater**: contamination of shallow and deep aquifers could be a risk associated with oil and gas well drilling and production activities due to poor well construction;
- **localised hydraulic connectivity between isolated aquifers along a well trajectory**: this can occur because of failed casing, poor cementing or generally poor well construction, decommissioning or abandonment practices; and
- **fugitive gas emissions**: localised gas leakage to both the atmosphere and into aquifers from oil and gas wells can occur because of equipment failure or poor well construction and abandonment practices.

5.1 Well barrier integrity failure mechanisms

This section discusses mechanisms for oil and gas well barrier failure in major phases of a production well life cycle. It also briefly discusses the likelihood of these failure mechanisms occurring, and the consequences and the mitigation measures required if they should do so.

5.1.1 Failure mechanisms associated with oil and gas well drilling

Drilling, the first step in constructing a well, presents a number of potential risks to well integrity. During drilling, the primary well barrier is the drilling fluid pressure exerted on the rock formation surrounding the well. The secondary well barrier includes the drilling blowout preventer, casing and cement, well head and cap rock formation.[49]

Drilling fluid density or mud weight is vital in maintaining well integrity before the casing is cemented. A safe mud weight range (or window) is determined by a lower bound (defined by the **formation pore pressure**) and an upper bound (defined by the formation **fracture gradient**). If the mud pressure is less than the formation pore pressure, formation fluid may enter the well. Uncontrolled influx of large volumes of hydrocarbons may lead to a blowout at the surface, which may in turn have a significant impact on the environment. In shale gas resources, blowouts are unlikely because high overpressures are uncommon in such resources, and the low permeability will limit the volume of any inrush into the well.[50]

Low mud weight can also result in wellbore instability (breakout or washout; that is, enlargement of borehole size). This is not a direct risk to well integrity in terms of containing and controlling the flow of wellbore fluids. However, the significantly enlarged wellbore may result in poor displacement of mud

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[48] Bore integrity review, CoA.
[49] NORSOK D-010.
[50] Royal Society & Royal Academy of Engineering 2012. p25

during cementing and therefore a poor-quality cement sheath behind the steel casing, which may lead to loss of well integrity.[51]

If the mud weight is greater than the formation fracture gradient, drilling fluid may enter the surrounding formations or reservoirs. Most drilling fluids currently used in Australia are water based, generally comprising a mixture of water, clays, fluid loss control additives, density control additives and viscosifiers.[52] If large volumes of drilling fluid are lost into overburden or the reservoir (in particular, into shallow aquifers), this can significantly affect the environment.

To reduce risks of blowout or massive loss of drilling fluid during drilling, formation pore fluid pressure along the well trajectory is estimated. The estimate is based on data from nearby oil and gas wells or a **seismic survey** before drilling. Leak-off tests are conducted to ensure the integrity of casing and cement, and to determine the formation fracture gradient. A functional BOP will significantly reduce or eliminate the risk of environment contamination due to blowout. Because of the low permeability of shale gas reservoirs, significant hydrocarbon blowout from shale gas reservoir is unlikely during drilling.

5.1.2 Failure mechanisms related to casing and cementing

Well integrity can be lost though casing and cementing issues such as channels or voids in the cement; gaps between the formation and the cement, or the cement and the casing; and pore adhesion. These issues can be caused by poor placement of the cement, leakage through casing connections, degradation of the cement sheath and corrosion of the casing.

If channels of drilling mud remain in the annulus, they may provide a **preferential flow** pathway for fluid to migrate inside the cement sheath.[53] If a build-up of compacted drilling mud (also referred to as filter cake) is left on the well surface before cementing, it could dehydrate after the cement sets, resulting in an annulus at the interface of the formation and the cement. Furthermore, cement can shrink during setting, resulting in a **microannualus** (a fracture between the cement and the casing or formation) along the interface between the cement and the casing, or between the cement and the formation rock. **Figure 9** shows photographs of a drilling mud channel in the cemented annulus due to incomplete displacement of the drilling mud and the inner casing being off centre, and of a cement sheath core containing shale fragments recovered from an old well due to poor hole cleaning.

A good cement sheath is a solid that has a low permeability (measured in microdarcies) and **hydraulic conductivity** (that is, in the order of 10^{-6} m/d),[54] and that bonds to the casing and formation surfaces. Such a sheath prevents fluid from migrating within or through the sheath. However, downhole pressure and temperature can change because of operations in the well's history, such as casing pressure tests, well production and shut-in, and reservoir hydraulic fracturing stimulation. These operations lead to changes in well pressure and temperature, which in turn can induce radial deformation of the casing and failure in the cement sheath. This can lead to debonding on the interfaces between the cement sheath and the casing or formation, creating migration pathways through radial fractures (**Figure 10**) and microannuli.[55]

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[51] Cook and Edwards 2009.
[52] Cook et al. 2013.
[53] Bonett and Pafitis 1996.
[54] Parcevaux et al. 1990.
[55] Goodwin and Crook 1992; Watson et al. 2002.

Figure 9: A) Incomplete displacement of drilling mud, the resulting drilling-mud channels, and the off-centre inner casing;[56] Used with permission from the Society of Petroleum Engineers. B) Photo of a sidewall cement core containing shale fragments in the cement sheath, indicating poor hole cleaning before cementing the casing.[57] Used with permission from Elsevier.

A B

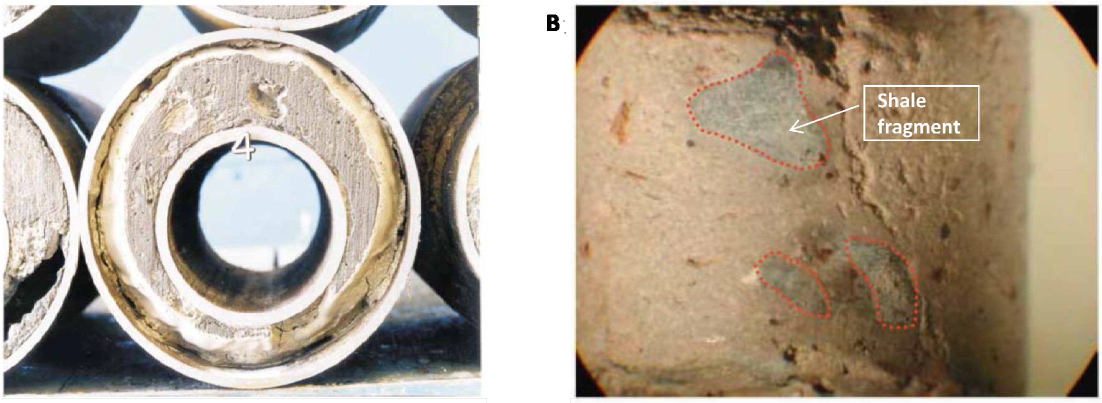

Figure 10: Cement sheath failure, resulting in cracks developing from pressure cycling on the internal casing.[58] Used with permission from the Society of Petroleum Engineers.

The impact of the cement sheath and bond failure on well integrity will depend on the extent of such failure along the wellbore and on specific geological conditions. For example, one study in the Gulf of Mexico found that there was no breach in isolation between formations with pressure differentials as high as 97 MPa (14,000 psi), provided there was at least 15 m (50 feet) of high-quality cement seal between the formations.[59]

Failure mechanisms related to corrosion of casing and chemical breakdown of the cement are discussed in Section 5.1.4.

The risks of the well integrity being compromised due to well casing and cementing can be mitigated by:

- setting the surface casing well below the base of the aquifer system;
- designing a cement slurry that is appropriate for the geological and geochemistry conditions;

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[56] Watson et al. 2002.
[57] Duguid et al. 2013. p5666
[58] Watson et al. 2002.
[59] King and King 2013.

- completing the coverage of the hydrocarbon bearing formations with cement in the well annulus;
- selecting materials for casing and other well barrier components that are compatible with the geochemistry environment;
- applying good industry cementing practice; and
- using wireline logging tools to check the quality of cement sheath and bonds on the interfaces and mediatory cementing.

5.1.3 Potential impact of hydraulic fracturing on well integrity

Fluid may migrate via pathways within or external to a production well, stimulated by hydraulic fracturing. These pathways may be created or enlarged by the high cyclic pressures exerted on the well during hydraulic fracturing operations. This section briefly discusses the aspects of hydraulic fracturing that could affect well integrity. These aspects are:

- casing failure induced by hydraulic fracturing; and
- cement sheath and cement bond failure induced by hydraulic fracturing.

Casing failure induced by hydraulic fracturing

High pressures associated with hydraulic fracturing operations can damage the casing and lead to a breach of the seal between formations or aquifers. The production casing through which fracturing fluids are pumped is subject to higher pressures during fracturing operations than during other phases in the life of a production well. Therefore, to maintain integrity, the well and its components must be strong enough to withstand the stresses created by the high pressure of hydraulic fracturing fluid, otherwise a casing failure may result. If casing failures are undetected or are not repaired, they could serve as pathways for fracturing fluids to leak out of the casing. Casing failures during hydraulic fracturing operation or shortly following the operation have been reported in Australia and the United States.[60] In the Northern Territory, the Baldwin 2HST-1 well experienced a shallow casing failure during hydraulic fracturing in 2012.[61] The hydraulic fracturing fluids were retained in the well as a result of the multiple casing design, and the well was subsequently abandoned. The US Environmental Protection Agency (EPA) reported mechanical barrier failures of 3%, but did not indicate whether the hydraulic fracturing fluid was contained by secondary barriers or escaped the well.[62]

Cement sheath and cement bond failure induced by hydraulic fracturing

Cycling of pressure associated with staged hydraulic fracturing operations can damage the cement sheath behind the casing, which in turn can lead to debonding on the interfaces or tensile failure of the cement sheath. **Figure 11** illustrates potential damages to the cement sheath from the high cyclic well pressures.[63] Although a small area of debonding may not lead to fluid migration, it has been found that a microannulus is usually present after perforating or immediately after hydraulic fracturing pumping begins.[64] Maintaining a good bond during hydraulic fracturing can be problematic because the hydraulic fracture fluid pressure can also cause the microannulus to propagate. If this propagation is extensive along the wellbore, it could be a conduit for fluid or gas migration. Migration of gas (in

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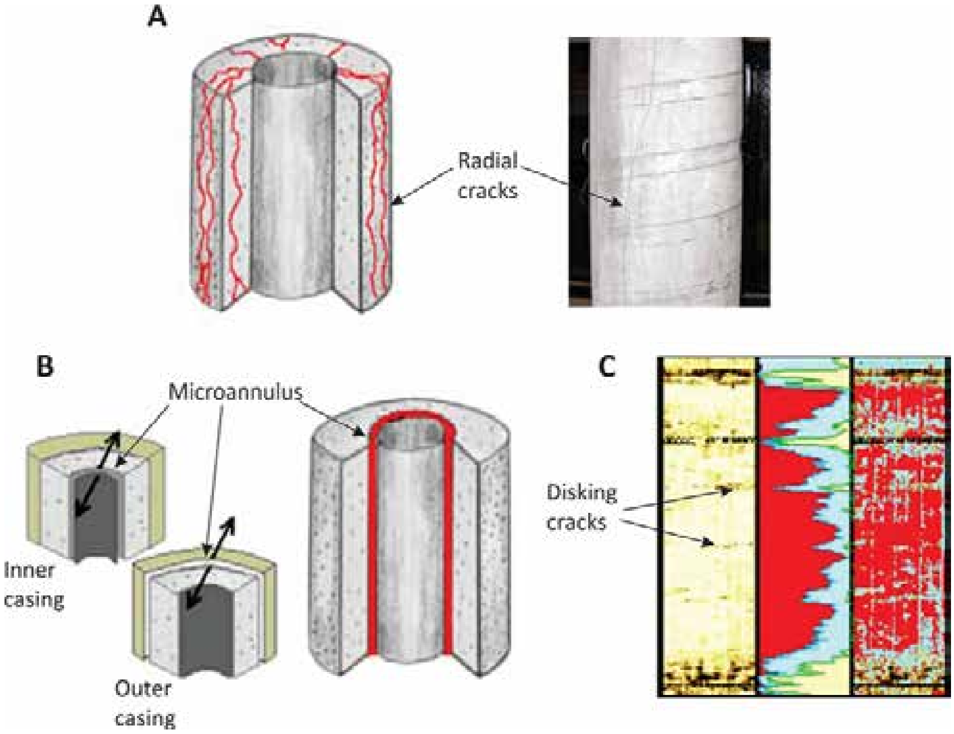
[60] Johnson et al. 2002; US EPA 2015.
[61] DPIR submission 226. p48.
[62] US EPA Report. p6-70
[63] Lecampion et al. 2011.
[64] Behrmann and Nolte 1998.

particular methane) is more likely than the migration of fluid, because the bouyancy of the gas provides a larger driving force for migration through the microannuli.[65] As an example of this mechanism, carbon dioxide (**CO_2**) migration to the surface along a microannulus in a CO_2 **injection well** was recognised as a plausible cause for observed leakage from a CO_2 injector.[66] Fluid migration along a microannulus may also be responsible for some of the sustained casing pressure often observed in production wells. [67]

Figure 11: Types of damage that could be encountered in the cement sheath: A) radial cracks, B) microannulus on the interface with the casing and formation rock, and C) disking cracks in a well log.[68] Used with permission from Elsevier.



The data available suggest that methane migration along the microannulus is the most common integrity issue. The source of a methane leak detected at the surface could be the shale reservoir or other methane-bearing strata in the overburden, including shallow biogenic methane sources. However, the rate of methane leakage along any potential microannulus is likely to be low because of the limited aperture and long length of this pathway and the limited driving mechanism.[69]

5.1.4 Potential fluid migration pathways in decommissioned and abandoned wells

As outlined in Section 3.6, the goal of abandoning a well is to ensure well integrity in perpetuity, re-establishing the natural barriers to the vertical movement of fluid (gas, oil or water) that existed before

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[65] Dusseault et al. 2000.
[66] Loizzo et al. 2011.
[67] Loizzo et al. 2011.
[68] Lecampion et al. 2011.
[69] Rocha-Valadez et al. 2014.

the well was drilled. Cement plugs are placed in the well (**Figure 5** and **Figure 12**), creating a barrier to flow within the well, and the combination of casing and cement creates a barrier.

For a leak to occur in an abandoned well, whether the leak is to the surface or cross flow subsurface between different geological formations, three elements are needed:[70]

- a source formation where hydrocarbons or other fluids exist in the pore space;
- a driving force between the source formation and the surface (in the case of leakage to surface), or between different geological formations (in the case of subsurface cross flow); such driving forces could be a difference in pressure, temperature, salinity or buoyance; and
- a leakage pathway between the source formation and surface, or between different geological formations.

Figure 12 shows a schematic of potential leakage pathways along an abandoned well. Well leakage or failure has been attributed to poorly cemented casing or hole annuli, casing failure and abandonment failure for abandoned wells.[71] Also, preferential pathways for fluid flow that have been identified are interfaces between cement and formation rock or casing, and casing and cement plug for abandoned wells.[72] In the cement sheath, migration of fluid could also occur through fractures, channels and the pore space. In the latter case, fluid flow would occur only when the cement sheath was degraded or did not form properly during the cementing process.[73]

For shale gas wells abandoned using current practices, if any of these leakage pathways were to develop, they are unlikely to allow large fluid flow rates. The small cross-sectional areas and long vertical lengths of the pathways will limit flow. Also, shale gas resources are unlikely to have large driving forces for flow once production is completed because they will generally be depressurised. The characteristically low permeability of shale gas resources will also limit the amount of gas available to flow along a well.

The National Petroleum Council (**NPC**) in the United States is an oil and natural gas advisory committee to the Secretary of Energy that comprises industry and non-industry members. A working group of the NPC made certain observations about abandonment practices:[74]

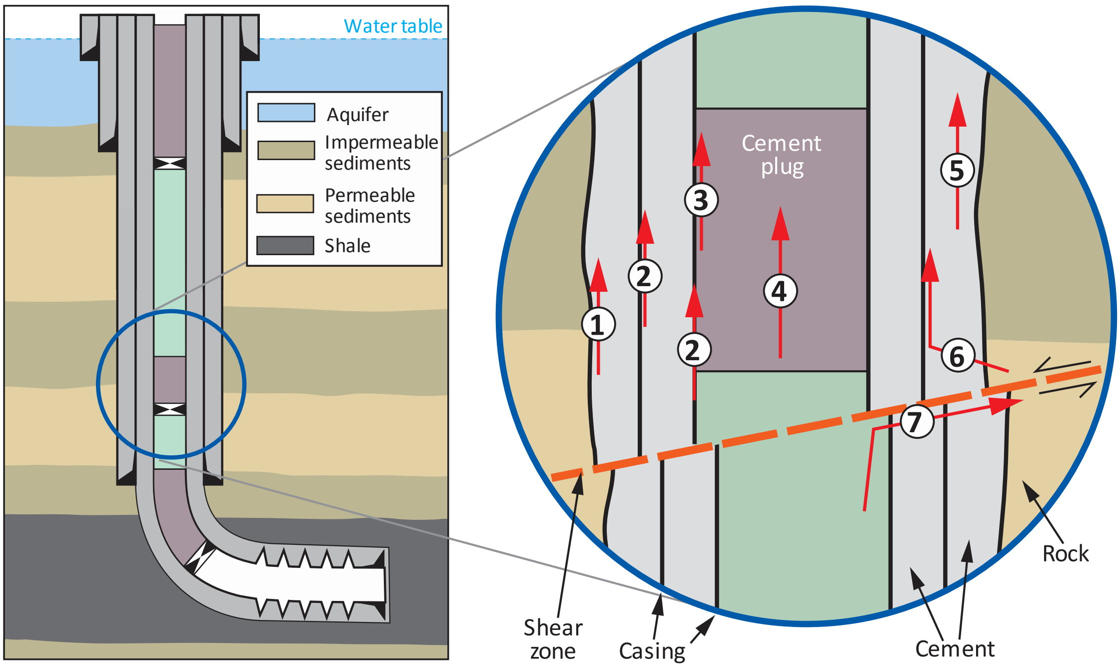
- the underlying technologies used have not seen significant progress since the 1970s, and there is room for innovation;
- abandonment is a cost for oil and gas companies, and any benefits may not be valued by the companies;
- companies are likely to minimise costs while meeting the minimum standards imposed by regulators – this contrasts with well integrity management during the rest of the well life cycle, where maintaining safety, production and operating efficiency are clear benefits to industry.[75]

The composition of fluids in the reservoir and formations that the well passes through will influence the durability of the casing and cement. Saline groundwater may corrode the casing, and the presence of CO_2 or hydrogen sulphide (**H_2S**) may also affect the casing and cement. The composition of shale gas is similar to that of natural gas in conventional reservoirs. Shale gas is typically a dry gas that contains 60-95% by volume methane and nitrogen, with ethane, propane, noble gases, oxygen and CO_2. The gases CO_2 and H_2S are referred to as sour gases because they can create an acid environment. CO_2

[70] Watson 2004.
[71] Watson and Bachu 2009.
[72] Gasda et al. 2004.
[73] Zhang and Bachu 2011.
[74] NPC North America 2011.
[75] Smith et al. 2016.

concentrations are typically in the range 0-10% by volume.[76] H_2S can occur naturally in some resources, typically at trace concentrations. H_2S generation as a result of hydraulic fracturing activities has also been reported.[77]

Figure 12: Routes for fluid leakage in a cemented wellbore: 1) between cement and surrounding rock formations, 2) between casing and surrounding cement, 3) between cement plug and casing or production tubing, 4) through cement plug, 5) through the cement between casing and rock formation, 6) across the cement outside the casing and then between this cement and the casing, 7) along a shear through a wellbore. After Davies et al.[78]



Durability of casing

Corrosion attacks every metal component, including casing, at all stages in the life of an oil or gas well.[79] Casing damage and loss of well integrity due to corrosion have been widely reported.[80] The cement quality, and cement sheath and bonding integrity are critical in protecting the casing from external corrosion. Factors that will expose the casing to corrosive fluids (if present) and therefore start the process of corrosion are degradation and failure in the cement sheath, and de-bonding of the interfaces along the casing and rock formation.

The impact of CO_2 corrosion on low-alloy steels has been studied extensively at pressures relevant for oil and gas transport (up to 1 MPa CO_2 pressure). A comprehensive review by Choi et al on corrosion of well-casing materials under high pressure for wet and supercritical CO_2 is relevant to geological storage of CO_2.[81] The review found that the corrosion rate of carbon steel under high CO_2 pressure without protective iron carbonate ($FeCO_3$) – that is, in the early stage of exposure – can be as high as about

[76] Speight 2013.
[77] Pirzadeh et al. 2014.
[78] Davies et al. 2014.
[79] Brondel et al. 1994.
[80] Bazzari 1989; Vignes and Aadnoy 2010; Watson and Bachu 2009.
[81] Choi et al. 2013.

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20 mm/year. The corrosion rate can decrease to low values (~0.2 mm/year) in long-term exposure because of the formation of a protective film or scale of $FeCO_3$ on the steel surface.

Corrosion rates depend on the type of steel used. Rates are higher for mild carbon steel (~0.1-1 micrometre/year in favourable conditions such as high pH, and up to 1 mm/year in the case of chloride-induced localised corrosion) than for stainless steel or steel coated with corrosion-resistant material (fractions of a micrometre/year).[82]

A relatively long-term experimental study (up to 1,000 hours) looked at corrosion of casing materials (J55 and N80 steels) exposed to wet and supercritical CO_2 under elevated temperature and pressure.[83] The study confirmed the formation of a protective layer of the corrosion product $FeCO_3$. The corrosion rate decreased dramatically with an increase in test duration, from several mm/year at the initial 100 hours to 0.1 mm/year after 1,000 hours because of the protective effect of the $FeCO_3$ scale formation. The study also evaluated the effect of H_2S (20 ppm) and CO (2,000 ppm) on the corrosion rate of the casing steel. In the presence of these impurities, the weight loss of the casing material was lower than with pure CO_2. The authors concluded that, given the protective effect of $FeCO_3$, there would be little corrosion of the steel casing over a long period of time under stagnant conditions. This means that casing in the reservoir under CO_2 geological storage conditions is likely to remain in place with little structural degradation.

Durability of cement

The cement used in well construction and abandonment is designed to have a long life span. Although no publications were found on the long-term durability of the cement under shale gas well conditions in Australia, studies have investigated cement degradation under simulated CO_2 geological storage conditions.[84] Laboratory experimental studies have focused on the characterisation of cement and of behaviour at the interface of cement and rock, or cement and casing, when exposed to high levels of CO_2. Although CO_2 is a common component of shale gas resources, the conditions in CO_2 storage scenarios are likely to be more challenging for well integrity than would be expected in the Northern Territory's shale gas resources.

Extensive experimental and numerical modelling studies have been conducted to investigate the rate of the interaction between well cement and CO_2 under geologic storage conditions. When pre-cured cement cores are exposed to stationary CO_2 saturated water and supercritical CO_2, the cement alters. This alteration is characterised by a series of concentric fronts of carbonation and dissolution, penetrating from the interface between the fluid and the cement into the unaltered cement core.[85]

Cement integrity is closely associated with the degree of cement carbonation. In general, moderate carbonation of well cement under CO_2 geological storage conditions reduces porosity and permeability, and increases mechanical strength of the cement. However, excessive carbonation has been reported to cause crack formation and loss of compressive strength (although what constitutes the "excessive carbonation" remains a topic for research).[86] For ordinary Portland cement without additives, most experimental studies suggest a carbonate layer thickness of 1-133 mm after 30 years of exposure to CO_2 saturated **brine** or supercritical CO_2. The rate of carbonation is expected to decrease with the increase of exposure time, because the carbonate layer formed in the early stage of exposure has lower porosity than that of the neat cement, hindering penetration of CO_2 and advancement of the

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[82] Elsener 2005; Kreis 1991.
[83] Azuma et al. 2013.
[84] Azuma et al. 2013; Satoh et al. 2013.
[85] Zhang et al 2015.
[86] Zhang et al 2015.

carbonate layer towards the interior of the cement.[87] The rate of cement carbonation is affected by temperature, pressure, salinity and mineral compositions of the host rock.

The long-term degradation behaviour of cement in abandoned wells under CO_2 geological storage conditions was evaluated by numerically simulating the **geochemical** reactions between the cement seals and CO_2.[88] The model was validated based on the laboratory experimental results by Satoh et al. before being applied to abandoned wells.[89] It was assumed that supercritical CO_2 or CO_2 saturated water was in contact with the cement. The geochemical simulation of the reactions yielded the extent (length) of the alteration of the cement seals after long periods. For example, the alteration length of cement seals after 1,000 year exposure was about 1 m, leading to the conclusion that cement would be able to isolate CO_2 in the reservoir over the long term.

Several studies have investigated the effect of well cement exposed to a mixture of the acid gases CO_2 and H_2S.[90] The studies have shown that, given a moderate concentration of H_2S in the acid gas (that is, less than 66 mol% H_2S), porosity and permeability changes of the cement are mainly determined by how much of the carbonate species is formed. Formation of sulphur-bearing minerals as a result of interaction between cement and H_2S does not result in significant porosity and permeability changes to the cement, or loss of mechanical strength.

The literature on corrosion and cement degradation considers CO_2 stored at high pressure to be more aggressive than methane.[91] Therefore, it can be concluded that the risk of long-term leakage from shale gas wells (from both casing and cement) would be minimal, provided that shale gas wells are properly designed, installed and maintained. However, there is scope for additional research to specifically assess the impact of abandoned shale gas wells over an extended timeframe.[92]

Durability of cement bonds

As discussed in Section 5.1.2, cement debonding is one of the mechanisms that could compromise well integrity. Permeability evolution along the interfaces (between cement and casing, and cement and host rock) due to flow of CO_2 saturated brine was evaluated in several injection experiments. Microannuli were created artificially between the cement and the casing or host rock, or within the cement core. However, the results from such experiments are not consistent. For example, Carey et al. and Newell and Carey observed an overall decrease in permeability of a cement-steel casing system and a cement-caprock system.[93] This decrease in permeability (or self-healing of defects) was mainly attributed to the migration of re-precipitation of alteration products; that is, $FeCO_3$ for a cement-steel casing system and $CaCO_3$ for a cement-caprock system within the microannulus (interfaces). In contrast, Cao et al. observed that the defects in cement were significantly enlarged, and the overall permeability of the cement-caprock system increased by a factor of eight after 10 days of CO_2 saturated brine flooding.[94] Different flow rates and interface apertures applied during the studies may have contributed to the different results; for example, Cao et al. used a higher flow rate than was used in some of the other studies.

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[87] Zhang et al 2015.
[88] Yamaguchi et al. 2013.
[89] Satoh et al. 2013.
[90] Jacquemet et al. 2012; Kutchko et al. 2011; Zhang et al 2015.
[91] Popoola et al. 2013.
[92] NSW Chief Scientist and Engineer, 2014.
[93] Carey et al. 2010; Newell and Carey 2013.
[94] Cao et al. 2013.

Several hypothetical scenarios were simulated in a study by Connell et al.[95] In one scenario, it was found that, for a flow channel 0.01 cm wide, the erosion front took 8 years to travel 50 m for a high deficit in calcium solubility (~400 mg/l) and a pressure gradient (above the hydrostatic gradient) of 0.5 MPa/100 m. The erosion front migration rate dropped significantly with decreased initial channel width; for an initial width of 0.005 cm, the erosion front had migrated 25 m after 12 years. Since the rate of migration drops with distance up the flow channel, the remaining 25 m for the 0.005 cm case would have taken considerably longer than the first 25 m. After the erosion front had broken through the cemented zone of the seal, there was an initial rapid increase in the volumetric flow rate, representing a loss of containment of stored CO_2. These hypothetical scenarios highlight the importance of microannuli in connectivity between different geological formations.

5.2 Well barrier and integrity failure mechanisms summary

Commonly considered well barrier integrity failure mechanisms can be broadly summarised into three categories:

- well integrity failure before installation of casing;
- integrity failure of cement; and
- integrity failure of casing.

Historically, the highest instance of well barrier integrity failures appears to be related to insufficient or poor-quality cementing coverage to seal aquifers or non-reservoir hydrocarbon-bearing formations. In older wells, this was probably due to a lack of information on non-reservoir hydrocarbon-bearing geological layers and the regulatory regime under which the wells were constructed.

The other common well barrier failure mechanism is associated with degradation of the cement sheath and cement bonds to the casing and rock formation. This failure mechanism can be exacerbated if the well is subjected to cyclic pressures, stresses and temperatures. There is a growing body of research on cement durability in the context of CO_2 storage, which is considered to be a more corrosive environment (that is, corrosive formation and reservoir fluids) than methane gas. This research suggests that the degradation length of cement seals after a theoretical 1,000 year exposure would be about 1 m. In a corrosive environment, failure of the metal casing can also occur through corrosion of the metal components of the well.

If a well barrier failure is observed or suspected to have developed, technologies, tools and mitigation measures are available to confirm the failure mechanisms, identify their extent and conduct mitigation operations.

5.2.1 Well integrity failure before casing installation

Before the casing and cement are installed into the borehole, there is the possibility of unintended fluid flow out of or into the borehole. These failures of well control could be caused by:

- drilling fluid pressure that is significantly less than the formation pore fluid pressure;
- overpressured formations or reservoirs;
- drilling fluid pressure that is greater than formation pressure in fractured or permeable formations; or

[95] Connell et al. 2015.

- drilling fluid pressure inducing hydraulic fractures.

Factors that mitigate these failures or the consequences of these failures include:

- identification of geological **hazards** before drilling;
- monitoring of drilling fluid pressure and volume; and
- well control equipment.

5.2.2 Well barrier integrity failure of cement

Failure of the casing cement though degradation, debonding, or insufficient or poor placement of cement could create a conductive pathway and allow movement of fluid or gas up the cement annulus outside the casing. This conductive pathway between formation pore fluids in different geological layers could provide a mechanism for fluid flow if there was a pressure differential or for gas flow driven by buoyancy. Causes of this type of well failure could include:

- unidentified hydrocarbon-bearing formation;
- poor wellbore condition due to excessive borehole breakout or washout;
- poor hole cleaning and mud conditioning, resulting in mud channelling in the cement sheath;
- cement slurry loss into fractured formations;
- uncentralised casing pipe, resulting in a partial cement sheath;
- cement shrinkage;
- cyclic wellbore pressures and temperatures; or
- cement degradation in a corrosive environment.

Factors that mitigate these failures or the consequences of these failures include:

- good quality geological information, including fractured formations or zones, and identification of hydrocarbon-bearing formations in the overburden and aquifers;
- good drilling practices to provide high-quality intact borehole for cementing;
- cement bond logging to investigate the integrity of the cement sheath; and
- remedial cement repairs applied to identified problem zones.

5.2.3 Well barrier integrity failure of casing

Failure of the wellbore casing though corrosion, burst or collapse could allow loss of wellbore fluid to the surrounding rock. Causes of these failures could include:

- corrosive formation or reservoir fluids;
- poorly cemented casing;
- internal damage or wear to casing; or
- a large pressure difference between the internal and external fluids.

Factors that mitigate these failures or the consequences of these failures include:

- casing pressure monitoring;
- Inspection of casing using multifinger caliper logs, magnetic thickness tool and borehole cameras; and
- casing patching or repair.

5.3 Well failure rates

Compromised well integrity or barrier failure can be an issue in oil and gas production operations. Several studies have identified single-barrier integrity issues in a significant percentage of oil and gas wells; however, the available data indicate that rates of complete well integrity failure (multibarrier failure) affecting groundwater are low. This section reviews barrier and well failure rates reported in open-source international literature for oil and gas wells, with data primarily from North America. The literature presented primarily covers conventional oil and gas resources. Well integrity risks and potential consequences are influenced by the resource characteristics, as outlined in Section 2, and this situation also applies to shale gas wells. There are enough similarities in the well construction methods and the geology (given that shale gas wells are often drilled in the same sedimentary basins as conventional oil and gas wells) for studies of well integrity in other settings to provide an indicator of potential well integrity issues in shale gas development. Data on the integrity of shale gas wells are included in several studies of oil and gas well integrity, and in two studies on unconventional wells. The data presented allow a comparison of shale gas wells with other types of oil and gas wells.

5.3.1 Oil and gas well failure rates in Ohio and Texas, United States

A comprehensive study on groundwater contamination incidents related to conventional oil and gas activities in Ohio and Texas, United States by Kell covered a large well population at different phases of the well life (**Table 1**).[96] It included incidents related to well integrity and those resulting from other activities, including leakage from surface pits, transport and storage of **produced water** and oil, and waste disposal. The data are predominately for conventional oil and gas wells, although the data from Texas include 16,818 wells drilled for shale gas and oil, primarily in the Barnett Shale.

Table 1: Summary of well numbers in the study of wells in Ohio and Texas, United States.[97]

Operation stage	Number	
	Ohio (1983-2007)	Texas (1993-2008)
Wells drilled	34,000	187,788
Hydraulic fractured wells	27,969	> 13,000
Producing wells	50,342-64,830	237,136-253,090
Wells plugged	28,000	140,818

The average depth of wells drilled in Ohio was 1,140-1,446 m (3,745-4,745 feet) during the study period (1983-2007). In Texas in 2007, the average depth was 2,517 m (8,258 feet). The groundwater contamination incidents and related contamination causes are summarised in **Table 2**; in relation to well-related groundwater contamination incidents, contamination from the orphaned wells had the highest number of reported incidents. For non-well-related incidents, contamination from surface pits or storage tanks had the highest number of reported incidents.

[96] Kell 2011.
[97] Kell 2011.

Table 2: Summary of groundwater contamination incidents at different stages of the well life cycle. Numbers of well integrity incidents related to groundwater contamination are shown in parentheses.[98]

Operation stage	Number	
	Ohio (1983-2007)	Texas (1993-2008)
Site preparation	0	0
Drilling and completion	74 (11)	10 (6)
Hydraulic fracturing	0	0
Production	39 (12)	56 (6)
Orphaned wells	41(41)	30 (28)
Waste management and disposal	26 (16)	75 (6)
Plugging and site reclamation	5 (4)	1 (1)
Unknown	0	39
Total number of incidents	185 (84)	211 (47)

King and King estimated barrier and well failure rates using the data from Kell's study (**Table 3**).[99] The barrier failure rate was 0.1-0.035% and the well failure rate was one order of magnitude lower than that. King and King defined a well barrier as "*a means of containing wellbore pressure and fluids*", and well failure as *"all well barriers failing in sequence and a leakage pathway being created across all the well barriers"*.[100]

The study by Kell relied on reported contamination incidents,[101] and there may have been integrity issues in other wells that did not result in contamination of a drinking water well or were not noticed and reported. Therefore, the barrier failure rate and well failure rate in the study should be considered a low-end estimate of the number of well integrity issues.

Table 3: Estimates of well barrier failure and well failure rates. Modified from King and King, primary data from Kell.[102]

State	Number of wells	Barrier failure frequency range (containment)	Well integrity failure range (containment lost)	Leaks to groundwater by sampling
Ohio	64,830	0.035% in 34,000 wells (0.1% in older wells – worst case)	0.06% for all wells	Details not available
Texas	253,090	0.02% all wells	0.02% for older era wells; 0.004% for newer wells	0.005-0.01% for producers; 0.03-0.07% for injectors
Texas	16,000 horizontal, multifractured	No failure reported	No failure data or pollution reported	No well-associated pollution

In Texas, no groundwater contamination incidents related to hydraulic fracturing were identified over the study period, during which large-volume, multistaged hydraulic fracturing operations for shale gas well stimulation were carried out in over 16,000 Barnett Shale wells. This may be because the wells were characterised while they were still young, so the failure mechanisms described earlier may have

[98] Kell 2011.
[99] King and King 2013.
[100] King and King 2013.
[101] Kell 2011.
[102] Kell 2011; King and King 2013.

not yet had a chance to develop. Intensive, long-term monitoring of stimulated wells would be required to establish whether groundwater contamination occurs over longer timeframes. Only one shale wells was drilled in Ohio during the study period.

5.3.2 Oil and gas well failure rates in Alberta, Canada

In the context of assessing site suitability for CO_2 storage in geological media, Watson and Bachu evaluated the potential for gas and CO_2 leakage along existing oil and gas wells by analysing a large dataset collected by the Alberta Energy Resources Conservation Board (**ERCB).[103]** The database contains information for more than 315,000 conventional oil, gas, and injection wells in the province of Alberta, Canada. No shale gas or oil wells were included in this study because the development of these resources in Alberta is at the exploratory stage. The ERCB records well leakage at the surface as either surface-casing-vent flow (referred to in the industry as **SCVF**) through wellbore annuli or gas migration (referred to in the industry as **GM**) along the outside of the casing. Surface-casing-vent flow occurs when gas enters the exterior production casing annulus from a source formation below the surface **casing shoe**, and flows to surface through the annulus when the casing vent is open, or builds gas pressure in the annulus when the casing vent is closed. Gas migration occurs when gas migrates along the outside of the cemented surface casing (**Figure 13**). The ERCB requires that all wells drilled and cased be tested for surface-casing-vent flow within 60 days of drilling rig release and before final abandonment. Wells must be repaired immediately if they have:

- positive surface-casing-vent flow and exhibit gas flow rates greater than 300 m^3/day;
- a stabilised surface-casing build-up pressure that is greater than the water hydrostatic pressure gradient to the depth of the surface-casing shoe; or
- liquid hydrocarbon flow or saline water flow.

Wells with positive surface-casing-vent flow that fall below these criteria must be checked regularly, with results reported to the ERCB and with repairs carried out at the time of abandonment.

Insufficient cement height in the annulus or poor-quality cement is the cause of surface-casing-vent flow and gas migration. However, producing reservoirs are often not the source for the surface-casing-vent flow and gas migration.[104] As illustrated in **Figure 13,** the gas for the surface-casing-vent flow and gas migration commonly originates from a thin intermediate depth gas zone. The wellbore interval in the reservoir and adjacent formations is often sealed with high-quality cement due to a significant water loss of the cement slurry in the reservoir section during cementing.[105] Conversely, intermediate and shallow depth intervals are often sealed with lower quality cement with a number of filler additives, which do not always generate good primary cement seals. [106]

Figure 14 shows historic drilling activity and occurrence of surface-casing-vent flow and gas migration in Alberta over the past 100 years, both as a percentage of wells drilled in a given year and as a cumulative figure over time. As shown in **Figure 14**, the percentage of cumulative wells with surface-casing-vent flow and gas migration is about 4.6%. The ratio of wells with surface-casing-vent flow and gas migration to the wells drilled decreased from over 4% in 1995 to below 2% in 2005 (**Figure 14**), probably as a result of important regulatory changes, which require that any leaking wells be repaired before well abandonment. An alternative explanation for this reduction is the age of wells. Since about

[103] Watson and Bachu 2009.
[104] Watson and Bachu 2009.
[105] Dusseault and Jackson 2014.
[106] Watson and Bachu 2009.

1995, there has been a significant increase in the number of wells drilled. These relatively new wells had a maximum age of about 10 years when the study was carried out; consequently, the well failure mechanisms (for example, corrosion) leading to the surface-casing-vent flow and gas migration may have not developed sufficiently to cause an evident problem.

Figure 13: Schematic of gas migration (left side of wellbore) and surface-casing-vent flow (right side of wellbore), originating from a thin, intermediate-source depth zone. Modified from Dusseault et al. 2014.[107]

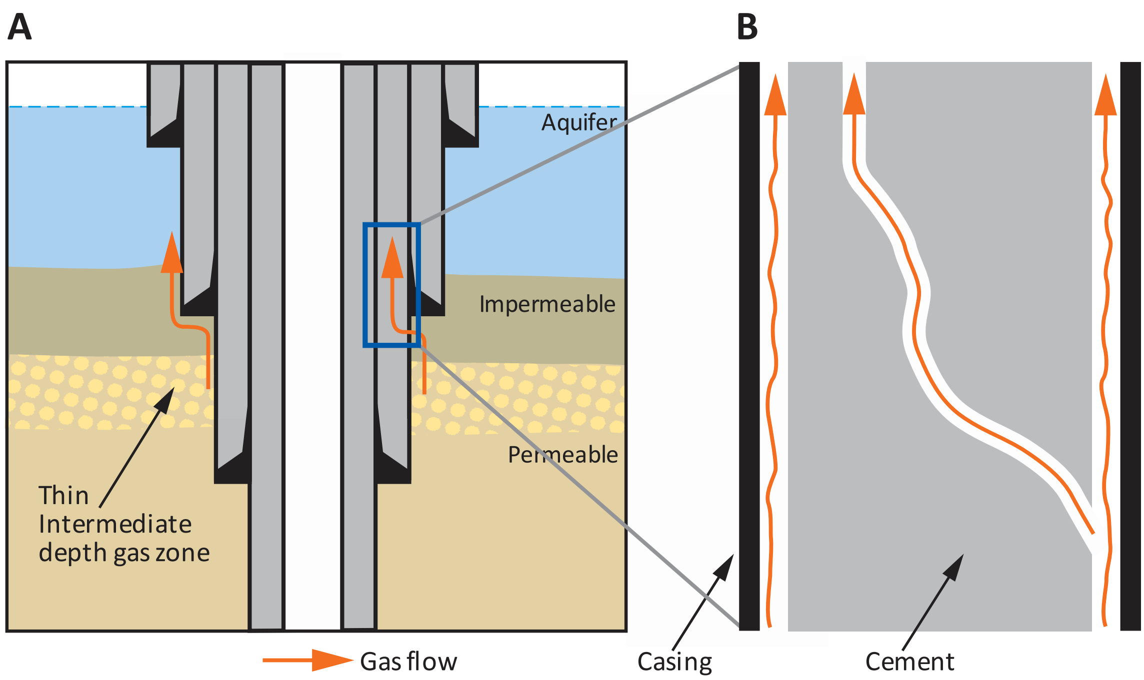
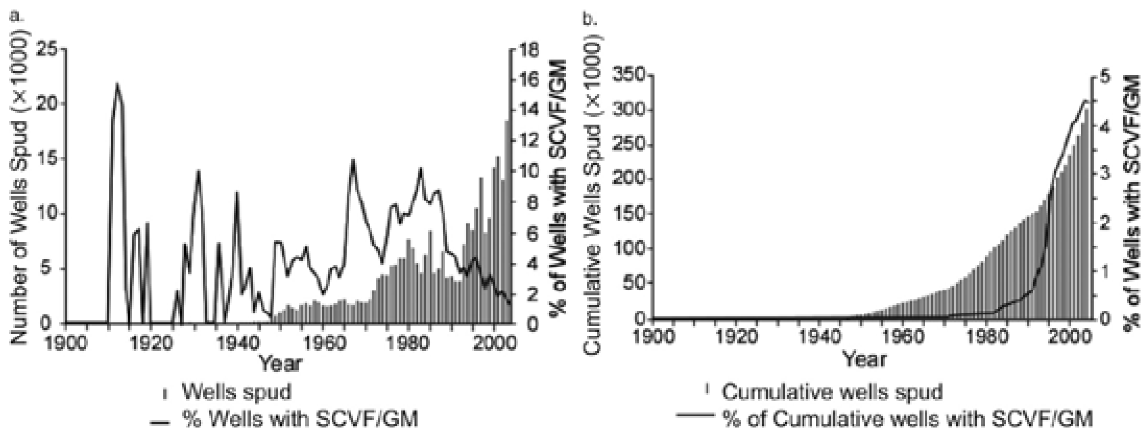


Figure 14: Historical levels of drilling activity and surface-casing-vent flow and gas migration occurrence in Alberta: (a) by year of well drilling commencement and (b) by cumulative wells drilled.[108] Used with permission Society of Petroleum Engineers.

GM, gas migration; SCVF, surface-casing-vent flow



[107] Dusseault et al. 2014.
[108] Watson and Bachu 2009.

Watson and Bachu identified six factors that have a major impact on the occurrence of surface-casing-vent flow and gas migration: geographic area; **well deviation**; well type; abandonment method; oil price, regulatory changes; and un-cemented casing and hole annulus. These factors are discussed below.

Geographic area

The occurrence of surface-casing-vent flow and gas migration is more likely in a test area designated by ERCB for special testing requirements for leakage. **Table 4** compares surface-casing-vent flow and gas migration occurrence in Alberta and within the test area. The percentage of wells with surface-casing-vent flow and gas migration is significantly higher in the test area than the average value in Alberta. The greater percentage of reported leakage may be a reflection of the testing requirements in the test area. However, the more stringent testing requirements could have arisen because of historical well integrity problems in the test area. Saponja discussed typical geological formations that made obtaining and maintaining an adequate cement seal much more difficult in the test area.[109] Furthermore, enhanced oil recovery and other stress-inducing operations that are performed in the area can significantly increase the potential for surface-casing-vent flow and gas migration to occur.[110]

Well deviation

Deviated wells have paths that 'deviate' from the vertical. As shown in **Table 4**, well deviation has a major impact on the occurrence of surface-casing-vent flow and gas migration in the test area. Poor casing centralisation was suspected to be the main reason for the poor cement seals and the resulting increase in well leakage. Casing that is not properly centred in the well may have caused insufficient mud displacement and non-uniform placement of the cement slurry, resulting in mud channels in the cement sheath or partial coverage of the casing.

Table 4: Occurrence of surface-casing-vent flow and gas migration in a test area compared with Alberta province. Data from Watson and Bachu[111]

GM, gas migration; SCVF, surface-casing-vent flow

	Alberta	Test area	% of deviated wells in the test area	Deviated well in the test area
Total number of wells	316,439	20,725	6.5%	4,560
Wells with SCVF	12,458	1,902	15.3%	1,472
Wells with GM	1,843	1,187	64.4%	1,550
Wells with GM/SCVF	176	116	65%	-
SCVF percentage	3.9%	9.2%	-	32.3%
GM percentage	0.6%	5.7%	-	34%
Combined percentage	4.6%	15.5%	-	66%

Well type

The study by Watson and Bachu showed that the drilled and abandoned wells (for example, exploration wells not developed as production wells) reported a surface-casing-vent flow and gas migration occurrence rate of about 0.5%, whereas the overall occurrence rate for all wells was about

[109] Saponja 1999.
[110] Dusseault and Jackson 2014.
[111] Watson and Bachu 2009.

4.6%.[112] The cased and abandoned wells had an overall occurrence rate of about 14%. The cased wells accounted for more than 98% of all well leakage cases reported. The authors attributed their results to historical changes in abandonment requirements for drilled and abandoned wells. The findings may also be due to the fact that the cased and abandoned wells had a long producing life, and the stimulation and production operations created a gas pathway behind the casing, whereas a well that is drilled and immediately abandoned and plugged with a number of long cement plugs does not have such a potential for fluid pathway development.[113]

Abandonment method

The predominant method for well abandonment in Alberta was bridge plugs capped with cement, placed using the dump-bailer method. It was found that this method may not be adequate in providing a sufficient cement seal in the long term.[114] Other abandonment methods – such as placing a cement plug across completed intervals using a balanced-plug method or setting a cement retainer and squeezing cement through **perforations** – are expected to have lower failure rates in the long term.

Oil price, regulatory changes and surface-casing-vent flow and gas migration testing

Watson and Bachu found that the occurrence of surface-casing-vent flow and gas migration correlated strongly with oil price in the period between 1973 and 1999 (**Figure 15**).[115] This correlation may be explained by the level of activity and equipment availability impacting wellbore construction practices in the field. Furthermore, higher prices were accompanied by economic incentives to develop the heavy oil area in Alberta that broadly correspond to the test area. Heavy oil wells require thermal stimulation; high well density; and deviated, directional and horizontal well technology. The correlation between oil price and occurrence of surface-casing-vent flow and gas migration started to diverge in 2000. This may be a reflection on the effect of the regulatory change that began in the mid-1990s.

Un-cemented casing and hole annulus

Watson and Bachu found that insufficient cement height and an **openhole** annulus are the most important indicators for occurrence of surface-casing-vent flow and gas migration.[116] These factors have a significant impact on external casing corrosion, which can create potential leaks through the casing wall. The authors analysed the logs of 142 wells to assess the casing and the cement bond quality, and observed that:

- most of the significant corrosion occurs on the external wall of the casing;
- a significant portion of wellbore length is un-cemented;
- external casing corrosion is most likely to occur in areas where there is no or poor cement; and
- some wells showed that external casing corrosion was located in the area with good cement quality; in most of these cases, channelling within the cement sheath accounted for the external casing corrosion.

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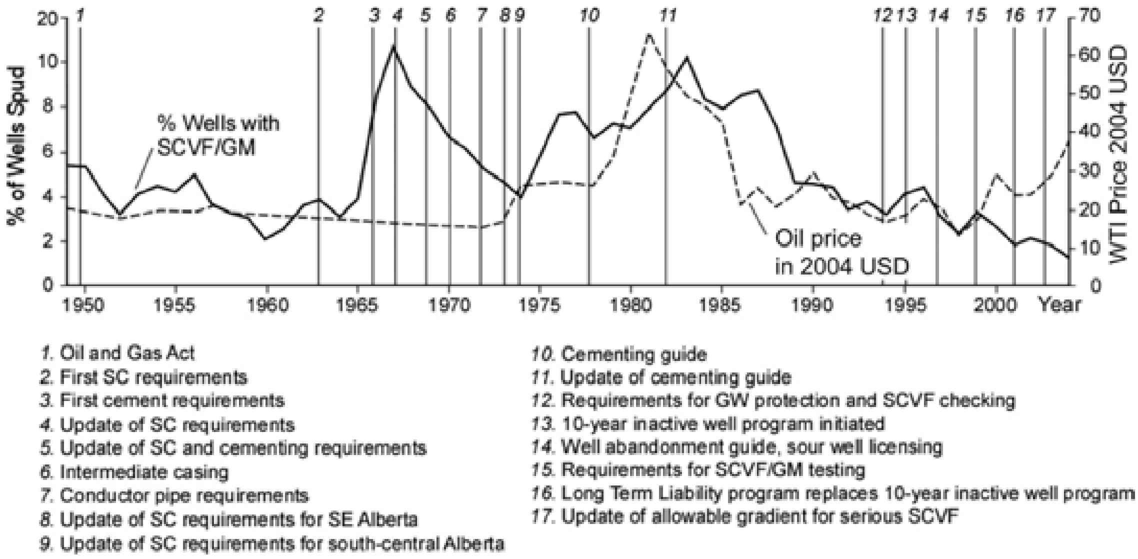
[112] Watson and Bachu 2009.
[113] Dusseault and Jackson 2014.
[114] Watson and Bachu 2009.
[115] Watson and Bachu 2009.
[116] Watson and Bachu 2009.

Figure 15: Occurrence of surface-casing-vent flow and gas migration in Alberta in relation to oil price and regulatory changes.[117] Used with permission Society of Petroleum Engineers.

GM, gas migration; GW, groundwater; SC, surface casing; SCVF, surface-casing-vent flow



5.3.3 Oil and gas well failure rates in Colorado, United States

Wattenberg Field, Denver-Julesburg Basin

Stone et al. conducted a risk assessment of fresh water aquifer contamination due to hydrocarbon or hydraulic fracturing fluid migration from oil and gas wells in Wattenberg field, the largest field in the Denver-Julesburg Basin in Colorado, United States.[118] The Wattenberg Field is predominately a conventional oil and gas field that has been actively developed since the 1970s, with tight gas development involving hydraulic fracturing in later years. Development of shale gas resources has been the focus since 2010, with 973 horizontal wells drilled by 2013. Water aquifer contamination was determined based on detection of **thermogenic** gas or other identified hydrocarbons or fracturing fluids in water wells that are within a radial distance of 0.5 miles from the oil and gas well. The study analysed data from 17,948 wells drilled between 1970 and 2013. It identified possible well barrier failures by remedial cementing operations below the surface casing shoe. The study assumed that remedial cement operations at shallow depths are generally characterised by faulty barriers and the possible presence of sustained casing pressure. Well integrity failures (or catastrophic barrier failures) resulting in migration of hydrocarbons to aquifers were identified by detection of thermogenic gas in **offset** water wells, combined with evidence of catastrophic barrier failure in the adjacent oil and gas wells.

Surface casings of wells drilled in the field in the 1970s were set at a shallow depth, insufficient to fully protect the aquifers. Later, cement remediation was performed below the surface casing shoe to rectify the problem. Since 1994, the surface casing has been set deeper to protect the aquifer. Furthermore, in the 1970s, the top of the production casing cement was designed to cover ‘known’ hydrocarbon-bearing formations. However, shallow hydrocarbon-bearing formations were not

[117] Watson and Bachu 2009.
[118] Stone et al. 2016b.

discovered until the early 1980s. These overpressured shallow formations have low permeability, and the production cement was not designed to isolate them in the annulus; only since the 1990s have the production cement tops been designed to cover the shallow hydrocarbon-bearing zones.

The wells in the field were categorised based on the well barriers; specifically, the shoe depth of the surface casing, the top of the cement in the production annulus and the number of intermediate casings (**Table 5**). A well in a higher category has a higher number of well barriers and a lower risk of well failure.

Table 5: Wellbore barrier categories, ranked from highest risk to lowest risk. Modified from Stone et al.[119]

Barrier	Category	Surface casing	Intermediate casing strings	Level of top of production casing cement	Risk level
1	1	Shallow		Below overpressured hydrocarbon reservoir	High
1	2	Shallow		Below under pressured hydrocarbon reservoir	↓
2	3	Shallow		Above top of gas	
2	4	Shallow		Above surface casing shoe	
3	5	Deep		Below under pressured hydrocarbon reservoir	
3	6	Deep		Above top of gas	
4	7	Deep		Above surface casing shoe	
5	8	Deep	1	Below top of gas	
4	9	Shallow	1	Above casing shoe	
6	10	Deep	1	Above top of gas	
6	11	Deep	1	Above casing shoe	
8	12	Deep	2	Above casing shoe	Low

The rates of barrier and well failures for the wells in the field were analysed based on well category, and are summarised in **Table 6** for vertical and horizontal wells. No wells of Category 8-12 exist in this field (all the wells have no intermediate casing).

Of the 17,948 wells studied, 10 wells (or 0.05% of original wells) were identified as having well failure (catastrophic barrier failure). Nine wells had a shallow surface casing set above the base of the aquifer, and the other well in Category 5 had deep surface casing and no evidence of water aquifer contamination. However, this latter well had elevated benzene levels at the surface near the well, which could have been due to surface leaks in the flowline or production tank; therefore, it was also included in the count for well failure.

A total of 418 vertical or deviated wells (2.48% of the original wells) were identified as having potential barrier failures that required cement remediation below the surface casing shoe. The shallow surface casing, coupled with the age of the wells, led to sustained casing pressure and subsequent cement remediation. However, no evidence of thermogenic gas migration to the aquifer was found associated with the potential barrier failures from the water testing in adjacent water wells. The most common barrier failure is insufficient surface-casing depth and inadequate production cement design. For wells that had been designed and constructed correctly, no well failures were observed.

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[119] Stone et al. 2016a.

Table 6: Potential barrier and well failures in the Wattenberg field. Modified from Stone et al. 2016. [120]

Cat., category; D & A, drilled and abandoned; P & A, plugged and abandoned

	Vertical deviated wells					Horizontal wells				
Well category	**Original well count**	**Potential barrier failures**	**Potential barrier failure rate (%)**	**Well failures**	**Well failure rate (%)**	**Original well count**	**Potential barrier failures**	**Potential barrier failure rate (%)**	**Well failures**	**Well failure rate (%)**
Cat. 1	166	100	60.24	3	1.81	0	0	0	0	0
Cat. 2	621	219	35.27	5	0.81	0	0	0	0	0
Cat. 3	46	16	34.78	1	2.17	0	0	0	0	0
Cat. 4	7	0	0	0	0	0	0	0	0	0
Cat. 5	8,789	77	0.88	1	0.01	0	0	0	0	0
Cat. 6	5,433	6	0.11	0	0	269	0	0	0	0
Cat. 7	1,766	0	0	0	0	704	0	0	0	0
Cat. 8 To Cat. 12	0	0	0	0	0	0	0	0	0	0
Total	**16,828**	**418**	**2.48**	**10**	**0.06**	**973**	**0**	**0**	**0**	**0**
D & A	147					0				
Total wells	16,975					973				
P & A	1105					3				

For horizontal wells that had been constructed since 2010, no barrier and well failures were identified. The study also found no evidence of hydraulic fracturing operations directly contaminating water aquifers in the field. All the well failures were related to hydrocarbon migration through the wellbore to the aquifer or surface.

No corrosion-related barrier and well failures were identified in these wells, because the produced water has lower total dissolved solids and lower salinity compositions than many gas fields in the United States.

Piceance, Raton and San Juan Basins, Colorado, United States

A risk assessment study similar to that for the Wattenberg field in the Denver-Julesburg basin was conducted for the oil and gas wells in three basins in Colorado: Piceance, Raton and San Juan.[121] The assessment confirmed that natural gas migration from poorly constructed wellbores can happen, but occurs infrequently. It also confirmed that there has been no occurrence of hydraulic fracturing fluid contamination in the three basins.

Piceance Basin

Drilling in the Piceance Basin is for conventional oil and gas resources, using vertical and deviated wells. There have been some horizontal exploration wells testing shale resources since 2008. The assessment analysed data from 10,998 wells completed between 1935 and mid-2014, of which 156 wells were drilled and then abandoned without completing for production. All the wells were

[120] Stone et al. 2016b.
[121] Stone et al. 2016a.

categorised based on their original casing and cement design (**Table 5**). Potential barrier failures were identified by any cement remediation of any casing string (not just below the surface casing shoe) or evidence of sustained casing pressure. Sustained casing pressure is common in the basin due to shallow gas shows above the top of the production cement in the annulus. In addition, effective cement isolation of the shallow gas-bearing formation is challenging because of **lost circulation** in these shallow formations. Well failures (catastrophic barrier failures) were identified as wells that had barrier failures inducing a conduit for hydrocarbon migration to water aquifers, which was confirmed by isotopic and compositional analysis from offset water wells.

The assessment found that potential barrier failures occurred in 377 of 10,842 wells (3.5% of original producing wells) in the basin (**Table 7**). Category 8 wells had the highest potential barrier failure rate (30%; 18 of the 60 wells). Even though this category had deep surface casing and an intermediate casing string, the top of the production cement was below the top of the gas-bearing formation. Furthermore, casing corrosion contributed to the higher potential barrier failure rates experienced for lower risk well barrier designs in the field. This is because the produced water had high salinity and the gas stream had an average elevated concentration of CO_2. Most of the cement remediation needed was because of holes and pitting developing in the carbon steel casing. The lower risk wells in Categories 6 and 7 had lower potential barrier failure rates (2.33-3.01%). Although the top of the production cement is designed to be above the top of gas-bearing formations for wells in these categories, the potential barrier failure rates being above zero demonstrated the challenging geological conditions that are present in the shallow formation. These conditions prevent effective isolation of production cement and sustained casing pressure from shallow hydrocarbon deposits. Nine of the 10,842 originally producing wells were identified as having well failure (catastrophic barrier failures) related to hydrocarbon migration to fresh water aquifers. All of these nine wells had high sustained casing pressure before thermogenic gas detection in offset water wells. No evidence was found of hydraulic fracturing fluid migration to fresh water aquifers or surface soil.

Raton Basin

Drilling in the Raton Basin has targeted coal bed methane (or **coal seam gas**, **CSG**) resources, with some hydraulic fracturing. There has also been some exploration for conventional and unconventional gas resources. The assessment analysed data from 3,547 wells drilled and completed between 1920 and December 2013 in the Raton Basin, with only 173 wells drilled before 1995. Some 188 of the wells were drilled and subsequently plugged and abandoned without completing for production. All the wells were categorised based on their original casing and cement design (**Table 5**). Potential barrier failures were identified by any sign of cement remediation of any casing string. Well failure (catastrophic barrier failure) was identified using the method similar to that for wells in Piceance Basin; that is, detection of thermogenic gas in offset water wells or surface soil, and evidence of well barrier failures contributing to migration of the thermogenic gas to the aquifer.

The assessment showed that the highest potential barrier failure rate occurred in wells of Category 5 or 6 (80.7% for Category 5 and 59.38% for Category 6, **Table 7**). However, cement remediation was mainly needed because of a change in regulations (which required the production cement tops to be above the previous casing shoes), rather than because of well barrier failure or development of sustained casing pressure. Most wells designed in the Raton Basin are in Category 7, which had the lowest potential barrier failure rate because of its redundant barrier designs and the top of production cement being above the surface casing shoe. Some 0.43% of wells in Category 7 received cement remediation due to cement contamination, presence of microannulus or cement cracking.

Table 7: Barrier and well failure in the Piceance, Raton and San Juan Basins.

Cat., category, D & A, drilled and abandoned; P & A, plugged and abandoned

	Piceance Basin					**Raton Basin**					**San Juan Basin**				
Well category	**Original well count**	**Potential barrier failures**	**Potential barrier failure rate (%)**	**Well failures**	**Well failure rate (%)**	**Original well count**	**Potential barrier failures**	**Potential barrier failure rate (%)**	**Well failures**	**Well failure rate (%)**	**Original well count**	**Potential barrier failures**	**Potential barrier failure rate (%)**	**Well failures**	**Well failure rate (%)**
Cat. 1	0	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
Cat. 2	48	4	8.33	0	0	23	2	8.70	1	4.35	12	0	0	1	8.33
Cat. 3	145	10	6.90	2	1.38	4	1	25.00	0	0	13	0	0	0	0
Cat. 4	5.9	10	1.96	0	0	45	1	2.22	0	0	71	0	0	0	0
Cat. 5	1,789	125	6.99	2	0.11	399	322	80.70	0	0	54	30	55.56	1	1.85
Cat. 6	6,233	145	2.33	4	0.06	32	19	59.38	0	0	348	84	24.14	0	0
Cat. 7	1,862	56	3.01	1	0.06	2,800	12	0.43	2	0.07	2,677	4	0.15	0	0
Cat. 8	60	18	30.00	0	0	7	3	42.86	0	0	64	5	7.81	0	0
Cat. 9	90	2	2.22	0	0	0	0	0	0	0	17	0	0	0	0
Cat. 10	0	0	0	0	0	20	2	10.00	0	0	148	4	2.70	0	0
Cat. 11	105	7	6.67	0	0	20	1	3.45	0	0	427	0	0	0	0
Cat. 12	1	0	0	0	0	0	0	0.00	0	0	0	0	0	0	0
Total	**10,842**	**377**	**3.48**	**9**	**0.08**	**3,359**		**10.81**	**3**	**0.09**	**3,831**	**127**	**3.32**	**2**	**0.05**
D & A	156					188					358				
Total wells	10,998					3,547					4189				
P & A	335					352					387				

Of the 3,359 original producing or shut-in wells, three (or 0.09%) were identified to have well failures, with one Category 2 well and two Category 7 wells. In one Category 2 well and one Category 7 well, the failure was due to ineffective plugging and abandonment of the wellbores rather than the initial wellbore design. The reason for the failure in the second Category 7 well was unclear because of uncertainty about the origin of the gas detected in the water well. The study also found no direct evidence that any of the hydraulic fracturing operations contaminated the fresh water aquifers in the basin.

San Juan Basin

Drilling in the San Juan Basin targeted coal bed methane (or coal seam gas) resources, with some hydraulic fracturing. There has been some exploration for conventional and unconventional gas resources, and some conventional oil production. The assessment analysed data from 4,189 wells drilled between 1901 and 2014 in the San Juan Basin, of which 358 wells were drilled and subsequently plugged and abandoned without being completed. All the wells were categorised based on their original casing and cement design (**Table 5**). Potential barrier failures were identified by any cement remediation of any casing string, based on the assumption that the remediation was needed because the oil and gas wells experienced sustained casing pressure. Well failure was identified using a method similar to that for wells in Piceance Basin; that is, detection of thermogenic gas in offset water wells or surface soil, and evidence of well barrier failures contributing to the migration of thermogenic gas to the aquifer. The potential barrier and well failures in the basin are summarised in **Table 7.**

Of 3,831 originally producing wells, 127 (3.32%) were found to have potential barrier failure. This relatively low overall potential failure rate resulted from the predominantly robust barrier designs implemented in the basin. Category 5 wells had a high potential barrier failure rate of 55.56%, due to the top of production cement being lower than the top of the gas-bearing formation, whereas the design of the Category 6 wells corrected this defect. However, the relatively high potential barrier failure rate of 24.14% in the Category 6 wells showed that the shallow geological conditions made it difficult to effectively create a cement seal in the production casing annulus. Most of the wells with a Category 7 well design had a relatively low potential barrier failure rate (0.15%). Some 54% of the wells with potential barrier failure were originally completed between 1999 and 2004.

As shown in **Table 7**, two of the 3,831 originally producing oil and gas wells (0.05%) in the basin were identified as having well failures. This relatively low failure rate was due to the implementation of a low-risk nested barrier design with deep surface casing (Category 7). This design was adopted because of the geology of the basin, shallow coal deposits and structurally shallow depth of hydrocarbon-bearing formations. The two wells with catastrophic well failure were drilled before 1961. The Category 2 well was found to have been improperly plugged and abandoned in the 1960s, and the Category 5 well had improper cement coverage in the intermediate casing annulus.

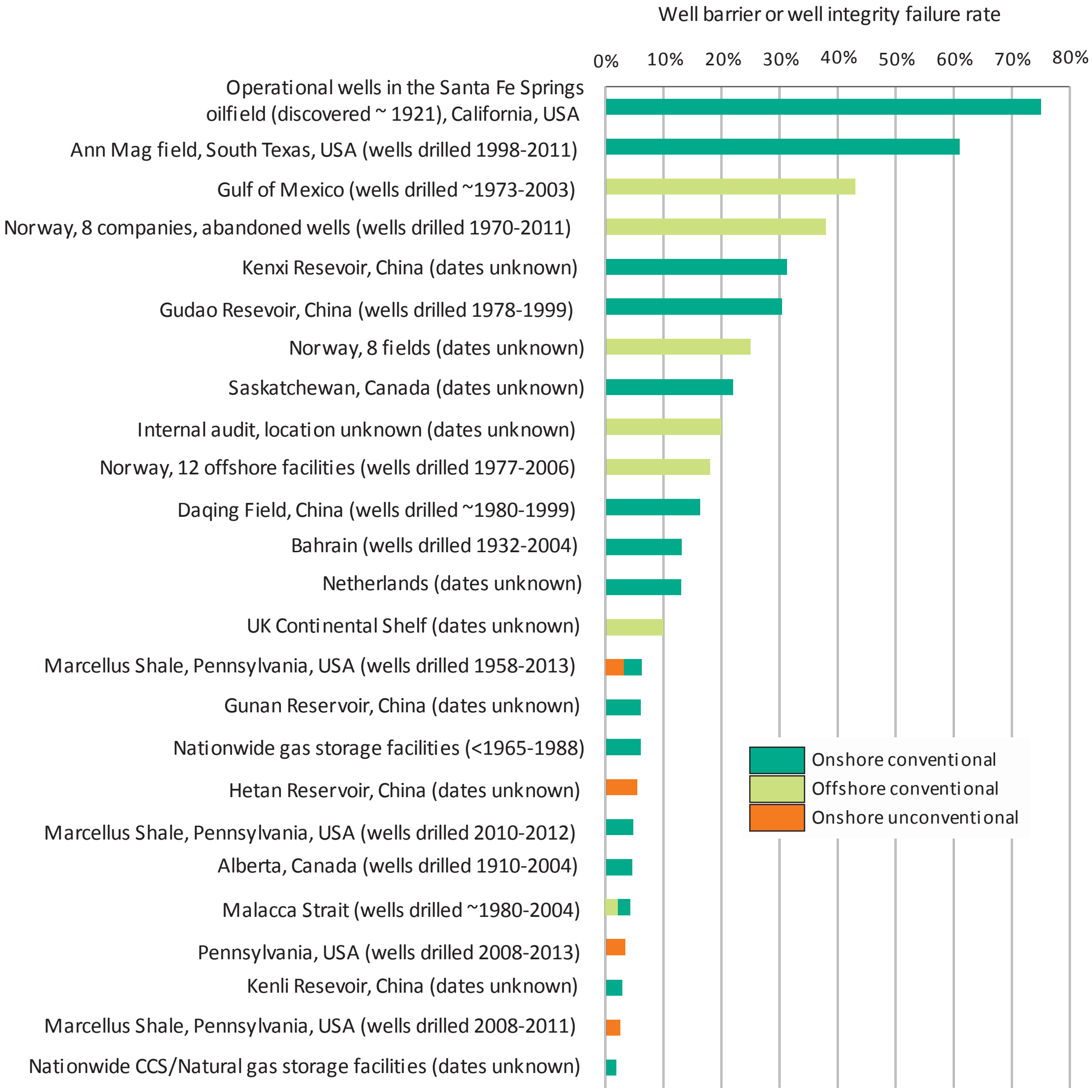
5.3.4 Global oil and gas well failure rates

Davies et al. reviewed studies of well barrier and well integrity failures, based on datasets collected from the public domain, including published literature and online resources.[122] The wells contained in the datasets included production, injection, idle and abandoned wells drilled globally, both onshore and offshore, for exploiting conventional and unconventional reservoirs, and CO_2 and natural gas storage. The datasets vary considerably in terms of the number of wells examined, well age and well design. The study did not attempt to distinguish barrier failures from well integrity failures that led to environment contamination. Also, the study compared data from a range of resource types, jurisdictions and well ages, and its significance and conclusions has been criticised on this basis.[123] As expected, the well barrier and integrity failure rates derived from this study vary widely, ranging from 1.9% to 75% (**Figure 16**). The weighted average rate across all studies is at the lower end of this range, at 6.8%.

The high variation in rates of well integrity issues reported in the literature studied by Davies et al. demonstrates the difficulty in comparing studies on wells that are drilled for different purposes, and that have different criteria for well integrity or well barrier failure. Other confounding factors include geological conditions, regulatory requirements on well construction and abandonment standards, well age, well type and well purpose. Davies et al. also analysed shale well data from Pennsylvania, and this is discussed in Section 5.3.6.

[122] Davies et al. 2014.
[123] Davies et al. 2015; Thorogood and Younger 2015.

Figure 16: Well barrier and integrity failure rates for wells from 25 different studies. Modified from Davies et al.[124]



5.3.5 Well integrity data from Australia

There are only two studies of well integrity data from Australian jurisdictions. One is on coal seam gas well failure rates in Queensland,[125] and the other is on oil and gas failure rates in Western Australia.[126] No other published data are available.

Coal seam gas well failure rates in Queensland, Australia

To date, few estimates have been made of failure rates for coal seam gas wells in Australia. The GasFields Commission Queensland reports statistics from well integrity compliance auditing undertaken from 2010 to March 2015.[127] During this period, 6,734 coal seam gas wells (for exploration,

[124] Davies et al. 2014.
[125] GasFields Commission Queensland 2015.
[126] Patel et al. 2015.
[127] GasFields Commission Queensland 2015.

appraisal or production) were drilled in Queensland, and about 3,500 wells were actively producing by the end of 2014. The non-producing wells do not have gas flow at the well head. The auditing involved testing for both subsurface gas well compliance and surface well head compliance. For the subsurface equipment, no leaks were reported, whereas there have been 21 statutory notifications (a rate of 0.3%) concerning suspect downhole cement quality during construction. After remediation, the cement failure rate was determined to be zero. For subsurface equipment, the conclusion is that the risk of a subsurface breach of well integrity is very low to near zero. A total of 199 surface well head leaks have been reported, all of which have subsequently been fixed.

Oil and gas well failure rate in Western Australia

Patel et al. reported a study on well integrity issues for all the oil and gas wells drilled onshore in Western Australia and in state waters that have not yet been decommissioned.[128] The study found that, of 1,035 non-decommissioned wells, 122 (less than 12%) had compromised well integrity or well barrier failure, but none of these failures resulted in leakage to the external environment.

Production **tubing** (see **Figure 3**) failure was the main cause of well barrier failure. Of the 1,035 wells studied, 86 wells (8.3%) had tubing failure. Tubing leaks can occur through holes being corroded or eroded by production and injected fluid inside the tubing, or from twisting of the tubing.

Casing failure in production casing is mainly due to corrosion, pressure differential and thermal effects, causing the pressure behind the production casing to exceed the collapse resistance of the casing. Of the 1,035 non-decommissioned wells, 22 (2%) had production casing failure.

The other barrier failure identified related to surface production equipment, such as the well head or Christmas tree (the assemblage of valves, spools and fittings used in developing wells, named for its resemblance to a decorated Christmas tree). Surface integrity failure is far less frequent than subsurface failure, because the surface is easier to access and maintain.

The study found that well barrier failure correlated with the age of the well, as shown in **Table 8**.

Table 8: Well integrity data for Western Australia showing a correlation between the age of the well and the type of barrier element failure. Data from Patel et al.[129]

Well age (years)	Tubing failure (%)	Well head or Christmas tree failure (%)	Casing failure (%)
0-10	0.2	0.1	0.4
11-20	0.8	0.0	0.2
21-30	0.9	0.2	0.6
31-40	0.7	0.3	0.3
41-60	5.5	0.8	0.5

5.3.6 Shale gas well integrity

Seven studies have analysed data specific to shale gas wells:

- Five studies – Considine et al., Davies et al. Ingraffea, Ingraffea et al. and Vidic et al. – present data for shale gas wells drilled in the Marcellus Shale in Pennsyvania, United States. The

[128] Patel et al. 2015.
[129] Patel et al. 2015.

Ingraffea et al. study is discussed in Section 5.3.5 and includes conventional oil and gas wells, whereas the other studies only consider unconventional wells;[130]

- Stone et al. present data on shale gas wells drilled in the Wattenberg field, Colorado, United States, as part of a broader study of well integrity in this field discussed in Section 5.3.3;[131] and
- Kell presents data on shale gas wells drilled in Texas, United States, as part of a broader study of oil and gas well integrity in Texas and Ohio, discussed in Section 5.3.1.[132]

All of these studies follow similar methodologies. They rely on reports of violations or incidents in publicly available databases of well data. The five studies conducted in Pennsylvania all relied on publicly available data from the Pennsylvania Department of Environmental Protection Office of Oil and Gas Management website and examination of notices of violations (**NOV**). As outlined in Section 5.3.5, Ingraffea, Ingraffea et al. and Davies et al. also reviewed inspectors' comments for additional evidence of well integrity issues.

The Considine et al. study analysed all well-related NOVs, including those related to surface operations. Their data showed that 2.58% of wells drilled in the study period had an NOV related to well integrity. They characterised these as blowouts (0.11%, 4 events), gas migration (0.06%, 2 events) and cementing and casing issues (2.41%, 85 events). The authors classified blowout and gas migration events as major events based on the level of severity of potential pollution, and these can be considered to be well integrity failures. For all but one of these major events, there is documentary evidence that the impacts had been remediated or that remediation was underway at the time of the study. Vidic et al. found that only 16 out of 6,466 wells (0.25%) were issued with an NOV indicating that the operator failed to prevent a gas or fluid release to an aquifer (interpreted as well integrity failures).

The Texas and Colorado datasets were part of larger studies described in Sections 5.3.1 and 5.3.3, which found no reported incidents of well integrity or hydraulic fracturing related issues for shale gas wells.

Table 9 summarises the findings of these studies. The percentages of wells with potential well integrity issues in the studies from Pennsylvania are similar to those found for oil and gas wells elsewhere. However, most of these studies do not distinguish between single-well barrier failures and total failure of well integrity that can lead to impacts on the environment. None of these studies looked at the scale or consequences of failures in well integrity.

Table 9: Summary of published well integrity data specific to shale gas resource development.

Location and study	Time period	Number of wells	Well barrier issue rate	Well integrity failure rate
Pennsylvania, Ingraffea	2010 - Feb 2012	4,934	7.6%	Not reported
Pennsylvania, Considine et al.	2008 - August 2011	3,533	2.58%	0.17% blowouts and gas migration
Pennsylvania, Vidic et al.	2005-2012	6,466	3.4%	0.25% release to groundwater
Pennsylvania, Ingraffea et al.	2002-2012	6,007	6.2%	Not reported
Pennsylvania, Davies et al.	2005-2013	8,030	6.26%	1.27% leak gas to surface
Colorado, Stone et al.	2010-2014	973	0	0
Texas, Kell	1993-2008	16,818	0	0

130 Considine et al. 2013; Davies et al. 2014; Ingraffea 2012; Ingraffea et al. 2014; Vidic et al. 2013.
131 Stone et al. 2016b.
132 Kell 2011.

5.4 Well failure rates summary

This section reviews the well barrier and well integrity failure rates reported in the open literature. Well barrier failure was identified in several ways, including by sustained casing pressure, surface-casing-vent flow or requirements for remediation of barriers. Well integrity failure was identified by the detection of hydrocarbons in nearby water wells, gas migration outside the surface casing or NOVs issued from regulatory bodies. Many studies do not distinguish between well barrier failures and well integrity failures. This distinction is important because a full integrity failure is required to allow a pathway for contamination of the environment.

The data that have been reviewed indicate that the rate of total well integrity failures that have the potential to cause environment contamination is about one in 1000, and several studies reported no well integrity failures. The rate for single-well barrier issues or failures is about 1-10 in 100, and is consistently in this range for onshore unconventional resources. Well barrier failures do not indicate that a well integrity failure will occur. In most cases, well barrier issues can be remediated. The data specific to shale gas wells indicate that well integrity issues occur at a rate at the lower end of the rates observed for oil and gas wells in general.

An important observation from the available data on well integrity for oil and gas wells is the importance of resource characteristics, well construction methods and regulatory settings. Few studies have investigated the correlation between well construction methods, geological conditions and failure rates. Notable exceptions are the studies by Stone et al. and Watson and Bachu.[133] This is demonstrated in **Figure 17**, which aggregates the data based on well category from the studies by Stone et al. The categories take into account the well construction (that is, the number of barriers) protecting shallow aquifers. There is a strong correlation between well construction category and well barrier failure rates, and between well barrier failure rates and well integrity failure rates. The only exception to this correlation is the barrier failure rates for Category 8 wells in the Raton and Picean Basins (**Figure 17, Table 5** and **Table 7**). Stone et al. described Category 8 wells as those having deep surface casing and intermediate casing strings, and with the top of the production casing cement below the top of the gas zone. The barrier failures were interpreted to be related to inadequate cementing of the production casing. There were no well integrity failures, indicating that the remaining barriers provided protection of shallow aquifers.

Watson and Bachu demonstrated that well barrier failure rates reflect the geological conditions of the wells, regulatory requirements in place during well construction and abandonment, era in which a well was constructed, well type, well purpose and well history, as well as factors such as oil price, availability of equipment and materials, and operator’s technical competence in the well construction or abandonment.[134] The authors also found that failure rates of well barriers and well integrity were lower for newer wells.

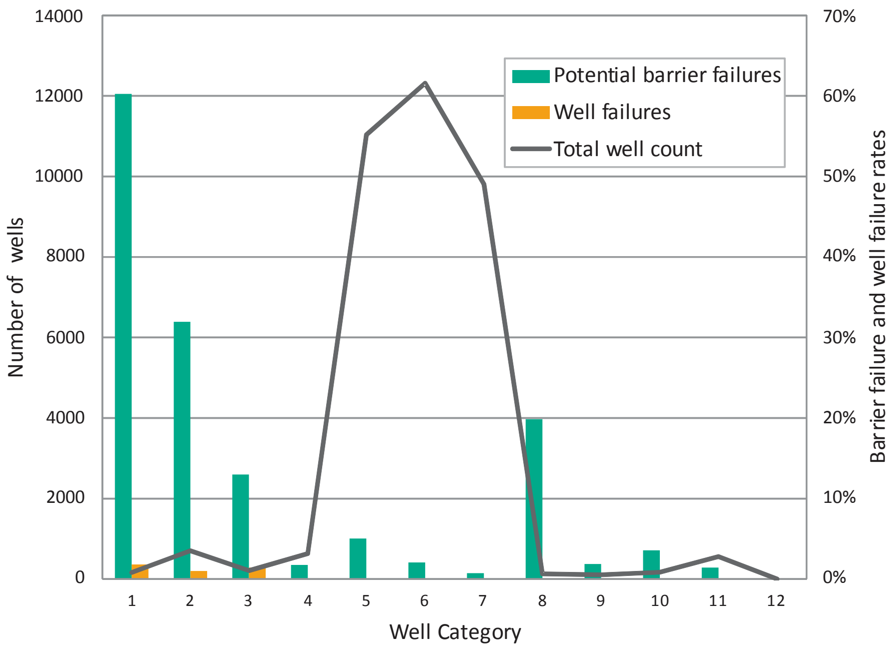
For shale gas wells, Stone et al. showed no well barrier or well integrity failures when wells were constructed according to modern construction standards; similarly low rates were found for conventional wells drilled in the same basin and constructed to the same standards.[135] Ingraffea et al. showed variations in well integrity issues for shale gas wells at different locations in Pennsylvania,

[133] Stone et al. 2016a; Stone et al. 2016b; Watson and Bachu 2009.
[134] Watson and Bachu 2009.
[135] Stone et al. 2016b.

again highlighting the importance of local resource characteristics.[136] Where well integrity issues occur, they can generally be remediated, as demonstrated by Considine et al.[137]

The risk of well integrity issues appears to be reduced by constructing wells with deep surface casing to protect aquifers, and using intermediate casing or production casing with adequate cementing. Local conditions (including geology, aquifer depth, presence of pressured zones, presence of shallow gas-bearing zones and presence of corrosive fluids) should be taken into account when determining casing and cementing depths.

Figure 17: Aggregated data from well integrity studies in several basins in Colorado (well categories are defined in **Table 5**). Stone et al.[138]



[136] Ingraffea et al. 2014.
[137] Considine et al. 2013.
[138] Stone et al. 2016a; Stone et al. 2016b.

6 Potential for hydraulic fractures to act as contaminant transport pathways

Contamination of surface and groundwater assets may occur if deep formation fluids or introduced chemicals from drilling and hydraulic fracturing activities reach water-bearing formations, overlying aquifers or nearby water bores. Conceptually, these migration pathways could be a hydraulic fracture lateral intersection with a water bore; a direct hydraulic fracture connection from the reservoir into the overlying aquifer; a hydraulic fracture intersection with a natural fracture or fault, which then connects to an aquifer; or cracks in the annular region between the casing and the well.[139] These pathways are illustrated in **Figure 18**.

Typically, shale resources are found 1,500-4,000 m below the earth's surface. Given that most groundwater resources are only a few hundred metres deep, it is unlikely that hydraulic fractures will grow into a nearby water bore, which are much shallower.[140] Dusseault and Jackson conclude that the migration of hydraulic fracturing or formation fluids (including natural gas) to the surface as a result of hydraulic fracturing of typical shale gas reservoirs is unlikely, except when abandoned or suspended wells are intersected by the hydraulic fracturing fluids during the high-pressure stage of fluid injection.[141]

Recent studies have looked into the possibility of shallow groundwater contamination due to hydraulic fracturing fluid migration along conductive faults. Birdsell et al. reviewed the recent literature on this topic and used transport simulations to quantify the amount of fracturing that could potentially reach an overlying aquifer.[142] Based on modelling studies, the authors concluded that the likelihood of hydraulic fracturing reaching a water resource is low when the vertical separation between the reservoir and the overlying aquifer is large and other natural pathways (such as faults or leaky wells) are absent. Even in the absence of a permeable pathway, their results show a potential upward migration of hydraulic fracture fluids of about 100 m through a relatively low-permeability overburden. Birdsell et al. also reported instances of fluid migration that have occurred in the past, and the need for detailed modelling approaches that can explain these occurrences. [143] The finding of this study have been cited in a report from the US EPA.[144] In the case of deep shale formations, it is unlikely that hydraulic fractures would grow in a way that stimulated a conductive pathway between a shale reservoir and an overlying aquifer, when the vertical separation distance is in the order of thousands of metres. [145]

Using a numerical groundwater flow model that considers advective transport through bulk media and preferential flow through fractures, Myers concluded that the interaction between fractured shale and fault zones can reduce the time for the contaminants to reach near-surface aquifers from thousands of years to tens or hundreds of years.[146] However, Saiers et al. identified significant shortcomings in that transport model; the authors concluded that the assumptions and the prediction do not faithfully

[139] Reagan et al. 2015.
[140] Davies et al. 2012; Flewelling et al. 2013.
[141] Dusseault et al. 2014.
[142] Birdsell et al. 2015.
[143] Birdsell et al. 2015.
[144] US EPA Report.
[145] US EPA Report.
[146] Myers 2012.

represent the reality, and they suggested ways in which the model could be improved.[147] Cohen et al. identified additional issues in the model assumptions and boundary conditions, and also pointed out critical errors in the calculations.[148] Gassiat et al. used a finite element-based numerical groundwater flow model and publicly available data for shale gas basins to simulate hydraulic fracturing in the vicinity of a permeable fault zone. The authors found that, under certain conditions (such as the presence of a highly permeable fault, high overpressure in the shale unit and fracturing in the upper portion of the shale near the fault), contaminants can reach shallow aquifers in less than 1000 years after fracturing.[149] They suggested that fracturing operations be avoided near potentially conductive faults, and that fluid migration via faults be monitored over longer timespans. Flewelling and Sharma argued that these predictions are unreliable because the analysis contains significant gaps, the modelled scenarios are unreasonable, and the model has not been validated against physically plausible conditions; they concluded that there is not enough evidence to conclude that this type of migration could occur over the specified timeframe.[150] Kissinger et al. simulated long-term methane migration through a fault zone for the Lower-Saxony region in Germany, and found that migration of methane to shallow layers can occur in the presence of a fully penetrating fault zone and low gas saturation of the overburden (1 %).[151] However, the authors noted that these results contain significant parameter and scenario uncertainties, and therefore need to be treated with caution. Further studies with better numerical models are required to fully understand subsurface flows, and to investigate fluid migration over long time scales and its impact on aquifers.

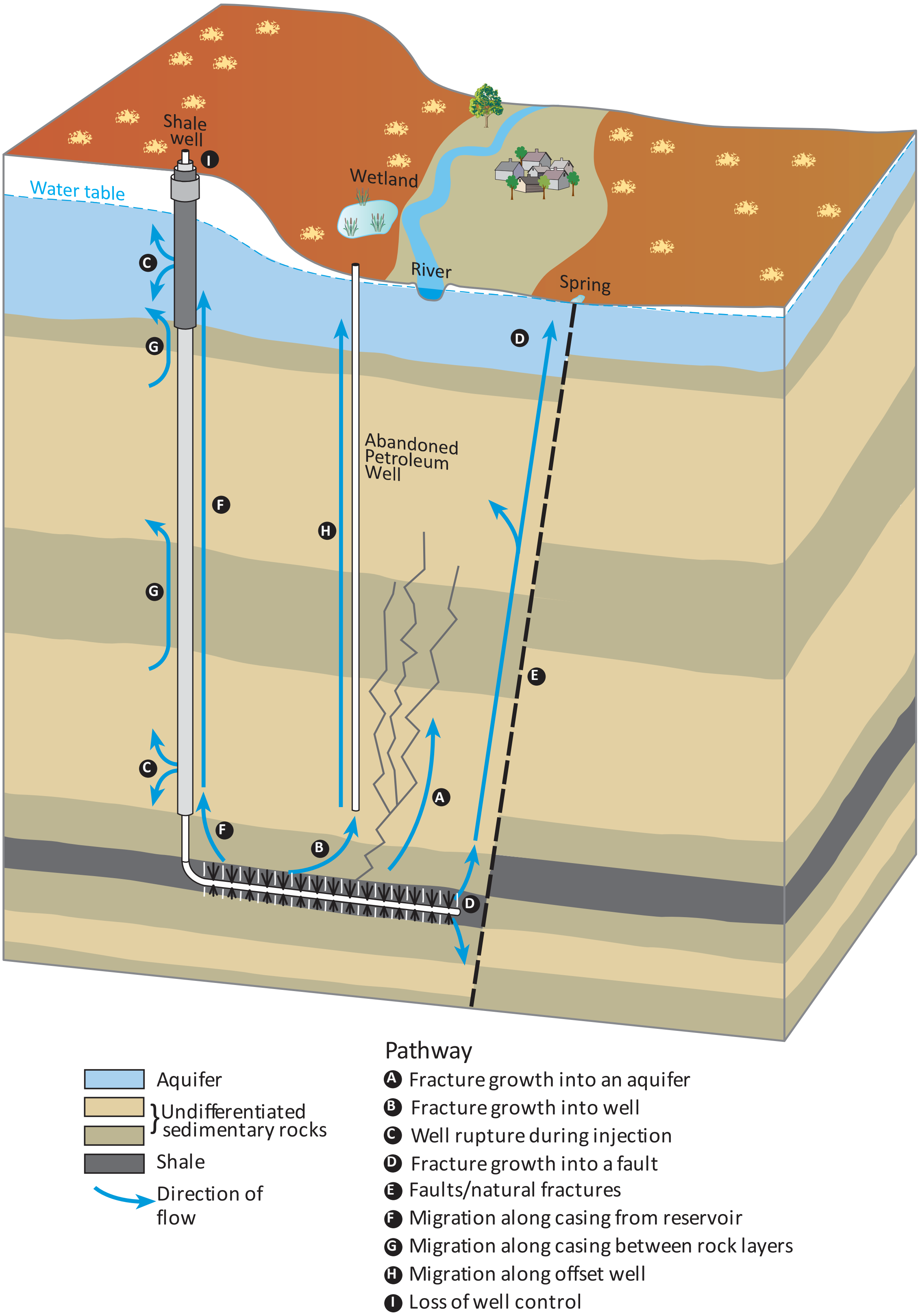
Laboratory studies suggest that aquifer contamination via a subsurface pathway is unlikely. Engelder et al. conducted a series of imbibition experiments on cuttings recovered from the Union Springs Member of the Marcellus gas shale in Pennsylvania, and on core plugs of the Haynesville gas shale from northwest Louisiana, and demonstrated that aquifer contamination due to fracture propagation through a subsurface pathway is unlikely.[152] The authors attribute this finding to reasons such as low water saturation of gas shale, sequestration of injected water into dry gas shale by imbibition, the presence of capillary seals that prevented gas leakage, and large osmotic pressures that will drive the treatment fluids into gas shale. A study by Flewelling and Sharma discusses the main barriers to upward fluid migration of fracturing fluids, concluding that the timescales for migration would be long (more than a million years), given that the permeability and flow rates are low.[153] Even in overpressured basins, they suggest that the permeability required to maintain elevated subsurface pressure over geologic time will result in negligible vertical flow rates.

In the context of shale gas development, microannulus delamination of the wellbore (as discussed in Section 5.1.2) is considered to be the most plausible contamination pathway by which introduced chemicals from drilling and hydraulic fracturing, and hydrocarbons in the formation, could leak into an overlying aquifer or the atmosphere. For fluid to move, there would need to be a driving force: buoyancy for oil and gas, and pressure gradients for water. Pressures within the shales will decrease during production, and any recovery in pressure would only occur over geological timescales. The volume of water in resource shales, including any residual fracturing fluid, is small in the context of the overall groundwater system, and it is mostly immobile.

[147] Saiers and Barth 2012.
[148] Cohen et al. 2013.
[149] Gassiat et al. 2013.
[150] Flewelling and Sharma 2014.
[151] Kissinger et al. 2013.
[152] Engelder et al. 2014.
[153] Flewelling and Sharma 2014.

In situations such as the Northern Territory where there is a large vertical separation between aquifers and the shale gas layer, and the layered geology includes large stress barriers, there is a low possibility for hydraulic fracturing fluids to reach an overlying aquifer.

Figure 18: Potential contamination pathways from drilling and hydraulic fracturing activities.



50 | The shale gas well life cycle and well integrity

7 Well integrity management

Well integrity management across the life cycle of a well has become a focus for industry over recent years, in recognition of the value of proactive well integrity management in reducing risks.[154] Well design needs to consider hazards that might arise throughout the life cycle, and the design will have ramifications for how wells can be operated later in their life. The operating life of a well can cover several decades, and responsibility for a well is often passed between different teams within the operator. Third parties are often involved in well drilling and operations, and in the supply of materials such as casing and cement. The level of complexity in the design and operating parameters for wells means that there are risks associated with the transfer of responsibility between different teams and throughout the life of the well. Life cycle well integrity management aims to minimise these risks by establishing processes around well integrity management.

The focus on well integrity management has led to the development of ISO 16530-1:2017, which states that *"The well operator should have a well integrity management system (**WIMS**) to ensure that well integrity is maintained throughout the well life cycle by the application of a combination of technical, operational and organizational processes"*.[155] The NORSOK D-010 standard also requires management of well integrity throughout the life cycle of a well.[156]

A WIMS provides a framework for managing the risk due to loss of well integrity over the life cycle of a well, and identifies the responsibilities of the organisation as a whole in safeguarding environmental assets and public health. The key elements of a WIMS framework are:

- **risk assessment**, which includes techniques to:
  - identify the well integrity hazards and associated risks over the life cycle of the well;
  - determine acceptance levels for risks;
  - define control measures and mitigation plans for managing and reducing risks that exceed acceptance levels;
- an **organisational structure** with clearly defined roles and responsibilities for all personnel involved in well integrity management;
- **well barrier documents** that clearly identify and define:
  - well barriers (that is, a combination of components or practices that prevent or stop uncontrolled movement of well fluids);
  - methods to combine multiple barriers and redundancies to ensure reliability;
  - administrative controls that provide information on controlling activities related to well integrity (such as design and material handling standards, procedures and policy manuals);
- **performance standards** for people, equipment and the management system;
- **defined standards for well barrier verification**, such as functional, leak and axial load tests, and well load case modelling verification, to ensure that well barriers meet the acceptance criteria;

[154] Connon and Corneliussen 2016; Smith et al. 2016; Sparke et al. 2011; Wilson 2015.
[155] ISO 16530-1:2017.
[156] NORSOK D-010.

- **a continuous improvement process** that defines how knowledge and information should be communicated to personnel responsible for well integrity during the life of the well, and how improvements can be implemented;
- **a management of change process** to record changes to well integrity requirements for an individual well or the WIMS itself; and
- **an audit process** that demonstrates conformance with the WIMS.

A summary of how different organisations have used WIMSs to manage their assets, the observed benefits, the technical challenges that were involved in their implementation, and the key lessons that were learned can be found in recent literature.[157] Wilson et al. provide recommendations and guidance for building an effective WIMS after taking into account the industry standards, local regulatory requirements and the organisation's needs.[158]

[157] Connon and Corneliussen 2016; Gell et al. 2015; Haga et al. 2009; Kumar et al. 2014; Smith et al. 2016.
[158] Wilson 2015.

8 Well integrity summary

Wells provide access to the shale gas resource to allow the controlled flow of the gas to the surface. Shale gas wells are drilled through the geological layers that overlie the shale resource. These layers will include permeable layers that contain aquifers or saline groundwater, as well as low-permeability layers that form natural barriers to vertical movement of fluid. However, wells may inadvertently provide potential pathways for the contamination of subsurface water and the release of fluids to the surface that include:

- unintended release of drilling muds, hydraulic fracturing fluids or gas from the well into aquifers or other groundwater bodies during well operations;
- unintended releases of fluids from the well at the surface; and
- migration of fluids along the well to other rock layers or to the surface.

Well integrity refers to how the well is constructed and operated to maintain safety, and to prevent these unintended releases of fluids to the environment or migration of fluid along the well. The concept of well barriers is fundamental to well integrity. Barriers prevent or stop uncontrolled fluid flow into, out of, or along the well. Physical barriers include casing and cement, drilling fluids, impermeable formations, well heads and BOPs. In addition to physical barriers, well integrity makes use of operational barriers (monitoring, work instructions and procedures), human barriers (competent personnel) and administrative barriers (standards and policies, and quality assurance).

Current industry practice for shale gas well design is to have at least two independent and verified physical barriers to maintain well integrity. A well integrity failure will therefore only occur if both physical barriers fail. If there is a multibarrier system, degradation or failure of one barrier will not lead to the release of fluids from the well. Such well barrier issues are often included in studies of well integrity in oil and gas wells, with rates of wells with a barrier issue of 1-10% reported. By contrast, studies that report on well integrity failure (all barriers failed), which is required for an actual release of fluids to the environment, show low rates of failure, typically less than one in 1,000.

The most commonly reported mechanism for well integrity failure is the migration of gas (predominately methane) along the outside of the casing, which shows that there is a pathway for flow. The buoyancy of gas provides the driving force for it to travel up these pathways. The gas may be sourced from any gas-bearing geological layer that the well passes through, and may originate from outside the shale reservoir. The presence of this pathway does not necessarily mean that other fluids (saline water, for example) will move between horizons, because this would also require sufficient pore pressure differentials between different rock layers to drive fluid flow. During production, pressures within a shale gas reservoir will be lowered, and any fluid flow is likely to be *towards* the reservoir rather than *away* from it. If there are saline groundwater layers in the overburden above the shale resource with pore pressures over the hydrostatic gradient, then some upward movement of this water may be possible. The rates of flow along the outside of the wellbore are likely to be low, even for gas, because of the limited size of the flow pathways.

The risk of fluid or gas migration along the outside of a well continues after the well has been plugged and abandoned, while other well integrity failure risks will no longer exist or will be significantly reduced. Although there are few studies of the long-term integrity of oil and gas wells, it is a topic of recent research for CO_2 geosequestration. The design and construction methods for wells for CO_2 geosequestration will be similar to those used in the oil and gas industry. Studies suggest that the cements used in well construction are likely to resist chemical and mechanical degradation, and maintain integrity for thousands of years, so long as the cement was appropriately designed and placed.

A well integrity failure may be catastrophic when there is a complete loss of control of the well that allows an inrush of formation fluids or gases, which then travel to the surface, resulting in a blowout. Blowouts are most likely to occur during drilling operations; they are potentially life-threatening for personnel working on the drill rig, and may also lead to release of fluids to the surface environment. The low permeability of shale gas resources reduces the inherent risk of blowouts in comparison with conventional oil and gas resources. Few blowouts have been reported in shale gas wells globally.

The risks associated with well integrity failure depend on how the well is constructed. For example, the risks of natural gas migration and contamination of shallow aquifers are increased when the surface casing does not extend below the base of these aquifers, or the production casing is inadequately cemented. Geological conditions are also important; for example, if there are shallow gas-bearing formations that may provide a source for gas migration along the well and overpressured layers that may drive fluid flow.

Current industry practice is to consider well integrity across the entire life cycle of the well. This approach recognises the fact that wells are often in operation for decades, and that actions at each phase have implications for well integrity in subsequent phases. The responsibilities for management of a well are often handed over to different teams within an organisation; therefore, a system that tracks well integrity is important for continuity. The implementation of WIMS is a fundamental component of this life cycle management, and allows well integrity to be tracked for each well in an operator's well inventory. The elements of a WIMS include risk assessment criteria; organisational structure (roles, responsibilities and competencies); well barrier design, verification and monitoring requirements; performance standards; and reporting requirements.

Shale gas wells are highly engineered, and well integrity is an important driver in their design, construction and operation. Each well must be designed to take into account its specific characteristics related to risk of integrity failure: characteristics such as the geology and the purpose of the well. Therefore, a WIMS outlines a process and objectives rather than prescribing particular design elements. Examples of leading operational practice in well integrity management can be found in ISO 16530-1:2017 on well integrity life cycle governance, NORSOK D-010 on well integrity in drilling and well operations, and the Norwegian Oil and Gas Association recommended guidelines.[159]

Hydraulic fracturing operations are conducted through wells, and place certain demands on well integrity due to the fluid pressures involved. These pressures may increase the likelihood of delamination of wellbore in the vicinity of the reservoir. However, engineering to withstand these pressures is a routine component of well design, and there are only a few examples globally of well integrity failure during hydraulic fracturing resulting in the release of fluids to the environment.

Other hydraulic fracture fluid pathways that could be created or dilated by the hydraulic fracturing operation include upward growth of hydraulic fractures and interaction of hydraulic fractures with natural faults. The literature suggests that the contamination of shallow aquifers via migration of hydraulic fracturing fluids from deep reservoirs in this way is highly unlikely where the vertical separation distance is large, as is likely to be the case in the Northern Territory.

The consequences of well integrity failures from shale gas development are likely to be less severe than those for conventional oil and gas resources. Shale gas resources have low reservoir deliverability,

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[159] ISO 16530-1:2017; Norwegian Oil and Gas 2016; NORSOK D-010.

which means that they cannot produce large volumes of fluids at a high rate. Conventional resources tend to have higher deliverability because each well accesses a larger reservoir volume of oil or gas and has a higher likelihood of overpressures. There have been several high-profile well integrity incidents on conventional oil and gas wells (the Montara and Macondo wells, for example) that have led to improvements to WIMSs in industry and regulation in many jurisdictions, including the Northern Territory. This increased focus on well integrity is also applicable to shale gas wells, and is likely to reduce the risks of well integrity incidents during the development of these resources.

The low rates of complete well integrity failure for shale gas developments reported in the literature have been achieved with current industry practices and regulatory frameworks, suggesting that well integrity risks are being addressed to a large extent during drilling and production. Longer term (post abandonment) well integrity and the potential for migration of gas along the outside of casing is not as well understood, and although the impacts of an individual well are likely to be small, this aspect warrants further investigation.

9 Regulatory frameworks for drilling and hydraulic fracturing operations

9.1 Well integrity regulatory frameworks in the Northern Territory

At the time the Inquiry was called in December 2016, the regulatory framework for petroleum activities in the Northern Territory was going through a process of reform in response to:

- the 2010 Montara Commission of Inquiry (**Montara Inquiry**);
- Dr Tina Hunter's review of the capacity of the Northern Territory's legal framework to regulate the development of an onshore petroleum industry (**2012 Hunter Report**); and
- the inquiries conducted by Dr Allan Hawke AC into the potential environmental impacts of hydraulic fracturing in the Northern Territory (**2014 Hawke Report**) and the environmental assessment and approval process (**2015 Hawke Report**).[160]

The regulatory framework was moving from a prescriptive approach to objectives-based regulation. This process started with the implementation of the Petroleum (Environment) Regulations (**PER**) to regulate environmental risks and impacts associated with petroleum activities. In its submission to the Inquiry, the Northern Territory Department of Primary Industries and Resources (**DPIR**), as the lead regulator, noted that two additional regulations were intended as part of the reform process to regulate exploration and production activities.[161] These regulations were also intended to be objective based and to follow the "as low as reasonably practicable" (**ALARP**) principle to manage risks, as adopted in the PER.

The current regulatory framework for petroleum activities consists of the *Petroleum Act* as the primary legislative instrument, supported by the PER, the Petroleum Regulations (which cover minor administrative aspects of resource management) and the Schedule of Onshore Petroleum Exploration and Production Requirements (**Petroleum Schedule**). The Petroleum Schedule is enforced by ministerial directive to licence holders; it regulates certain petroleum activities, drilling and hydraulic fracturing. The schedule is highly prescriptive and lacks flexibility. Hunter has recommended phasing out the Petroleum Schedule because it does not have the same legal force as regulation and does not align well with objective-based regulation.[162]

under the current regulatory framework, an operator must first obtain an exploration permit by application through a competitive process. Once a permit has been obtained, before any drilling or hydraulic fracturing activity can commence on a tenure, the tenure holder must obtain a petroleum project approval for those activities. To obtain such approval, the tenure holder must submit a project application for well drilling, workover or stimulation activities. The application is assessed by the DPIR Energy Division. In the DPIR's submission, they state that "T*he integrity of wells is a particular focus of*

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[160] Borthwick 2010; 2014 Hawke Report; 2015 Hawke Report; Hunter 2012. DPIR submission 226 p37.
[161] DPIR submission 226 p39
[162] Hunter 2016.

the Energy Division's assessment".[163] The assessment process has requirements that directly relate to well integrity, including:[164]

- **BOP** systems, BOP drills and a well control manual;
- minimum depths for the setting of surface casing, a requirement for the cementing of all casing strings to surface, and mandatory validation of casing and cement using cement bond logs;
- mandatory validation of all barriers by pressure testing, and mandatory formation integrity testing or leak-off tests;
- installation and testing of a completion tubing string (additional barrier); and
- all reasonable steps being taken to prevent communication between, leakage from, or the pollution of aquifers.

There are similar requirements for hydraulic fracturing activities, including:

- mandatory water quality testing, before, during and after the hydraulic fracturing;
- safe separation, through impermeable formations, between shallow aquifers and the hydrocarbon target zone (the section that is to be fractured);
- submission of fracture modelling confirming maximum **fracture height** and length (confirming safe separation);
- chemicals list for public disclosure on DPIR's website;
- use of pressure safety trip-out systems during fracture stimulation activities; such systems prevent exceedance of allowable pressure limits of surface pipework and downhole casing; and
- pressure monitoring confirming that well integrity has not been affected by fracture stimulation activities.

The tenure holder must also submit an environment management plan (**EMP**) for the activities that complies with the **PER** for assessment. One of the EMP requirements is a risk assessment of potential environmental impacts on aquifers from hydraulic fracturing, including baseline assessment of known aquifers, monitoring, modelling of fracture propagation and well completion schematics. There is overlap between the EMP requirements and the Petroleum Schedule.

If the tenure holder already has approval for project activities, the holder cannot vary from the approved program and must operate in accordance with any conditions of the approval. Approval for revised or additional activities requires an operational application.

The DPIR has implemented a process for the regulator to continually assess the integrity status of wells during drilling operations.[165] The *Well integrity verification form* and process was developed following the Montara Inquiry; it requires the assessor to evaluate the integrity of the well, confirming that the well has been constructed to levels exceeding API standards. This assessment is based on information provided by the tenure holder in daily drilling and other reports, and the well planning information submitted in the application for the drilling activity.

The Petroleum Schedule also has requirements for well abandonment. Wells cannot be abandoned in the Northern Territory without prior approval. The tenure holder is required to describe the plugging and abandonment program, and the procedures that will be used to validate the integrity of the barriers.

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[163] DPIR submission p29
[164] DPIR submission Attachment C
[165] DPIR submission p34

The DPIR has implemented a range of other measures related to well drilling and hydraulic fracturing in response to the Montara Inquiry and the Hawke reports of 2014 and 2015.[166] These measures include:

- increasing capability through recruitment of more petroleum engineers, training in well integrity and a mandatory CERT IV in Government Investigations;
- more robust approval assessment processes, with guidelines and checklists to increase the rigour of assessments, and a triple signatory and assessment approval system;
- introduction of additional prescriptive mandatory requirements that tenure holders must follow, including the requirement to cement all casing strings to surface; submission of fracture propagation models to illustrate separation between the stimulated zone and aquifers; and water monitoring before, during and after any hydraulic fracturing activities;
- improvement of transparency by requiring EMPs to be publicly available via DPIR's website;
- improvement of audit processes, with checklists for well drilling operations, hydraulic fracturing operations and well testing operations; and enabling of independent third-party inspectors, in addition to DPIR officers, to carry out operational and environmental inspections and audits through the Petroleum Schedule;
- implementation of the PER and associated processes; and
- a full review and update of the Petroleum Schedule in 2016.

A well operations management plan could operate in conjunction with an EMP, as recommended by Dr Tina Hunter.[167]

9.2 Well integrity regulatory frameworks in other jurisdictions

The regulatory framework for petroleum activities is objective based in Western Australia , the Commonwealth (offshore operations administered by the National Offshore Petroleum Safety and Environmental Management Authority, **NOPSEMA**) and South Australia. These jurisdictions do not have codes of practice for drilling or hydraulic fracturing operations; instead, they rely on the operator to identify hazards and manage risks according to the ALARP principle. The Commonwealth and Western Australian regulations are those that have most recently been updated, in 2016 and 2015, respectively. Both require the submission of a well operations management plan (**WOMP**, referred to as a well management plan in South Australia) for drilling. Relevant regulation in these two jurisdictions requires well integrity to be addressed in the WOMP. NOPSEMA provides guidance on the information required in the WOMP, and guidelines for applying the ALARP process to well integrity.[168] Neither jurisdiction has any prescriptive requirements about well design or well integrity. The Commonwealth regulations do, however, define reportable incidents for well integrity. Commonwealth and Western Australian regulations also provide for multiwell WOMPs to be created. Such WOMPs may be used for a group of wells in close proximity and with similar characteristics; for example, multiple directional wells drilled from a single location.

In South Australia, the long history of industry operation and regulation is worth noting. There are several operators with a long track record of operations, providing a track record of environmental and safety performance. The South Australia regulatory framework requires a statement of environmental objectives (**SEO**) to be developed on the basis of an environmental impact report that must be

[166] DPIR submission p37-45
[167] Hunter 2016.
[168] NOPSEMA 2016; NOPSEMA 2017.

conducted for all petroleum activities. The SEO describes how potential threats and risks of the specific activity on the environment will be managed. Approved SEOs effectively become project-specific regulations that are gazetted and made publicly available. SEOs are reviewed every five years, allowing for adaption to changing requirements and operational practices. The South Australia regulations also allow the classification of operators as requiring either high-level or low-level official surveillance. The classification is based on a rigorous audit and assessment process, and allows the regulator to place more emphasis on operators with less experience or those conducting novel activities. Before commencing activities, operators must submit an activity notification, and approval is granted based on an assessment of the operator's demonstrated capabilities and how the activities will be conducted to comply with relevant SEOs. This is largely similar to the WOMPs used by the Commonwealth and Western Australia. South Australia has no prescriptive requirements for well operations.

The Commonwealth, South Australia and Western Australia all have requirements for inspection or surveillance of field activities. All jurisdictions have a team of technical staff with expertise in petroleum operations to undertake assessment and inspection activities.

The New South Wales and Queensland regulatory frameworks are also largely objective based; however, both have codes of practice for coal seam gas drilling that are mandated in regulations.[169] Queensland also has a code of practice for other petroleum drilling, although this has not been made mandatory.[170] These codes were developed in close consultation with stakeholders, and are specific to the context of each jurisdiction. The codes are mandatory and include prescriptive requirements around process (requirements for matters to be considered during design of a well, for example) and some specific requirements for well construction and abandonment (surface casing setting depths and pressure testing of casing, for example). Santos supported the use of codes of practice in their submission to the Inquiry.[171] The Queensland codes of practice mandate the use of WIMSs.

[169] NSW Department of Trade and Investment 2012; QLD Department of Natural Resources and Mines 2017.
[170] QLD Department of Natural Resources and Mines 2016.
[171] Santos submission 168, p72.

10 Policy options for regulation related to well integrity

The following policy options address well integrity in the context of shale gas development in the Northern Territory, and need to be considered in the context of the overall regulatory framework for petroleum development. Local conditions are important in determining well integrity risks, and policy options must take into account the uncertainty that arises from the current limited amount of activity in shale gas resources in the Northern Territory to date.

10.1 Collection of baseline data

Baseline studies of **environmental receptors** are critical for assessing the performance of the industry. In the context of well integrity, appropriate baseline information should include measurements of shallow aquifer characteristics and surface hydrocarbon gas fluxes. The parameters that should be measured in shallow aquifers include water chemistry, water levels and hydrocarbon content (including isotopic composition, to provide indication of source). Similarly, baseline measurements of surface hydrocarbon gas flux should include characterisation of the chemical and isotopic compositions. The baseline characterisation of hydrocarbon gases will be important for understanding the occurrence of gas migration along the outside of casing (the most commonly reported well integrity failure mechanism). Harkness et al. provide a recent example of the techniques that can be used in integrated geochemical investigation of potential sources of natural gas and water contamination in a region with shale gas drilling activities, and demonstrate the value of baseline data.[172] Regional variability and the scale of proposed development will dictate the spatial density of the baseline measurements required.

10.2 Developing an understanding of well integrity risks in the Northern Territory

Onshore petroleum activity in the Northern Territory has been limited, with only 236 wells drilled as at October 2017. These wells have been drilled over a period of more than 50 years, and have primarily targeted conventional petroleum resources. The amount of data available from offset wells in the Northern Territory's prospective shale gas basins is limited. Similarly, the experience of the operators and regulators working with this resource is limited, although they bring experience from working in similar resources elsewhere. Although a great deal of knowledge of well integrity risk and its management is available from other jurisdictions, information on the characteristics of the Northern Territory's resources are an important input into the hazard identification process for well integrity management.

No shale gas projects in the Northern Territory have advanced past the exploration phase. If the moratorium is lifted, there will be a period of time as operators progress from exploration to appraisal. This increase in activities provides an opportunity for adaptive regulation through an objective-based

[172] Harkness et al. 2017.

regulatory regime. Setting prescriptive regulatory requirements based on limited data and experience may not allow risks to be managed effectively as additional information on local hazards is discovered. Therefore, an objective-based regulatory regime that recognises the uncertainty may be a more appropriate way of managing the risks.

During the early stages of shale gas developments, there may be an opportunity for collaboration between operators, to share relevant data on well integrity. Although the regulator receives data from operators soon after wells or geophysical surveys are completed, these data are not made public for a period of time. Basic information in well completion reports is kept confidential for 2 years and 28 days from the date of rig release (that is, when the drill rig is demobilised at the completion of drilling activities), and geophysical data is kept confidential for a period of 3 years. Interpreted data are not released for a period of 6 years from when they are collected. There may be a role for the regulator to facilitate the early sharing of data relevant to well integrity hazard identification and risk assessment between operators and with other stakeholders. This could be through a simple data exchange, or the regulator could coordinate the development of a basin-wide well integrity management approach.

Development of a basin-wide approach to well integrity management that involves the regulator, all operators in the basin, independent advisers and other stakeholders may provide a means of reducing risks and accelerating the development of leading practices for the region. This process could facilitate the sharing of baseline environmental survey methods and data, information on well integrity hazards and operational practices for well integrity management.

10.3 Requirement for well integrity management throughout the well life cycle

The prevention of well integrity failures throughout the life cycle of a well requires active management, and many jurisdictions require operators to demonstrate that they have a WIMS that takes into account well integrity throughout the well life cycle. The management of integrity for individual wells should be conducted within a system for managing well integrity for all of the operator's well stock. There are several international standards that set out well integrity management processes, and well integrity management methods are continually improving. Policies should allow or require operators to continually update their processes, to keep up to date with evolving industry practices and standards. Independent certification against these international standards by recognised classification societies could also be part of demonstrating the standing of an operator's well integrity management processes. There are multiple points at which compliance with this requirement could be evaluated, including the assessment of the technical capacity of applicants during permit application, renewal or amendment processes; during the approval process for well drilling and associated activities (such as hydraulic fracturing or abandonment); or during periodic review of an operator's performance.

A comprehensive policy on well integrity management will also set out the regulator's responsibilities for review and assessment of an operator's well integrity management approach, and for an inspection regime to ensure compliance. The policy should also state the operator's reporting requirements for well integrity incidents, and should set out penalties for non-compliance.

In addition to a WIMS, assessment of well integrity management on a well-by-well basis is necessary to address well-specific risks. Well integrity hazard identification and risk assessment is an important component of well integrity management. Commonwealth and Western Australian regulations require well management plans that outline the risk assessment approach used, the risks identified and the well integrity management practices that will be put in place to be submitted to the regulator for assessment. The current project application process for drilling activities in the Northern Territory requires the operator to describe components of well integrity management, but does not explicitly require an overall well integrity management plan for the full life cycle of a well.

10.4 Considerations for codes of practice, guidelines and minimum standards

The intention of the regulator in the Northern Territory is to adopt an objective-based regulatory regime, with regulations for petroleum exploration and production alongside the PER. These regulations would be supported by guidelines (which already exist for the PER), and codes of practice that would assist in the interpretation and implementation of the regulations by operators and regulators. The content of a code of practice around well integrity or well construction and abandonment for the Northern Territory will depend on the structure of relevant regulations. The Commonwealth (NOPSEMA) and Western Australian regulatory frameworks provide examples of recently implemented objective-based regulation. In regard to well integrity, the guidelines in these jurisdictions set out what a well management plan must contain, but do not prescribe minimum technical requirements. The operator must demonstrate that they are managing risks in accordance with the ALARP concept. In contrast, the codes of practice developed in New South Wales and Queensland contain many prescriptive elements.

Consideration must be given to the interaction between prescriptive components of a code of practice and the ALARP concept that is integral to objective-based regulation. Based on the well integrity risks identified in this report, the following items could be prescribed through regulation or associated guidelines and codes of practice to be included in a well management plan for the Northern Territory:

- requirement for a well integrity management plan that includes consideration of:
  - well integrity management across the well life cycle;
  - the operator's process for managing well integrity risks;
  - how well integrity hazards are identified, and risks assessed and managed;
  - well barrier plans throughout the life cycle, performance standards and a verification approach;
  - reporting and documentation;
  - change management;
- requirements to characterise aquifers, saline water zones and gas-bearing zones in the overburden during drilling;
- how the well design and operation will provide protection of aquifers;
- requirements to monitor for methane migration along the outside of casing; and
- requirements to verify the integrity of the bond between casing, cement and the formation, periodically and before abandonment.

The New South Wales and Queensland codes of practice were developed in consultation with industry and other stakeholders. A similar consultative approach that draws from the basin-wide well integrity management approach outlined in Section 10.2 is recommended for the Northern Territory. This approach can be used to identify whether any minimum standards should be put in place.

10.5 Developing leading well abandonment practices for the Northern Territory

Although the objectives of abandonment are clear, the long-term integrity of shale gas wells post abandonment is uncertain. There has been little monitoring of well integrity post abandonment and, where integrity issues have been found, it has been difficult to investigate the causes. Effective well abandonment requires wells to have integrity at the end of their operating life. It is important to consider the post-abandonment integrity requirements as part of the design of the well and management of its integrity, and this is part of the reasoning for the policy option set out in Section 10.3. The impacts of well integrity failure post abandonment are likely to be small on a well-by-well basis, with the main risk being migration of gases along the outside of the casing.

Given the current state of shale gas development in the Northern Territory, it is unlikely that a large number of wells will be abandoned in the near future. This provides an opportunity to determine appropriate practices for abandonment of shale gas wells in the Northern Territory, by establishing a long-term abandonment assessment program. This program could assess well abandonment options in the context of the Northern Territory's shale resources, and could be conducted in conjunction with the basin-wide well integrity management approach outlined in Section 10.2. The difficulty of remediating integrity issues in abandoned wells means there must be an emphasis on abandonment practices that will reduce the risk. A long-term abandonment assessment program could consider:

- geological zones along the well that need to be isolated in the long term;
- reviews and testing of durability of cements and casing;
- partial abandonment of some wells to allow for long-term monitoring;
- evaluation of post-abandonment monitoring approaches;
- trials of novel abandonment methods and materials; and
- calculation of costs of abandonment, to assist in the calculation of security bonds.

Well abandonment is a global issue, with estimates that about 30,000 wells will need to be plugged and abandoned globally over the next 15 years.[173] DNV GL (an international accredited registrar and classification society) has recently developed guidelines for risk-based abandonment of offshore wells.[174] Well abandonment practices are likely to see a good deal of innovation as the scale of abandonment activity increases globally and there is increased scrutiny of environmental performance.

The Northern Territory currently does not allow wells to be abandoned without prior approval (according to the Petroleum Schedule, Clause 328 (1)). The requirement for approval for abandonment of a well and for the operator to outline the approach to well abandonment and the maintenance of well integrity post abandonment will reduce risk associated with abandoned wells.

10.6 Providing transparency to address community concerns

Well integrity is often raised as an issue by the broader community, and this was reflected in many of the submissions to the Inquiry from both advocacy groups and private individuals.[175] Greater

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[173] Ouyang and Allen 2017.
[174] DNVGL-RP-E103.
[175] Arid Lands Environment Centre, Submission 411, (Arid Lands Environment Centre submission), p3; Lock the Gate Alliance, Submission 171, (Lock the Gate Alliance submission), p21; Carol Randall and Andrew Smith, Submission 395, (C Randall and A Smith submission), p7; Rod Dunbar, Submission 297, (Dunbar submission), p3

confidence in regulatory processes can often by developed through inclusive participation of stakeholders, the implementation of transparent processes and open communication.[176] Transparency requires open publicly available communication about the well integrity process, including details of the process, roles and responsibilities of regulators and operators, and the information used within the process to make decisions.[177] The basin-wide well integrity management approach outlined in Section 10.2 provides a mechanism through which the community can participate in well integrity management. This approach would allow stakeholders to have input into the identification of the well integrity issues that must be managed; it would also make publicly available information on well integrity hazards and risk assessments for basins prospective for shale gas in the Northern Territory.

The requirement for EMPs to be published provides a level of transparency around the management of environmental risks. Should WOMPs be used in the Northern Territory, consideration should be given to making at least the well integrity management component of these plans publicly available. Also, consideration should be given to making a well integrity summary for all wells in the Northern Territory publicly available. These summaries could contain the current well barrier schematic (similar to the one shown in Appendix 2) along with a statement of the status of the barriers in the well, and could be accessible through the Spatial Territory Resource Information Kit for Exploration (STRIKE) web-mapping tool. Interested stakeholders could then easily see the current well integrity status for wells in a region.

A simple mechanism for public complaints should also be available. This system could be for complaints about any aspects of shale gas development, not just well integrity issues. There are several examples of such systems in other jurisdictions around the world.[178]

10.7 Avoiding legacy issues

Wells that are suspended (that is, not in production and yet to be abandoned) may present an unnecessary well integrity risk. When there are legitimate reasons for a well to be suspended, it is crucial that well integrity continues to be actively managed. The Northern Territory currently only allows wells to be suspended for two years at a time (According to the Schedule, Clause 328 (5)(e)). This is a similar approach to the 'idle iron' policy adopted for offshore wells in the Gulf of Mexico, according to which wells must be abandoned within five years of production ceasing.[179] The requirement for approval for suspension of a well, along with the time limit, and requirements for the operator to outline the well integrity management and monitoring of the suspended well, will reduce risk by ensuring that wells are only suspended with good reason and that their integrity is maintained while they are suspended.

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[176] Dietz and Stern 2007.
[177] Dietz and Stern 2007.
[178] For example Queensland's CSG Compliance Unit https://www.business.qld.gov.au/industries/mining-energy-water/resources/land-environment/landholders/monitoring-complaints; Colorado's Oil and Gas Conservation Commission http://cogcc.state.co.us/complaints.html#/complaints.
[179] US Bureau of Ocean Energy Management 2010.

11 Conclusions

Well integrity is the quality of a well that prevents the unintended flow of fluid (gas, oil or water) into or out of the well, to the surface or between rock layers in the subsurface. Well integrity is established via the use of barriers that prevent these unintended fluid flows. For shale gas wells, a two-barrier principle is applied, whereby at least two independent and verified barriers are in place. Unintended or uncontrolled fluid flow will only occur if both barriers fail, resulting in failure of the integrity of the well.

Well integrity and its management throughout the life cycle of the well is important for the safe, efficient and environmentally sustainable development of shale gas resources. Potential hazards to the integrity of a well can relate to the purpose of the well, the way it has been constructed, and the characteristics of the resource and the overlying geology.

The characteristics of shale gas resources mean that there is a low likelihood of catastrophic well integrity failures (such as blowouts) that result in a release of drilling or formation fluids to the surface environment and a potentially hazardous release of gas. Specifically, the low permeability of shale resources limits the rate at which fluids can enter the well, decreasing but not eliminating the risk of catastrophic well integrity failures.

The most plausible environmental risk related to shale gas well integrity is from the migration of gas up the outside of the well. This gas may originate from the shale gas resource or from gas-bearing layers in the rock layers that overlie it. The rates of gas leakage for individual wells are likely to be small because of the small cross-sectional area and long length of leakage pathways; however, the cumulative effects from a large number of wells may be significant. This risk is also present after wells have been abandoned, and there is limited data on the long-term integrity of shale gas wells.

Subsurface risks associated with hydraulic fracturing relate primarily to the impacts of hydraulic fracturing on the potential for gas migration up the outside of the well. The potential for hydraulic fracturing fluid to reach shallow aquifers via other mechanisms – such as excessive vertical growth of hydraulic fractures or hydraulic fracture intersection with existing structures – is considered to be low.

There is limited published data on rates of well integrity failure in shale gas developments globally. The data available indicate that failure rates are at the lower end of those for other oil and gas wells.

The risks posed by well integrity issues require proactive management of well integrity. The industry and regulators have increasingly focused on well integrity over the past decade, to improve safety and environmental performance. In particular, the focus has been on managing well integrity across the life cycle of the well, with operators now routinely deploying WIMSs. These systems allow the integrity of wells to be managed across their entire life cycle so that the risks can be managed. WIMSs involve:

- identification of hazards and assessment of risks;
- clear identification of well barriers at every phase of the well's life cycle;
- performance standards for well barriers and their components;
- verification procedures for well barriers against the performance standards; and
- an organisational approach to well integrity management that includes identification of roles and responsibilities, and processes for continuous improvement, change management and audit.

Although global experience in shale gas development provides useful evidence of well integrity risks and their management, there is limited experience in the Northern Territory's onshore gas resources because of the nascent stage of the industry. A basin-wide well integrity management approach that facilitates the sharing of data and well integrity management approaches between operators, regulators and other stakeholders may prove useful in reducing well integrity risks, should an onshore gas industry develop. This approach would allow industry to develop leading practices appropriate for the risks identified in the Northern Territory's shale gas resources. Methods for ensuring the long-term integrity of wells post abandonment could also be explored, helping to reduce the uncertainty around this phase of the well life cycle. Baseline studies to characterise environmental receptors before shale gas activities start will be important to assist in any future evaluation of the environmental impact of the industry.

A regulatory framework that addresses well integrity risks and other subsurface risks during drilling and hydraulic fracturing activities will need to provide a balance between providing guidance on the identification and minimisation of risks while allowing operators to adopt better practices as they are developed.

Appendix A Example well barrier schematic

WELLBARRIER

Field	: Csiro		
Well	: 01		
Schematic	: WB.D 4.1-a1 rev. 1	Prepared by	: Tore Fjågesund (u)
Date	: 23.Oct.2017	Verified by	:

Producer

Gas producer

Draft

Primary barrier elements

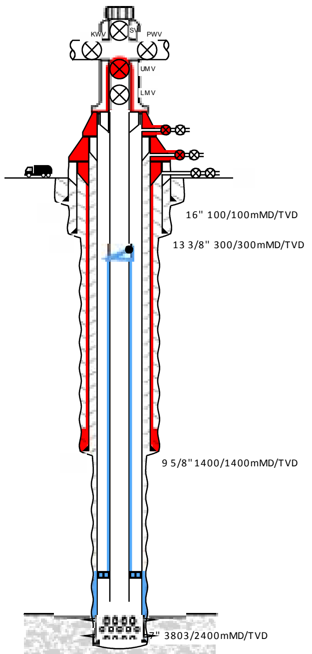
Element	Qualification	Monitoring
Downhole safety valve	Inflow test to xxx Bar	Periodic inflow testing
Tubing	Pressure test to xxx Bar	A-annulus pressure
Production packer	Pressure test to xxx Bar	A-annulus pressure
Production casing	Pressure test to xxx Bar	B-annulus pressure
Production casing cement	Formation test, job performance or bond log	B-annulus pressure

Secondary barrier elements

Element	Qualification	Monitoring
Surface x-mas tree	Pressure test to xxx Bar	Periodic testing
Spool wellhead B with access valve	Pressure test to xxx Bar	External observation and periodic testing ov valves
Spool wellhead A with access valve	Pressure test to xxx Bar	External observation and periodic testing of valves
Casing hanger	Pressure test to xxx Bar	C-annulus pressure
Intermediate casing	Pressure test to xxx Bar	C-annulus pressure
Intermediate casing cement	Formation test, job performance or bond log	C-annulus pressure

Healthy well, no or minor issue

Note :



Depth reference: Landrig, unspecified depth reference

Graphics by Wellbarrier

Glossary

Term	Description
Abandonment	Ceasing efforts to produce fluids (oil or gas) from a well and plugging the well without adversely affecting the environment.
Annulus	The gap between any of the following: tubing and casing, two casing strings, or casing and wellbore. The annulus between the tubing and casing is the primary path for producing gas from coal seam gas wells.
Aquifer	An identifiable stratigraphic formation that has the potential to produce useful flows of water and may include formations where, due to hydraulic fracturing activity, a changed hydraulic conductivity allows such water flows.
Blowout	A sudden and uncontrolled escape of fluids to the surface from the wellbore.
Blowout preventer	A large valve or mechanical device placed at the top of a well that can be used to seal and regain control of the well in the case of a blowout.
Borehole	Generally refers to a narrow, artificially constructed hole drilled for purposes other than production of oil, gas or water (for example, to intercept, collect or store water from an aquifer; to passively observe or collect groundwater information; or to undertake mineral exploration). Also known as a bore, drill hole or piezometer hole.
Borehole breakouts	Enlargement and elongation of a borehole cross-section in a preferential direction. Formed by the break up of the wall of the wellbore in a direction parallel to the minimum horizontal stress.
Brine	Saline water with a total dissolved solid concentration greater than about 40,000 ppm. Sea water has total dissolved solids of around 30,000 ppm.
Casing	Steel pipe used to line a well and support the rock. Casing extends to the surface and is sealed by a cement sheath between the casing and the rock.
Casing shoe	A short adaptor that fits on the downhole end of the casing string, to facilitate insertion of the casing into the well.
Casing string	Steel pipe used to line a well and support the rock. The casing extends to the surface and is sealed by a cement sheath between the casing and the rock. Often, multiple casings are used to provide additional barriers between the formation and well.
Catastrophic barrier failure	A complete loss of control of the well that allows an inrush of formation fluids or gases, which then travel to the surface, where they are released to the environment.
Cement sheath	A cement ring in the annulus between the casing and the wellbore, or between two casing strings.
Coal seam gas (CSG)	A form of natural gas (generally 95-97% pure methane, CH_4) that is typically extracted from permeable coal seams at depths of 300-1000 m. Also called coal seam methane or coalbed methane.

Decommissioning	The process used to remove a well or other infrastructure from service.
Drilling mud	Also known as drilling fluid, provides cooling and lubrication to the drill bit and drill string, lifts drill cuttings from the well and is a component of well control.
Environmental receptors	Living organisms, habitats or natural resources that may be adversely affected by environmental contamination.
Exploration well	A well that is drilled to test for: • the presence of oil or gas; • natural underground reservoirs suitable for storing oil or gas; or • obtaining stratigraphic information for exploring for oil or gas.
Flowback	Allowing fluids to flow from the well following a hydraulic fracturing treatment. Flowback fluid is composed of a mixture of hydraulic fracturing fluid and formation fluid.
Formation fluid	Any fluid within the pores of the rock. May be water, oil, gas or a mixture. Formation water in shallow aquifers can be fresh. Formation water in deeper layers of rock is typically saline.
Formation pore pressure	The pressure in the porous rock around the well.
Fracture gradient	The pressure required to induce fractures in rock at a given depth.
Fracture height	The distance between the top and bottom of the fracture.
Fracture width	Fracture width is the separation between the two faces of the fracture. Its value is largest at the wellbore and tapers towards the tip of the fracture.
Gas migration (GM)	Flow of gas along the annulus between casing strings, cement and the formation.
Geochemical	Relating to the chemistry of geological material (rocks, the Earth).
Groundwater	Water occurring naturally below ground level (whether in an aquifer or other low-permeability material), or water occurring at a place below ground that has been pumped, diverted or released to that place for storage. Does not include water held in underground tanks, pipes or other works.
Hazard	Inherent property of an agent or situation having the potential to cause adverse effects when an organism, system or population (or subpopulation) is exposed to that agent.
Horizontal drilling	Drilling of a well in a horizontal or near-horizontal plane, usually within the target formation. Requires the use of directional drilling techniques that allow the deviation of the well on to a desired trajectory. Horizontal wells typically penetrate a greater length of the reservoir than a vertical well, significantly improving production while minimising the surface footprint of drilling activities.
Hydraulic conductivity	A coefficient of proportionality describing the rate at which a fluid can move through a permeable medium.

Hydraulic fracturing	Also known as 'fracking', 'fraccing' or 'fracture simulation', this is a process by which geological formations bearing hydrocarbons (oil and gas) are 'stimulated' to increase the flow of hydrocarbons and other fluids towards the well. In most cases, hydraulic fracturing is undertaken where the permeability of the formation is initially insufficient to support sustained flow of gas. The process involves the injection of fluids, proppant and additives under high pressure into a geological formation to create a conductive fracture. The fracture extends from the well into the production interval, creating a pathway through which oil or gas is transported to the well.
Hydraulic fracturing fluid	The fluid injected into a well for hydraulic fracturing. Consists of a primary carrier fluid (usually water or a gel), a proppant such as sand and one or more additional chemicals to modify the fluid properties.
Impact	The difference between what would happen as a result of activities and processes, and what would happen without them. Impacts can be changes that occur to the natural environment, community or economy. They can be a direct or indirect result of activities, or a cumulative result of multiple activities or processes.
Injection well	A well used to inject fluid into the subsurface. This may be for waste water disposal, enhanced oil recovery, gas storage, or CO_2 sequestration.
Lost circulation	The reduced or total absence of fluid flow up the annulus when fluid is pumped through the drill string.
Microannulus	See 'Annulus' above.
Offset well	An existing well in close proximity to a proposed well. An offset well may provide information for the planning of a new well, or may be imacted by the drilling of a new well.
Openhole	An uncased section of a well.
Overburden	Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials such as ores or coal, especially those deposits that are mined from the surface by open-cut methods.
Overpressure	Occurs when the pore is higher than the hydrostatic pressure, caused by an increase in the amount of fluid or gas in the rock, or changes to the rock that reduce the amount of pore space. If the fluid cannot escape, the result is an increase in pore pressure. Overpressure can only occur where there are impermeable layers preventing the vertical flow of water, otherwise the water would flow upwards to equalise back to hydrostatic pressure
Packer	A device that can be run into a well; the device has a small initial outside diameter and is expanded inside the well to seal the wellbore. Used to isolate zones within a well in applications such as multistage hydraulic fracturing.
Perforation	A channel created through the casing and cement in a well to allow fluid to flow between the well and the reservoir (hydraulic fracturing fluids into the reservoir, or gas and oil into the well). The most common method uses perforating guns equipped with shaped explosive charges that produce a jet.

Permeability	The measure of the ability of a rock, soil or sediment to yield or transmit a fluid. The magnitude of permeability depends largely on the porosity and the interconnectivity of pores and spaces in the ground.
Plug	A mechanical device or material (such as cement) placed within a well to prevent vertical movement of fluids.
Plugged and abandoned	A well that has been permanently closed, with plugs inserted to isolate sensitive formations and aquifers, and surface infrastructure removed.
Pore pressure	The pressure of formation fluids in pores within rock in the subsurface.
Porosity	The proportion of the volume of rock consisting of pores, usually expressed as a percentage of the total rock or soil mass.
Preferential flow	The uneven and often rapid and short-circuiting movement of water and solutes through porous media (typically soil), characterised by small regions of enhanced flux (such as faults, fractures or other high permeability pathways), which contributes most of the flow, allowing much faster transport of a range of contaminants through that pathway.
Pressure test	A method of testing well integrity by raising the internal pressure of the well up to maximum expected design parameters.
Principal stress	The stress component perpendicular to a given plane, which may be compressional or tensional (that is, there is no shear stress component). Also known as normal stress.
Produced water	Water brought to the surface via a well; in the case of coal seams, water that is pumped out of the seams to release the natural gas during the production phase. Some of this water is returned fracturing fluid and some is natural ‘formation water’ (often salty water that is naturally present in the coal seam). This produced water moves back through the coal formation to the well along with the gas, and is pumped out via the well head.
Production zone	The section of a well from which fluids or gas are produced.
Proppant	A component of the hydraulic fracturing fluid system comprised of sand, ceramics or other granular material that 'prop' open fractures to prevent them from closing when the injection is stopped.
Reservoir	A geological formation with adequate porosity, fractures or joints that can store hydrocarbons.
Risk	The probability of an adverse effect in an organism, system or population (or subpopulation) caused under specified circumstances by exposure to an agent.
Seismic survey	A method for imaging the subsurface using controlled seismic energy sources and receivers at the surface. Measures the reflection and refraction of seismic energy as it travels through rock.
Shale gas	Natural gas that is generally extracted from a fine grained sedimentary rock that has naturally low permeability. The gas has usually formed in place (source rock is the reservoir).

Stress	Force applied to a body with units of force per area. Rocks within the earth are subjected to stresses caused by the weight of overlying rocks and tectonics (movement within the earth).
Surface casing vent flow (SCVF)	Flow of gas from a vent in the annulus between surface casing and other casing strings in a well.
Sustained casing pressure (SCP)	Sustained pressure in the annulus between casing strings.
Tight gas	A gas resource in very low permeability reservoir rock. The reservoir usually requires stimulation (hydraulic fracturing) to enable economic production. Shale resources are differentiated from tight gas resources based on their rock type.
Tubing	Steel pipe that is hung inside the casing. The tubing string may have a pump installed at its lower end and, for pumped wells, is a primary path for producing fluids from coal seam gas wells.
Thermogenic	Produced by a thermal process. Shale gas and oil are typically thermogenic and are produced by thermal maturation of organic matter.
Unconventional resource	Petroleum (oil and gas) resources that cannot be developed using conventional oil and gas technologies. Includes coal seam gas, shale gas and oil, tight gas and basin centred gas.
Washout	An enlarged region of a wellbore. A number of factors can cause this, such as excessive bit jet velocity, soft or unconsolidated formations, and in situ rock stresses.
Well	A hole drilled in to the earth from which petroleum or other fluids can be produced.
Wellbore	The hole produced by drilling, with the final intended purpose being for production of oil, gas or water.
Well barrier	Envelope of one or several dependent barrier elements (including casing, cement, and any other downhole or surface sealing components) that prevent fluids from flowing unintentionally between a bore or a well and geological formations, between geological formations or to the surface.
Well breach	Failure in cement, casing, downhole or surface sealing components.
Well deviation	The angle at which a wellbore diverges from vertical.
Well head	The surface infrastructure that controls pressure and access at the top of a well.
Well integrity	Well integrity is the quality of a well that prevents the unintended flow of fluid (gas, oil or water) into or out of the well, to the surface or between rock layers in the subsurface.
Well integrity failure	May result from a well breach (or a number of well breaches), and can take the form of a hydrological breach (fluid moves between different geological units) or an environmental breach (fluid leaks from the well at the surface or contaminates water resources).
Well logging	The process of recording a signal from a geophysical tool run into a well.

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Well pad	The area of land on which the surface infrastructure for drilling and hydraulic fracturing operations are placed. The size of a well pad depends on the type of operation (e.g. well pads are larger at exploration than at production).
Workover	The restoration or stimulation of a production well to restore, prolong or increase the production of oil or gas.
Zonal isolation	Exclusion of fluids such as water or gas in one zone from mixing with fluids in another zone.

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Scope of Services

3.1 Background to the Inquiry

On 14 September 2016 the Chief Minister of the Northern Territory, the Hon Michael Gunner MLA, announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs in the Northern Territory. At the same time, the Chief Minister announced that a *Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory* (the **Inquiry**) would be established and released draft Terms of Reference, which were open for public comment for four weeks.

On 3 December 2016 the Northern Territory Government announced the final Terms of Reference for the Inquiry and the composition of the panel that will be undertaking the Inquiry (the **Panel**).

The Inquiry was established under section 4 of the *Inquiries Act 1945* (NT) and is comprised of a judicial chair, the Hon Justice Rachel Pepper, and ten scientists with expertise in areas ranging from hydrogeology to social science.

The Inquiry's final Terms of Reference can be read in full on the Inquiry's website (www.frackinginquiry.nt.gov.au).

On 20 February 2017 the Inquiry released a Background and Issues Paper, also available on the Inquiry's website, which was followed by hearings and community meetings in March 2017 in various town centres and remote communities across the Northern Territory. The Issues Paper includes a timeline for the Inquiry, which indicates that an interim report will be released in mid-2017, a draft final report will be released during the last quarter of the year, and a final report will be released in December 2017.

The Hydraulic Fracturing Taskforce (the **Taskforce**) has been established in the Department of the Chief Minister to support the Panel.

3.2 Terms of Reference for the Inquiry and the social impact theme

The Panel has divided the work of the Inquiry into the following themes: water, land, air, social impacts, economic conditions, cultural conditions, human health, land access, and the regulatory framework. This request for tender relates to the social impacts theme only, however, there are overlaps with the economic, cultural and regulatory framework themes.

The Terms of Reference for the Inquiry require the Panel to do the following:

a. determine and assess the impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the associated activities;
b. determine whether additional work or research is required to make that determination;
c. for each risk that is identified, advise the level of impact or risk that is acceptable in the Northern Territory context;
d. describe methods, standards or strategies that can be used to reduce the impact and risk to acceptable levels; and
e. identify what government can do, including implementing any policy, regulatory or legislative changes, to ensure that the impacts and risks are reduced to the required levels.

The Background and Issues Paper includes a non-exhaustive list of the potential risks and benefits associated with the social impact theme at page 21.

The Terms of Reference make it clear that the Panel must not only look at the impacts of hydraulic fracturing and the associated activities on social conditions in the Northern Territory – the Panel must also consider the social impacts of the onshore unconventional gas industry as a whole on the Northern Territory. This is made clear in the following extract from the Terms of Reference, which has been amended to include the relevant language only:

"When the inquiry makes a determination… about whether or not there has been an impact or risk on … social conditions, the inquiry will … consider the impacts and risks of the development of the onshore unconventional gas industry, including exploration activities such as seismic surveys and aerial surveys, land access and costs and benefits of the industry. This may be undertaken through a social impact assessment or similar activity."

In accordance with the definitions in the Terms of Reference, a reference to an "unconventional reservoir" in this document is a reference to a reservoir where the rock formation is shale. There is currently no gas being produced from shale reservoirs in the Northern Territory. The Amadeus Basin is currently producing gas from conventional reservoirs.

3.3 Steering Committee

A Steering Committee has been established to oversee the work of the supplier. The Steering Committee is comprised of the Hon Justice Rachel Pepper, Dr David Ritchie, Prof Peta Ashworth and the Executive Director of the Hydraulic Fracturing Taskforce. The point of contact for all matters will be the Executive Director of the Hydraulic Fracturing Taskforce.

3.4 Probity Advisor

The Territory has appointed a Probity Advisor to oversee the Territory's processes in relation to the stages of this process. The Probity Advisor's role is to ensure that fairness and impartiality are observed throughout, and that the evaluation criteria stated in any related documentation are consistently applied to all submissions.

Part A – Social Impact Assessment

3.5 Development and implementation of a social impact assessment framework

The supplier must develop a leading practice framework for the identification, assessment and management of the social impacts associated with the development of onshore unconventional gas in the Northern Territory.[1] The framework:

a) must include a requirement for public participation;

b) may include components of both strategic and project-level social impact assessment; and

c) must operate in conjunction with the Northern Territory and Commonwealth environmental assessment frameworks in a way that minimises unnecessary duplication and inconsistency.

The supplier must explain why the proposed framework is leading practice and in doing so must refer to the literature and leading practice social impact assessment frameworks used in other jurisdictions, including overseas jurisdictions.

The supplier must describe the current policy and regulatory regime in the Northern Territory for the identification, assessment and management of social impacts associated with onshore unconventional gas development.

The supplier must identify the structural, policy, regulatory and legislative reforms that must be made to the current regime in the Northern Territory to implement the social impact assessment framework described above.

The supplier must describe how the framework will operate in conjunction with the Northern Territory and Commonwealth environmental assessment frameworks in a way that minimises unnecessary duplication and inconsistency.

3.6 Beetaloo Sub-basin

The supplier must identify the people or groups of people that are most likely to be impacted by the development of unconventional gas resources in and around the Beetaloo sub-basin, shown in Attachment B, which may include, without limitation, community members, pastoralists, Aboriginal organisations and local businesses (the Affected Communities).

1 A 'social impact' is defined as a change to any of the values or conditions set out at **Attachment A** and must include cumulative social impacts.

The supplier must describe the methodology used to identify the Affected Communities.

The supplier must describe the Affected Communities (that is, describe the community profile or baseline conditions), which must include a description of the values listed at Attachment A and how such information was collected.

The supplier must describe the type of potential social impacts, issues, concerns, risks and benefits that may arise from the development of the unconventional gas industry in the Beetaloo sub-basin on the Affected Communities. In identifying the potential impacts the supplier must consider:

a. the list of social impacts, risks and benefits described in sections 7.5, 7.6, 7.7, and 7.8 of the *Background and Issues Paper*;
b. submissions made to the Panel in connection with the *Background and Issues Paper*;
c. social impacts, issues, benefits and risks typically associated with the development of onshore unconventional gas resources that have been identified in the literature and in other jurisdictions; and
d. issues that have been identified in other social impact assessments and related studies that have been completed in or around the Beetaloo sub-basin, including those listed at **Attachment C**.

For each potential impact identified, the supplier must, to the extent possible:

a. assess the potential impact (or risk) in terms of likelihood and consequence (high, medium, low);
b. identify a potential measurable indicator, which can be qualitative or quantitative, and develop a methodology for the collection of appropriate baseline data in the Affected Communities so that changes in social values or conditions as a result of any unconventional gas development can be measured over time;
c. collect such baseline data;
d. identify ways to avoid, mitigate and/or manage the risk over time (including the entity that should be responsible for the management and monitoring of such risk) and predict what the level of risk will be following mitigation; and
e. indicate whether or not the level of risk following mitigation would be deemed acceptable, and why.

For every potential social benefit that is identified, the supplier must recommend strategies to realise and maximise such benefit.

The supplier must identify any issues that must be addressed in subsequent project-based social impact assessments associated with the development of unconventional gas in the Beetaloo sub-basin.

The supplier must develop and implement a leading practice community consultation program to support its responses to section 3.6. The supplier must consult, without limitation and where practicable, the Aboriginal Areas Protection Authority; the Northern Land Council; the Departments of Primary Industry, Resources and Trade, Business and Innovation, and Tourism Northern Territory; local and regional councils; the Northern Territory Cattleman's Association; Northern Territory Farmers, and petroleum operators and titleholders in the Beetaloo sub-basin. The Steering Committee must approve the program prior to implementation.

Part B - Social Licence to Operate

3.7 The supplier must describe, with reference to the literature and examples from other jurisdictions:

a. the concept of a "social licence to operate" as it applies to the onshore unconventional gas industry in the Northern Territory;

b. the nature and extent of any potential risks to affected stakeholders, including the Northern Territory Government, petroleum titleholders and operators in the Northern Territory, the Northern Territory community, and the communities affected by development, where industry has not obtained and/or maintained a social licence to operate;
c. the measures that onshore unconventional gas industry and government can take to enable industry to earn and maintain a social licence to operate in the Northern Territory; and
d. how industry's social licence to operate can be measured in the Northern Territory, including a part of the Northern Territory.

3.8

The supplier must identify, to the extent practicable, the measures that the petroleum titleholders and operators in the Beetaloo sub-basin have taken in the past, and can take in the future, to earn and maintain a social licence to operate in the Affected Communities.

3.9 Timelines and Reporting

The work must be in the form of a written report.

The report must include a literature review that includes all references used in section 3.5 and 3.6.

At the end of each calendar month following the award of the tender the supplier must provide the Steering Committee with a written progress report and a verbal presentation within five working days of receipt of the report.

The supplier must provide the Steering Committee with a draft final report and a verbal presentation to the Steering Committee on or prior to 1 September 2017.

A final report must be provided to the Steering Committee by 15 September 2017 and the supplier must present the final report to the Panel on a date to be determined.

The Inquiry will publish the final report on the Inquiry's website on a date to be determined.

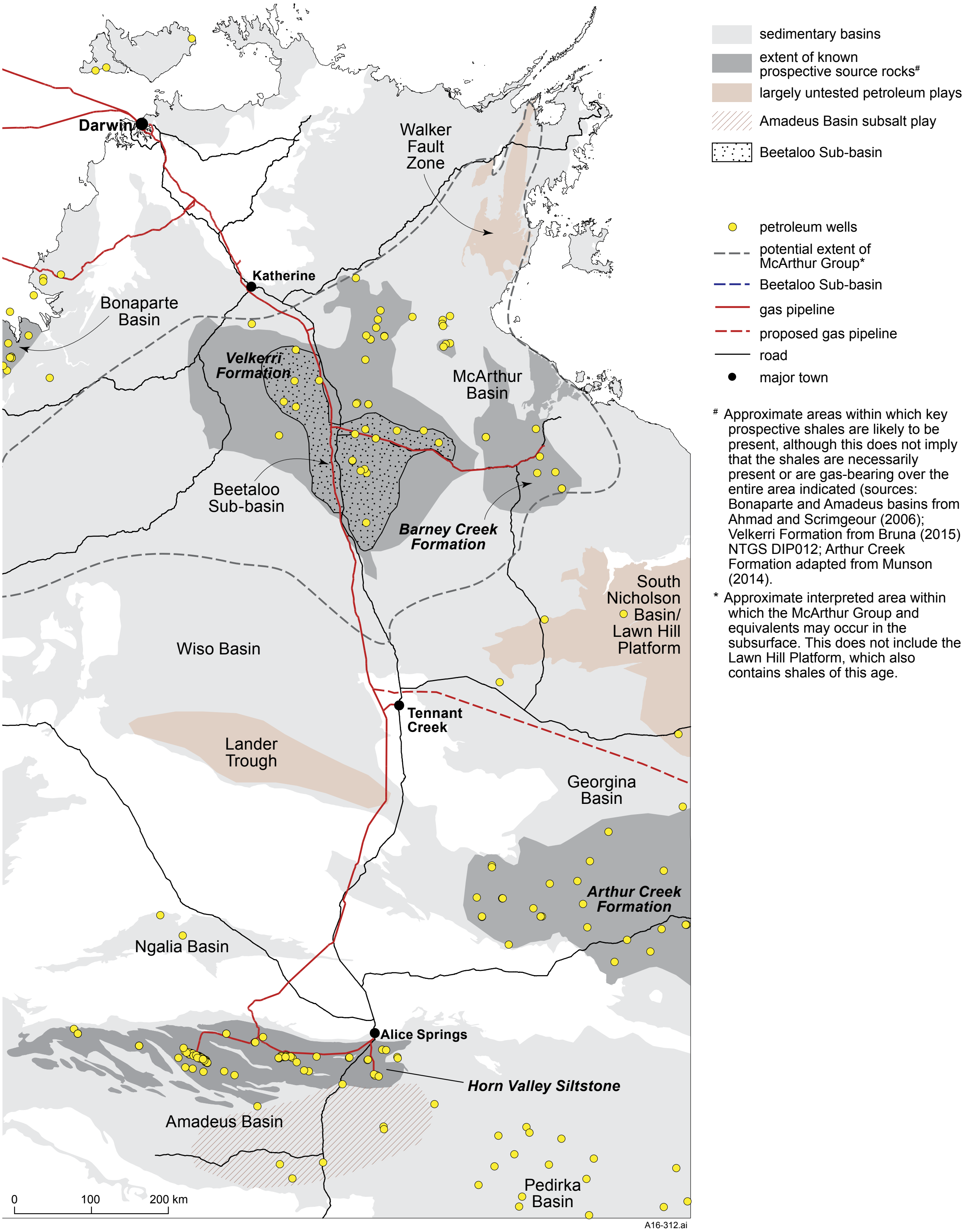
Attachment A

The *International Association for Impact Assessment* defines "social impacts" as changes to one or more of the following:[2]

a. people's way of life – that is, how they live, work, play and interact with one another on a day-to-day basis;
b. their culture – that is, their shared beliefs, customs, values and language or dialect;
c. their community – its cohesion, stability, character, services and facilities;
d. their political systems – the extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place, and the resources provided for this purpose;
e. their relationship with their environment – the quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust and noise they are exposed to; the adequacy of sanitation, their physical safety, and their access to and control over resources;
f. their health and wellbeing – health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity;
g. their personal and property rights – particularly whether people are economically affected, or experience personal disadvantage which may include a violation of their civil liberties; and
h. their fears and aspirations – their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children, in each case, to the extent such impact would not otherwise be assessed as part of an environmental impact assessment under Northern Territory or Commonwealth legislation.

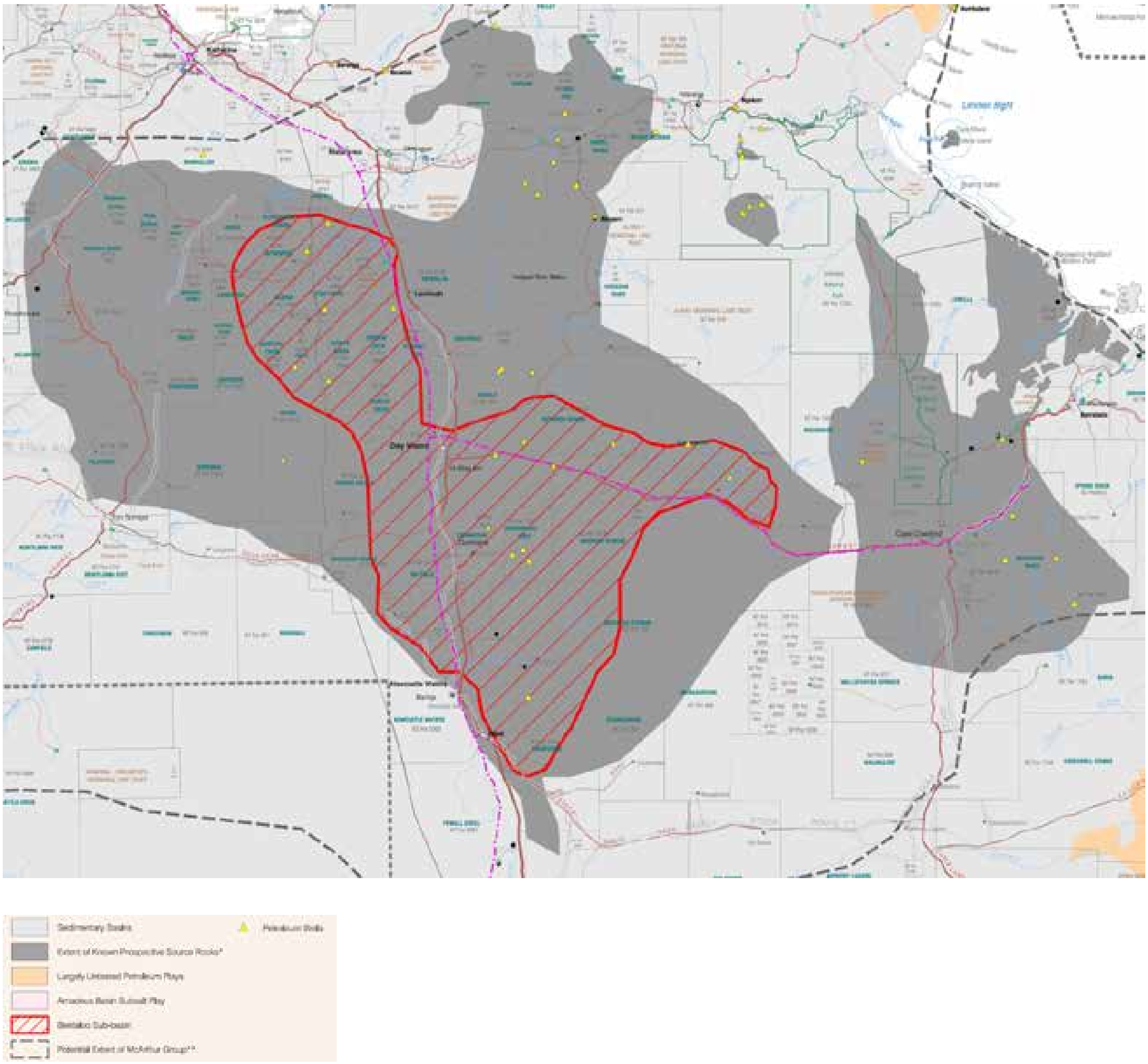
2 Adapted from Vanclay, F. 2003 International Principles for Social Impact Assessment. Impact Assessment and Project Appraisal 21(1), 5-11 (available at http://dx.doi.org/10.3152/147154603781766491 last accessed 21 April 2017).

Attachment B(1)



NORTHERN TERRITORY GOVERNMENT

Attachment B(2)



Attachment C

- The research monograph entitled Ngukurr at the Millenium:" A Baseline Profile for Social Impact Planning in South East Arnhem Land, by J. Taylor, J. Bern, and K.
- Social Impact Assessment undertaken by EcOz in connection with the Western Desert Resources Roper Bar Iron Ore Project.
- The Economic and Social Impact Assessment undertaken by EcOz in connection with the Sherwin Creek Iron Ore Project.
- The Social Impact Assessment Scoping Study and the Economic and Social Impact Assessment undertaken by Circle Advisory in connection with the Northern Gas Pipeline.

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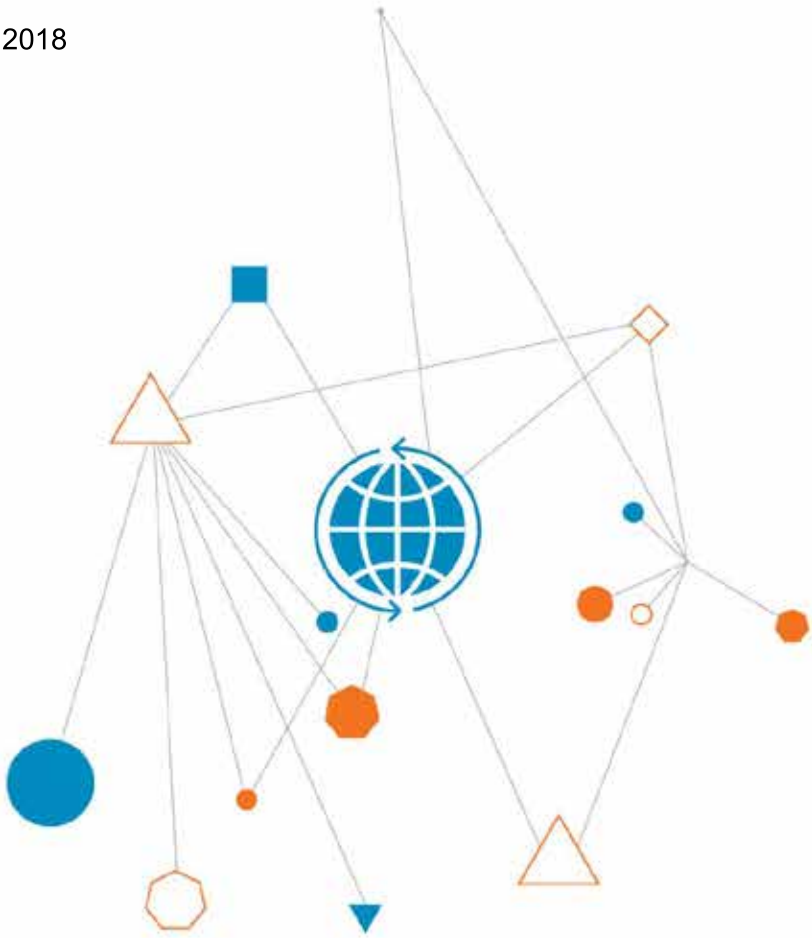
SMI CSRM
Centre for Social Responsibility in Mining

CSIRO

Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Beetaloo sub-basin Social Impact Assessment Summary Report

17 January 2018



When you think with a global mind problems get smaller

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Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Prepared for
Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

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17 January 2018

DRWEN208121_SIA_Summary_Report

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1. Background

The Terms of Reference of the Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Gas Reservoirs and Associated Activities in the Northern Territory (the Inquiry) require the independent scientific panel (the Panel) to determine the nature and extent of the risks of hydraulic fracturing of onshore unconventional shale reservoirs and its associated activities on water, land and air conditions in the Northern Territory, as well as on the social, economic and cultural conditions in the Northern Territory.

The Inquiry engaged Coffey and its partners the University of Queensland Centre for Social Responsibility in Mining (CSRM) and CSIRO to address three elements relating to the social and economic conditions.

First, the development of a leading practice framework (SIA Framework) for the identification, assessment and management of the potential social impacts associated with the development of onshore unconventional gas in the Northern Territory, and a description of how this framework could operate in in conjunction with Northern Territory and Commonwealth environmental assessment frameworks.

Secondly, as described in the Inquiry Background and Issues Paper (available at https://frackinginquiry.nt.gov.au/background-and-issues-paper) the Panel will *'use the example of a possible unconventional shale gas project in the Beetaloo Sub-basin, which is where exploration is most advanced, as a case study to demonstrate how the framework could operate, including how risks are to be identified, assessed, and managed'*. As exploration for onshore unconventional gas is at an early stage in the Northern Territory, scenarios for any future development in relation to location, scale and timing are uncertain, which conditioned this assessment to be high-level and indicative of potential impacts of onshore unconventional gas development.

Thirdly, to *'describe, with reference to the literature and examples from other jurisdictions, the concept of a "social licence to operate" as it applies to the onshore unconventional gas industry in the Northern Territory'* and to investigate *'measures that onshore unconventional gas industry and government can take to enable industry to earn and maintain a social licence to operate in the Northern Territory'*. Broadly speaking, a 'social licence to operate' is a measure of the acceptance of an industry within society.

The scope of work was undertaken through a combination of research, analysis of public submissions to the Inquiry, and engagement with key stakeholders through a program of targeted consultation with communities in and around the Beetaloo sub-basin, as well as consultation with government agencies and relevant organisations in relation to their views on the elements of an appropriate SIA Framework, an industry 'social licence to operate', and the potential for social impacts and opportunities for benefits associated with a conceptual development scenario in the Beetaloo sub-basin.

2. Context

Following an extensive community engagement program, the Northern Territory Government released its Economic Development Framework[1] (the Framework) on 20 June 2017. The Framework indicated that in the short to medium-term *'industry sectors expected to experience strong demand growth included energy and minerals, tourism, agribusiness, and international education and training'*. With respect to energy and minerals, the Framework stated that *'To ensure Territorians benefit from our resource wealth we need to ensure there is community support for industry activities and that investors have confidence and certainty when they make investment decisions. In the near-term, government and industry need to work together to ensure key concerns held by the community are addressed and there is a clear, agreed and endorsed pathway to facilitate industry development'* (emphasis added). High-level actions to advance implementation of the Framework included the development of a *'communication strategy to inform the community of benefits from energy and minerals industry activity, including business and job opportunities, and to clarify the impact on the environment'* and a commitment to *'review energy and mineral legislation to improve consistency in applying legislation'*.

The Inquiry has acknowledged the importance of addressing the potential for social impact, and to develop and maintain, in collaboration with industry proponents, a 'social license to operate' associated with the development of a new component of the oil and gas industry (onshore unconventional shale gas) in the Northern Territory. Key to obtaining a 'social licence to operate' is information about how the communities' concerns could be addressed.

CSRM[2] has proposed a SIA Framework for addressing community concerns about how the social impacts will be identified, understood and managed. Drawing upon the lessons of gas industry development on a regional scale in new domains, in Australia (e.g., Surat Basin) and internationally (shale gas development in the United States and South Africa), CSRM's recommendations emphasise the importance of adopting a strategic industry approach for baseline characterisation. This should be complemented with comprehensive education and awareness programs for the potentially affected communities so that informed consideration may be given to the potential for impacts that may be experienced, as well as opportunities that may be available for capture. A key feature of the SIA Framework is the requirement for ongoing participatory monitoring and government-community-proponent collaboration in the development and implementation of strategies to mitigate impacts and capture socio-economic development opportunities.

The Beetaloo sub-basin SIA case study[3] adopted relevant aspects of the SIA Framework to identify and assess the potential social and economic impacts of a conceptual development. The conceptual development was based on the Shale WIND scenario developed by ACIL Allen and presented in their report[4].

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[1] See https://edf.nt.gov.au/home
[2] Witt, K., Vivoda, V., Everingham, J., Bainton, N. (2017). A framework for social impact assessment of shale gas development in the Northern Territory, Centre for Social Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland.
[3] Coffey Services Australia Pty Ltd, Beetaloo sub-basin Social Impact Assessment Case study, Report to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, December 2017
[4] ACIL Allen Consulting, The Economic Impacts of a Potential Shale Gas Development in the Northern Territory, Final Report to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory, October 2017

The Beetaloo sub-basin is an area of the Northern Territory where exploration for shale gas is most advanced, and includes towns and communities typical of urban and remote areas of the Northern Territory. The socioeconomic context for undertaking the SIA case study of the conceptual development in the Beetaloo sub-basin is characterised as follows:

- The Beetaloo sub-basin has seen almost no industrial development. Some affected communities have experience with development. For example, experience with mining development south of Ngukurr (iron ore) and at McArthur River (large-scale underground and open pit mining of lead and zinc). The installation of gas transmission and lateral pipelines through the sub-basin (Amadeus Basin to Darwin Pipeline in 1986; the Elliott Spur Pipeline in 1989, and the McArthur River Pipeline in 1995) that occurred 20 to 30 years ago is not readily recalled by community members. The current installation of the Northern Gas Pipeline from just north of Tennant Creek to Mount Isa is in an early stage of development, and a significant distance south of the Beetaloo sub-basin communities.

- Economic activity is centred on agriculture development (pastoral operations throughout the sub-basin, horticulture south of Katherine and along the Roper Highway) together with Defense activity at RAAF Base Tindal, and tourism activity mainly servicing self-drive visitors. Regional service townships (Katherine and Tennant Creek) are located outside the sub-basin.

- Obvious significant disparities in social status and living conditions between remote Aboriginal communities and regional service townships, as a result of their remoteness affecting access to services, their poor state of housing, limited access to a functioning labour market, and differences in health and education status. This has a significant influence on the potential for community members to capture potential benefits from industry development should it occur.

- Community members have a reasonably high level of awareness (due to the activities of groups opposed to industry development) of historical issues surrounding the development of unconventional gas resources in other jurisdictions but not of the potential unconventional gas industry in the Northern Territory. The Inquiry's Interim Report (Inquiry, 2017b) acknowledged that levels of knowledge in Aboriginal communities about future development is inadequate.

In the absence of any firm proposals and limited information on how a shale gas field would be developed, the case study assumed that initial development would occur to the west of Larrimah and to the east of Daly Waters, in the areas that have shown favourable exploration results. It is assumed the projects would be offset by three years and produce gas for 25 years. Assumptions were made regarding the scale of the development and its key components, project stages and duration; construction and operation workforce numbers, employment policies (i.e., FIFO and DIDO), logistics and maintenance bases etc. The conceptual development was sufficiently defined to support the high-level assessment of social impacts of onshore unconventional gas development and identification of opportunities for benefits.

The nature and elucidation of the concept of the 'social license to operate' or 'how community acceptance of the industry could be assessed' was undertaken by the CSIRO[5]. CSIRO detailed the key drivers of trust and acceptance for the extractive industries in the Northern Territory, and in other jurisdictions and commodities. The drivers include feeling heard, respected and involved in decision making processes (procedural fairness), feeling that the benefits (and impacts) of extraction are shared fairly (distributional fairness), that government has the capacity and will to ensure public

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[5] Moffat, K., Lacey, J., McCrea, R., & Poruschi, L. (2017). Social licence to operate in the Beetaloo Basin and Northern Territory. CSIRO, EP177961.

interests are protected and industry held to account (governance capacity), that physical and social impacts are managed effectively and appropriately, and that interactions between company personnel and community members is a positive experience (contact quality). CSIRO proposed a measurement and modelling framework for ‘social licence to operate’, focusing on the following principles for its development:

- The engagement of a trusted third party – engendering trust and confidence in the process.
- Protection of community rights and safety.
- Longitudinal design – placing the experiences of community at the centre of the process, and to identify issues before they become conflicts.
- Accessibility of data – transparency of process and data provision back to community and other stakeholders is central to building trust that this is a vehicle for community voice.
- Inclusiveness of process – so that vulnerable, marginalised and special status groups are included in ‘social licence to operate’ research using appropriate methods.

3. Key findings

The following sections summarise the key findings of the three social elements of onshore unconventional gas development.

3.1. The approach to assessing potential social impacts of industry development

Key characteristics of a leading practice SIA Framework for shale gas in the NT must include:

1. ***Strategic assessment*** is needed for a program of development. The strategic assessment would clearly identify the objectives of the program and define the scale (and staging) of development in terms of balancing economic, social and environmental impacts at local, Territory and national scales.
2. A ***strategic regional approach*** is needed that aligns individual projects and their outcomes with the objectives of the NT Economic Development Framework, regional planning objectives and community values and aspirations.
3. ***Coordination and collaboration between multiple projects*** is needed in order to minimise negative cumulative impacts, minimise the ‘footprint’ of the industry in the placing of associated infrastructure (including workers ’accommodation) and maximise long term social and economic benefits to local and regional communities.
4. Particular attention to ***human rights issues***, and the rights and vulnerabilities of all Aboriginal peoples, (not only those recognised as Traditional Owners).

5. Particular attention to ***psycho-social impacts***, in recognition of the interconnectedness of personal, cultural and environmental integrity for Aboriginal peoples. Also, in recognition of the potentially stressful nature of land access agreements for pastoralists.

6. An ***independently led social baseline assessment***, using ‘agreed indicators’ to measure impacts, ongoing social performance of the industry and sustainability outcomes (the indicators should be selected in consultation with local people and stakeholders).

7. An ***independently led community engagement*** program with affected stakeholder groups to discern the significance of impacts and to co-develop acceptable and appropriate mitigation and enhancement strategies.

8. The SIA framework should contribute to an ***open data policy*** with ***regular reporting*** on the social, economic and environmental performance of the shale gas industry.

9. Each additional project should provide an adaptive SIA risk assessment that specifically addresses ***cumulative impacts*** and its contribution to the development program’s objectives.

Gaps in the current Northern Territory regulatory environment for SIA are considered to include:

1. There are currently no mechanisms for strategic assessment (including strategic SIA) under NT regulations, although implementing strategic assessment has been accepted as a recommendation in a review of environmental assessment policy (the 2015 Hawke Report).[6]

2. There is scope for a strategic assessment under the *Environmental Protection and Biodiversity Conservation Act (*EPBC Act*) 1999 (CW)*, where matters of national environmental significance (MNES) may be affected. A map of protected matters[7] shows there are few matters that would trigger the EPBC Act in the NT. However, if the current ‘water trigger’ for coal seam gas and large coal projects was to be amended to include shale gas development (as water from underground aquifers is intended to be used) by the Commonwealth Government, all NT projects would be required to gain *EPBC Act* approval.

3. SIA is required only as a subset of an environmental impact assessment, and as such, has the potential to be undervalued in the approvals process.

4. While generic guidelines exist, there are no industry specific guidelines for conducting an SIA in the NT where there is a uniquely high proportion of Aboriginal people and interests.

5. There are currently no requirements or guidelines for cumulative impacts assessment.

Recommendations to adopt a leading practice SIA Framework include:

1. Initiate mechanisms for strategic environmental assessment of a specific program of shale gas development (e.g. Beetaloo sub-Basin) in either NT regulations (as recommended in the 2015 Hawke Report), or in partnership with the Commonwealth government in a Strategic Assessment Agreement under the *EPBC Act* 1999.

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[6] Hawke, A. (2015). Review of the Northern Territory Environmental Assessment and Approval Processes. May 2015.
[7] Australian Government, Department of the Environment and Energy, (2017) Protected Matters Search Tool http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

2. The Terms of Reference for strategic environmental assessment should include various specialist assessments, including cultural impact assessment. Due to the interconnectedness of Aboriginal peoples and their culture with environmental condition, predicting the significance of social (cultural) impacts (particularly for Aboriginal people, but also pastoral leaseholders) requires the integration of social, environmental, economic and cultural assessments.
3. Consult with the Commonwealth Department of the Environment and Energy in relation to possible amendments to the 'water trigger' under the *EPBC Act* to apply to shale gas projects, as it does for all coal seam gas and large coal projects. If the 'water trigger' were also to apply to shale gas projects, then Territory assessment processes must align with Commonwealth assessment requirements to avoid duplication.
4. Establish or enhance an independent authority (separated from government decision making) for the oversight of the strategic assessment, baseline studies and ongoing monitoring and reporting, as well as for social and environmental compliance auditing. This could be the existing NT Environmental Protection Agency to avoid structural complexity and the fragmentation of decision making that has confounded the effective regulation of the industry in other jurisdictions.
5. Collaboration and coordination between projects, and between gas companies, government and community organisations is necessary for effective identification, assessment and responses to cumulative impacts. A platform for such collaboration (such as a multi-stakeholder working group) would ideally be linked with the ongoing monitoring platform and come under the jurisdiction of the same independent Authority.
6. Third parties should be able to report grievances, or perceived breaches of conditions to the independent Authority where grievances relate to cumulative impacts and issues beyond the scale of project-level grievance mechanisms.
7. The costs of undertaking independent baseline studies (usually conducted by project proponents) should be recovered to an extent from project proponents (who would no longer have to do them individually, but who would use the available data in their risk assessments) by increasing the cost of the petroleum production license (PPL) for operators and/or by charging an annual levee or fee for use of the baseline data and ongoing monitoring and reporting platform.
8. Produce clear guidelines and simple fact sheets for negotiating Land Access Agreements in different tenure types that outline the rights of both the landholder and the project proponent. Considerable stress and negative impact has been associated with misunderstood land rights and perceived disrespect for attachments to, and interests in land.
9. Identify strategies to build local institutional and business capacity early. To best capture the potential economic benefits of shale gas development, adequate lead-time and institutional, business and individual capacity is required.
10. Negotiations with Aboriginal Traditional Owners (TOs) should be inclusive and transparent (on agreement). General informed consent is insufficient. Details of activities should be negotiated in recognition of rights to self-determination and to ensure these groups fully understand the terms of the project and the impacts, benefits and management strategies. The placement of each well and associated infrastructure should be negotiated on a case-by-case basis with local TOs to avoid any culturally sensitive places, and 'sacred sites' as identified by the Aboriginal Areas Protection Authority (AAPA). The process for such negotiations should be fully documented.

11. Royalty payments should not be exclusive to TOs, but a community benefits trust, or other fund designed to distribute economic benefits to regions should be established. (e.g. 'Royalties for Regions' schemes such as in Queensland and Western Australia).
12. Perceptions or evidence of negative impacts on the spiritual wellbeing and social cohesion in Aboriginal communities should be given high priority in risk assessment, as personal safety could be at risk.

3.2. The Beetaloo sub-basin SIA case study

The Beetaloo sub-basin SIA case study identified the threats to community social values. The threats assessed as likely or almost certain to arise in urban communities are:

- Increased risk of road accidents from construction and operations traffic, particularly heavy vehicles during the construction phase.
- Increased levels of anxiety for sub-basin residents over potential risks to groundwater resources.
- A perception that industry development approval is against majority community wishes, contributing to a weakening in trust in government.
- The potential for higher wages to affect local businesses on-going conflict between supporters and opponents of unconventional gas development.

The threats assessed as likely or almost certain to arise in rural communities are:

- Increased risk of road accidents from construction and operations traffic, particularly heavy vehicles during the construction phase.
- Heightened divisions in Aboriginal communities driven by perceived inequity in the receipt of royalties.
- Increased levels of anxiety for sub-basin residents over potential risks to groundwater resources.
- A perception that industry development approval is against majority community wishes, contributing to a weakening in trust in government.
- Heightened perceptions of cultural loss due to perceived impacts to water resources, and uncertainty about the ultimate scale of industry development and landscape alteration.
- The potential for reduced investment in pastoral and horticultural operations due to uncertainty over the long-term sustainability of groundwater resources

The identified threats (and impacts) identified in the high-level assessment can be mitigated and managed, as they are being managed in other onshore gas development areas. Effective management will require close collaboration between various industry groups and project proponents, government and the community to ensure that responsibility for management and reporting of sub-basin level impacts is clear, and that mechanisms for community feedback and response are widely-known and effective.

Ongoing effective community and stakeholder engagement is fundamental to the effective management of impacts and the maintenance of a 'social licence to operate'. Community and stakeholder engagement must commence in the strategic assessment phase at least two to three years prior to the project's environmental and planning approvals phase commencing. Key factors to consider in the development of a community engagement strategy include:

- The need for community industry awareness campaigns, particularly for Aboriginal communities. This needs to be an ongoing process, as the development and deployment of improved technology is proceeding at a rapid rate.
- The requirement for implementation of robust land access protocols.
- The need to provide regular environmental monitoring results to communities in a transparent manner that builds community confidence and trust in the monitoring process.
- Participation in regular community forums with government and other industry participants to discuss industry issues. Responsibility for the design and leadership of these forums may rest with government and peak bodies, however to be successful they will require the participation of industry at a senior level.
- The implementation of a Grievance Management Program, including community access to an independent advocate if necessary.
- The need for monitoring of community and visitor sentiment on a structured basis to ensure that the views of all sectors are heard and considered.
- The development and implementation of a workforce cultural awareness program and a workforce code of conduct to contribute to ongoing positive and supportive community relations.
- The development and implementation, in consultation with government, of local content policies and programs to maximise opportunity for Northern Territory business input and development.

3.3. A Social Licence to Operate

A 'social licence to operate' is a term widely used in the community, though with no common conceptual understanding or agreed method for assessing its status amongst a community or group of stakeholders. With the widespread level of distrust experienced during SIA community consultation and Inquiry hearings, it is imperative that there be a means of independently assessing the status of community acceptance of industry development and operations. CSIRO research indicates that:

- The key drivers of trust and acceptance for the extractive industries in the Northern Territory include:
  - feeling heard, respected and involved in decision making processes (procedural fairness);
  - feeling that the benefits (and impacts) of extraction are shared fairly (distributional fairness);
  - that government has the capacity and will to ensure public interests are protected and industry held to account (governance capacity);
  - that physical and social impacts are managed effectively and appropriately; and

  - that interactions between company personnel and community members is a positive experience (contact quality).

- Data from a CSIRO national survey of citizen attitudes toward the extractive industries revealed that for residents of the Northern Territory, good governance was significantly more important for social acceptance of the extractives than for residents in the rest of Australia.

- The most important predictor of social acceptance was perceived balance of benefits over impacts of mining, or its value proposition for the Territory and its people. Like the rest of Australia, perceived employment from extractives and financial community benefits was the highest predictor of 'balance of benefits over impacts' variable.

- The balance of benefits over impacts with respect to extractives was viewed quite positively in the Northern Territory, in line with the national average.

- Engagement with industry, community and government stakeholders revealed that uncertainty about how the industry would look and fracking as a technology was a locus of attention for all of these stakeholders. Reducing this uncertainty in a framework supported by government appears to be of real interest to most of those spoken with. And extending this, that government plays a more active and creative role in the discussion and engagement of these issues and the development of the industry itself.

- A measurement and modelling framework for 'social licence to operate' should be developed based on the following principles:

  - *The engagement of a trusted third party* – ensuring independence from vested interests.

  - *Protection of community rights and safety* – ethical and privacy standards are applied under the National Statement on Ethical Conduct in Human Research (2015), placing the safety of participants first.

  - *Longitudinal design* – placing the experiences of community at the centre of the process, and to identify issues before they become conflicts.

  - *Accessibility of data* – transparency of process and data provision back to community and other stakeholders in central to building trust that this is a vehicle for community voice.

  - *Inclusiveness of process* – it is important that vulnerable, marginalised and special status groups are included in 'social licence to operate' research using appropriate methods.

4. Conclusion and recommendations

CSRM has proposed a leading practice SIA Framework that adopts the well-established and understood phases of social impact assessment. CSRM's key recommendation is that future project-level SIA be conducted within the framework of a strategic SIA informed by sub-basin wide baseline studies. CSRM recommends monitoring during the construction and operation phases of shale gas developments to enable the effectiveness of strategies and management measures developed to address the socioeconomic impacts to be measured and adapted to changing circumstances.

Independently-led community and stakeholder engagement is recommended, which is supported by CSIRO in its advice on what constitutes a 'social licence to operate'. Independently acquired or verified information that is transparently reported is seen by CSRM and CSIRO as crucial to building confidence in the affected communities and more broadly in the Northern Territory community.

The SIA case study identified the socioeconomic impacts of a conceptual development in the Beetaloo sub-basin. Importantly, it concluded that the impacts are manageable with appropriate strategies and programs. This conclusion was based on experience of unconventional gas development in other jurisdictions where social impacts have been, and are being, successfully managed. Understandably, the scale and pace of development has, in some instances, resulted in suboptimal outcomes. The lessons learned in other jurisdictions provide valuable insight to the practices and processes that can be improved.

The key findings of these investigations are:

- Strategic assessment is required to enable a comprehensive sub-basin wide baseline from which project-level and cumulative impacts can be identified, assessed and managed.
- The comprehensive baseline must be informed by independently-led project-independent studies that are participatory.
- Mitigation strategies and management measures must be developed through collaboration between territory and local government, industry and communities.

The highest risk issues identified in the investigations relate to Aboriginal communities and their unique circumstances. Aboriginal communities are beset by complex issues that are products of history, their current circumstances, and evolving policy.

The remoteness of the Beetaloo sub-basin and gas fields will naturally mitigate some impacts experienced in more densely populated areas where regional centres and towns provide opportunities for colocation of facilities. For example, it is expected that accommodation facilities will be located at the gas fields and remote from Aboriginal communities, thereby avoiding the effects of rapid population increase and competition for housing in vulnerable communities. In these circumstances, the key issue will be how to create opportunities for the people on whose country the gas fields will be developed.

Aboriginal communities are disadvantaged by their lack of experience of unconventional gas development, knowledge of its techniques and impacts, and how they are managed, and most importantly, how these relate to their country and circumstances. Awareness, education and participation in the planning and development process will be crucial to their engagement and ability to put forward ideas and suggestions for involvement in the industry and opportunities to benefit from the industry.

While independently-led baseline studies and independently-led community and stakeholder engagement may build community confidence in the planning and development process, it is crucial that proponents own the relationship with communities. Proponents need to develop working relationships with communities that are built on trust, respect and cooperation. CSRM and CSIRO's recommendations must have regard to the important role proponents play in community and stakeholder engagement and in supporting the strategies for managing the socioeconomic impacts of unconventional gas development.

Effective communication methods that build trust should incorporate:

- Raising awareness of the unconventional gas industry, the contemporary technology employed and environmental performance achieved (complex technology needs to be explained effectively to non-technical lay persons).
- Industry site inspections for community leaders and members to observe industry exploration and production activity, including the deployment of environment management measures in practice.
- Making available technical leaders to engage in dialogue around issues with community members and leaders.
- The allowance of adequate time to establish an authentic dialogue with Aboriginal communities.
- Environmental monitoring, management and reporting measures that include on-going community participation in planning and implementation.

Equity is a key issue in the distribution of benefits from resource projects. CSIRO noted that where this occurred, a 'social licence to operate' was more forthcoming. A key concern raised in the SIA case study and community consultation was the risk of dividing Aboriginal communities between the 'haves' and 'have nots' through royalty distribution.

Consideration must be given to the establishment of a transparent royalty distribution mechanism so that regional areas that host gas development may benefit commensurate with the impacts to which they are subject. This will involve novel approaches to the distribution of benefits under statutory agreements, for example Indigenous Land Use Agreements, where benefits are currently paid to the Traditional Owners registered as Native Title claimants.

4.1. Recommendations

A 'social licence to operate' for an unconventional gas industry, as explained by CSIRO (2017) is possible with implementation of the SIA Framework proposed by CSRM (2017). The Beetaloo sub-basin SIA case study and associated consultation has confirmed that inclusive, well-informed engagement with affected communities is critical to achieving a 'social licence to operate'. The following recommendations will facilitate the quality and effectiveness of the engagement, leading to an environment in which informed decisions can be made about the social, economic and cultural impacts of an unconventional gas development. The recommendations require a collaborative approach – which experience has shown – produces the best outcomes.

Recommendation 1

The SIA Framework proposed by CSRM (2017) is implemented with appropriate lead time allowed for compiling a comprehensive social baseline. The framework to be implemented is to have regard to the following recommendations.

Recommendation 2

Shale gas development proponents and the Northern Territory Government enter into a memorandum of agreement to share socioeconomic data to enable compilation of a comprehensive sub-basin social baseline that is periodically updated.

Recommendation 3
Shale gas development proponents enter into a memorandum of agreement for cost recovery of expenditure on baseline study, whereby late entrants who benefit from the comprehensive social baseline proportionally fund the work of the first movers.

Recommendation 4
A representative consultative committee comprising the Northern Territory Government, shale gas development proponents and community representative bodies is convened to deal with sub-basin wide issues and to integrate government and industry initiatives with community aspirations where appropriate.

Recommendation 5
Shale gas development proponents implement awareness and education programs for affected communities that provide basic information on unconventional gas development, its impacts and their management ahead of discussion about impacts associated with a particular project. The programs involve suitably qualified technical experts to answer community questions and involve visits to operating unconventional gas fields to assist community representatives understand the activities and nature of impacts.

Recommendation 6
The Northern Territory Government implements an awareness and education program on unconventional gas industry regulation that informs affected communities about the approval process and their rights under the applicable statutory processes including access to land.

Recommendation 7
Shale gas development proponents build, own and maintain relationships with communities and are involved in consultation and the compilation of social baselines supported by independent consultants and technical experts.

Recommendation 8
Aboriginal community engagement adopts a structured approach that incorporates preparatory meetings, dialogue on social values, industry awareness and education meetings, project-specific meetings covering proposed development and implementation issues. The meetings are timed and structured to accommodate the needs of each community noting the different issues confronting communities including the potential need for interpreters.

Recommendation 9
Independent monitoring and evaluation is implemented and designed to differentiate industry-related impacts from other impacts and identify the extent to which industry-related impacts exacerbate or ameliorate other impacts. The CSIRO's principles for a 'social license to operate' measurement and modelling framework are incorporated in the design of the monitoring and evaluation program.

Recommendation 10
Social programs and mitigation strategies are to be adaptive and able to be refined to accommodate the findings of monitoring and evaluation of programs and initiatives.

Recommendation 11
Novel approaches, including those proposed by CSRM (2017), to the distribution of benefits (relative to impacts) are investigated to ensure equity within and between communities.

SMI CSRM
Centre for Social Responsibility in Mining

A framework for Social Impact Assessment of shale gas development in the Northern Territory

Final Report
January 2018

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

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SMI CSRM
Centre for Social Responsibility in Mining

The Centre for Social Responsibility in Mining (CSRM) is a leading research centre, committed to improving the social performance of the resources industry globally.

We are part of the Sustainable Minerals Institute (SMI) at the University of Queensland, one of Australia's premier universities. SMI has a long track record of working to understand and apply the principles of sustainable development within the global resources industry.

At CSRM, our focus is on the social, economic and political challenges that occur when change is brought about by resource extraction and development. We work with companies, communities and governments in mining regions all over the world to improve social performance and deliver better outcomes for companies and communities. Since 2001, we have contributed to industry change through our research, teaching and consulting.

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Executive Summary

Background

This report is one component of a larger task to develop and pilot a framework for social impact assessment specifically relating to potential shale gas development in the Northern Territory (NT). The task was commissioned by the Independent Scientific Panel (the Panel) for the Inquiry into Hydraulic Fracturing in the Northern Territory and awarded to Coffey Services Australia (Coffey). Coffey engaged the team at the Centre for Social Responsibility in Mining (CSRM) at the University of Queensland's Sustainable Minerals Institute to:

a) review current literature on best practice social impact assessment;
b) review the current regulatory environment for social impact assessment in the NT;
c) review case studies of similar onshore unconventional gas development; and
d) develop a 'fit for purpose' leading practice SIA framework for shale gas development in the NT.

This report presents the work undertaken by CSRM.

Purpose

The purpose of this report to provide to the Panel a framework for SIA specific to shale gas development in the NT that is based on leading practice and lessons learned from similar developments elsewhere. The SIA framework presented in this report also informs the accompanying Beetaloo sub-Basin case study report, which is produced separately by Coffey.

Methods

CSRM conducted a review of academic and leading practice literature on SIA, a review of the regulatory environment for SIA in the NT, and distilled lessons learned from case studies of similar developments elsewhere. From these reviews, CSRM developed a conceptual model for a SIA framework that addresses the specific circumstances of shale gas development in the NT. This conceptual model was internally peer-reviewed by senior CSRM researchers, who have substantial international experience in SIA, indigenous agreements and community relations in relation to extractive industries. The conceptual model was then distilled to show the steps involved in implementing the approach. The models are presented and explained further in Section 4 of the report.

Key findings

Key components of a leading practice SIA Framework for shale gas in the NT

1. ***Strategic assessment*** is needed for a program of development. The strategic assessment would clearly identify the objectives of the program and define the scale (and staging) of development in terms of balancing economic, social and environmental impacts at local, Territory and national scales.
2. A ***strategic regional approach*** is needed that aligns individual projects and their outcomes with the objectives of the NT Economic Development Framework, regional planning objectives and community values and aspirations.
3. ***Coordination and collaboration between multiple projects*** is needed in order to minimise negative cumulative impacts, minimise the 'footprint' of the industry in the placing of

associated infrastructure (including workers 'accommodation) and maximise long term social and economic benefits to local and regional communities.

4. Particular attention to ***human rights issues***, and the rights and vulnerabilities of all Aboriginal peoples, (not only those recognised as Traditional Owners).
5. Particular attention to ***psycho-social impacts***, in recognition of the interconnectedness of personal, cultural and environmental integrity for Aboriginal peoples. Also, in recognition of the potentially stressful nature of land access agreements for pastoralists.
6. An ***independently led social baseline assessment***, using 'agreed indicators' to measure impacts, ongoing social performance of the industry and sustainability outcomes (the indicators should be selected in consultation with local people and stakeholders).
7. An ***independently led community engagement*** program with affected stakeholder groups to discern the significance of impacts and to co-develop acceptable and appropriate mitigation and enhancement strategies.
8. The SIA framework should contribute to an ***open data policy*** with ***regular reporting*** on the social, economic and environmental performance of the shale gas industry.
9. Each additional project should provide an adaptive SIA risk assessment that specifically addresses ***cumulative impacts*** and its contribution to the development program's objectives.

Gaps in the current NT regulatory environment for SIA

1. There are currently no mechanisms for strategic assessment (including strategic SIA) under NT regulations, although implementing strategic assessment has been accepted as a recommendation in a review of environmental assessment policy (the 2015 Hawke Report).[1]
2. There is scope for a strategic assessment under the *Environmental Protection and Biodiversity Conservation Act (*EPBC Act*) 1999 (CW)*, where matters of national environmental significance (MNES) may be affected. A map of protected matters[2] shows there are few matters that would trigger the EPBC Act in the NT. However, if the current 'water trigger' for coal seam gas and large coal projects was to be amended to include shale gas development (as water from underground aquifers is intended to be used) by the Commonwealth government, all NT projects would be required to gain *EPBC Act* approval.
3. SIA is required only as a subset of an environmental impact assessment, and as such, has the potential to be undervalued in the approvals process.
4. While generic guidelines exist, there are no industry specific guidelines for conducting an SIA in the NT where there is a uniquely high proportion of Aboriginal people and interests.
5. There are currently no requirements or guidelines for cumulative impacts assessment.

Lessons learned from similar developments elsewhere

1. The scale and pace of development determines the significance of social impacts. So too does the pre-existing / pre-project social, economic, political and cultural environment.
2. The terms of 'co-existence' between shale gas and agricultural (or other industries) need to be negotiated on a business-to-business, case-by-case basis.

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[1] Hawke (2015)

[2] Australian Government, Department of the Environment and Energy, (2017) Protected Matters Search Tool http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

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3. Social impact mitigation strategies should not be bilateral agreements (e.g. government placing conditions on operators), nor overly prescriptive (e.g. operator must construct 50 new houses). Instead they should involve local communities (and other key stakeholders who have a role to play), be aligned with their aspirations and needs, and be 'outcomes-focussed'.
4. The social impacts of shale gas development are unevenly distributed. Those with capacity and information can prosper while inflexible or vulnerable groups can be negatively affected.
5. Social impacts, such as impacts on local social cohesion, and psycho-social stress, arise well before there is 'a project', and these are often not adequately addressed in SIA processes.
6. There is low trust in the onshore unconventional gas industry worldwide. Trust is time-consuming and difficult to earn but quickly and easily lost. In developed countries like Australia, mass media can have a large influence on the process. But not to lose sight of the importance of managing relationships at the ground level, especially in remote areas.
7. Local institutions need to be strengthened (ideally prior to development occurring) to address the challenges and harness the benefits that the industry can bring. SIA needs to identify existing levels of capacity within these institutions and those that would need attention
8. Underlying much of the public concern about hydraulic fracturing (fracking) and the shale gas industry generally has been a lack of engagement of affected people in meaningful ways (particularly prior to the current Inquiry). Aboriginal people particularly require detailed information about the proposed activities and likely impacts of the industry to make informed decisions about their land.

Recommendations

1. Initiate mechanisms for strategic environmental assessment of a specific program of shale gas development (e.g. Beetaloo sub-Basin) in either NT regulations (as recommended in the 2015 Hawke Report), or in partnership with the Commonwealth government in a Strategic Assessment Agreement under the *EPBC Act* 1999.
2. The Terms of Reference for strategic environmental assessment should include various specialist assessments, including cultural impact assessment. Due to the interconnectedness of Aboriginal peoples and their culture with environmental condition, predicting the significance of social (cultural) impacts (particularly for Aboriginal people, but also pastoral leaseholders) requires the integration of social, environmental, economic and cultural assessments.
3. Consult with the Commonwealth Department of the Environment and Energy in relation to possible amendments to the 'water trigger' under the *EPBC Act* to apply to shale gas projects, as it does for all coal seam gas and large coal projects. If the 'water trigger' were also to apply to shale gas projects, then Territory assessment processes must align with Commonwealth assessment requirements to avoid duplication.
4. Establish or enhance an independent authority (separated from government decision making) for the oversight of the strategic assessment, baseline studies and ongoing monitoring and reporting, as well as for social and environmental compliance auditing. This could be the existing NT Environmental Protection Agency to avoid structural complexity and the fragmentation of decision making that has confounded the effective regulation of the industry in other jurisdictions.

5. Collaboration and coordination between projects, and between gas companies, government and community organisations is necessary for effective identification, assessment and responses to cumulative impacts. A platform for such collaboration (such as a multi-stakeholder working group) would ideally be linked with the ongoing monitoring platform and come under the jurisdiction of the same independent Authority.
6. Third parties should be able to report grievances, or perceived breaches of conditions to the independent Authority where grievances relate to cumulative impacts and issues beyond the scale of project-level grievance mechanisms.
7. The costs of undertaking independent baseline studies (usually conducted by project proponents) should be recovered to an extent from project proponents (who would no longer have to do them individually, but who would use the available data in their risk assessments) by increasing the cost of the petroleum production license (PPL) for operators and/or by charging an annual levee or fee for use of the baseline data and ongoing monitoring and reporting platform.
8. Produce clear guidelines and simple fact sheets for negotiating Land Access Agreements in different tenure types that outline the rights of both the landholder and the project proponent. Considerable stress and negative impact has been associated with misunderstood land rights and perceived disrespect for attachments to, and interests in land.
9. Identify strategies to build local institutional and business capacity early. To best capture the potential economic benefits of shale gas development, adequate lead-time and institutional, business and individual capacity is required.
10. Negotiations with Aboriginal Traditional Owners (TOs) should be inclusive and transparent (on agreement). General informed consent is insufficient. Details of activities should be negotiated in recognition of rights to self-determination and to ensure these groups fully understand the terms of the project and the impacts, benefits and management strategies. The placement of each well and associated infrastructure should be negotiated on a case-by-case basis with local TOs to avoid any culturally sensitive places, and 'sacred sites' as identified by the Aboriginal Areas Protection Authority (AAPA). The process for such negotiations should be fully documented.
11. Royalty payments should not be exclusive to TOs, but a community benefits trust, or other fund designed to distribute economic benefits to regions should be established. (e.g. 'Royalties for Regions' schemes such as in Queensland and Western Australia).
12. Perceptions or evidence of negative impacts on the spiritual wellbeing and social cohesion in Aboriginal communities should be given high priority in risk assessment, as personal safety could be at risk.

Contents

1. Social Impact Assessment

1.1 What are Social Impacts?

Social impacts are the changes experienced by people and communities, as a result of projects and activities that impact on the way they live work, relate to one another, relax and organise themselves.[3] Social impacts can be both positive and negative as Illustrated in the Table 1. They include "changes to the norms, values and beliefs that guide and rationalise their cognition of themselves and their society".[4] Social change is not an impact until it has an effect on people. Because social impact is conceived as being anything linked to a project that benefits, affects or concerns any impacted stakeholder group, almost any change can potentially have a social impact so long as it affects something that is valued by or important to a specific group of people.[5] Consequently, it is difficult to pre-emptively narrow the scope of analysis.

Major resources projects can generate multiple impacts and/or contribute to existing stresses within social systems.[6] Project-specific social impacts vary greatly in their nature, causation, magnitude and other characteristics (see Table 1 for classification). Depending on the context, different receiving environments (such as a social group or geographic region) may experience the same impacts differently.[7] It is the responsibility of the proponent, in consultation with project-affected peoples and other stakeholders, to ensure that all the relevant issues and impacts are identified and considered.

Table 1: Classification of social impacts[8]

Category	Descriptor	Examples and explanation
Nature	Tangible	Improved access to health services, better living standards, shortage of affordable housing options
	Intangible	Breakdown in social cohesion due to population movement
	Perceived	People's subjective perceptions or experiences of impacts
Directionality	Positive	Improved access to health services, new recreational areas, upgrades to community facilities and improved education and employment opportunities
	Negative	Increased crime rates, higher cost of living and increased health risks caused by pollution
	Mixed	The impact of some changes is positive in some respects and negative in others; e.g. population increase
Causation	Direct	Directly connected (in space and time) to the activity; e.g. resettlement, project-related employment and road construction

[3] Burdge & Vanclay (1996).
[4] The Interorganizational Committee on Principles and Guidelines for Social Impact Assessment (2003), p. 231.
[5] Vanclay et al (2015), p. 2.
[6] Franks et al (2010a).
[7] Ibid.
[8] Adapted from Initiative for Responsible Mining Assurance (2016); Burdge & Vanclay (1996); Franks et al (2010b); and Joyce & MacFarlane (2001).

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	Indirect	Impacts that occur due to actions resulting from direct impacts; usually less obvious, later in time or further away from the source of direct impact; e.g. increased income to tradespeople as project employees upgrade houses
	Induced	Cause is several times removed from project activities; e.g. loss of access to land due to market speculation
	Cumulative	Successive, incremental and combined impacts of one or more projects on society, the economy and the environment; can arise from the compounding activities of a single project or multiple projects and from the interaction with other past, current and future activities; the overall effect being larger than the sum of the parts[9]
Magnitude	Intensity	The scale of change from the existing condition as a result of the impact; e.g. major/critical, high, moderate, minor, negligible
	Geographic extent	Spatial concentration (e.g. site-specific, local, regional, widespread);[10] Distribution (e.g. localised, dispersed, contained)
	Duration	Short term (e.g. the noise arising from the operation of equipment during construction), medium term, long term (e.g. the inundation of land by a dam) Temporary (e.g. during construction), fixed term, permanent
	Frequency	Intermittent (e.g. blasting), continuous (e.g. electromagnetic fields caused by electricity lines)
	Rate of change	Immediate, delayed, incremental, rapid, gradual
	Reversibility	Reversible, irreversible/residual
Probability	Likelihood	Unlikely, possible, likely, certain
	Confidence	The level of reliability in the estimates of likelihood and consequences

1.2 What is Social Impact Assessment?

In general terms, social impact assessment (SIA) is a framework of analysis for the evaluation of impacts on humans and on the ways in which people and communities interact with their socio-cultural, economic and biophysical surroundings.[11] SIA is also a field of research and practice consisting of a body of knowledge, techniques and values.[12]

As a methodology, SIA is used by governments, companies and communities to identify, assess and manage the social impacts of project activities, and ensure that projects are conducted in a socially responsible manner. It is best understood as the process of analysing, monitoring and informing the management of intended and unintended social consequences of planned interventions, and any social change processes invoked by those

[9] The word "cumulative" anticipates a consideration of not just the development the subject of the application, but the development in combination with other development in the locality and the effect that the accumulation of such development and successive development of a similar type, will have on the community.
[10] Project-specific SIA is more focussed on potential social impacts on site-specific, local and regional as opposed to widespread (state-level, national and international) levels of analysis.
[11] Vanclay (2003).
[12] Ibid.

interventions, on affected communities, from the earliest stages of the planning process to future generations.[13] The objective of the SIA process is to identify, measure, predict and assess the effects of a project on the surrounding population's quality of life, culture, health, social interactions and livelihoods. It involves processes for analysing, monitoring and managing the intended and unintended consequences of a project.[14]

SIA is widely practised internationally as a predictive study that is part of the regulatory approval process for resources projects. Many resource-rich jurisdictions have a regulatory regime in place to ensure that the social impacts of resources projects are assessed and managed. This includes statutory requirements in place to undertake SIAs, either as a separate procedure, or as part of a broader environmental impact assessment (EIA). According to a 2012 survey, some form of EIA is mandated in 191 of the 193 nations of the world.[15] Despite the widespread and longstanding practice, in most cases SIA remains included as a component of EIA. Initially, SIAs were narrowly conceptualised and, as such, applied mainly at the project level, and were limited to prediction of the negative consequences of projects. This understanding of SIA continues to dominate policy, regulation and procedures in many jurisdictions.[16]

1.3 Leading Practice

SIA has the potential to contribute to sustainable development if it is implemented to the standard recommended in the literature as best or leading practice.[17] This growing body of literature provides detailed guidelines and benchmarks for the management of the social impacts of major resource developments. Several influential publications, mainly commissioned and published by the International Association for Impact Assessment (IAIA), have had the greatest impact on SIA practice.[18] Their most recent publication, *Social Impact Assessment: Guidance for Assessing and Managing the Social Impacts of Projects*,[19] published in 2015, provides detailed advice on leading practice in the undertaking and appraisal of SIA and the adaptive management of projects to address the social ramifications. The guidance serves as the definitive standard on leading SIA practice.[20]

[13] Vanclay (2003); Franks (2012), p. 6.
[14] Vanclay (2003).
[15] Morgan (2012).
[16] Vanclay (2006).
[17] Esteves et al (2012). The term "best practice" means cutting edge or leading, and thus good to advocate, but cannot be expected in all circumstances.
[18] The IAIA is the global authority on the leading practice in the use of impact assessment for informed decision-making regarding policies, programmes, plans and projects. The association provides an international forum for advancing innovation and communication of leading practice in impact assessment.
[19] Vanclay et al (2015).
[20] It is widely used by SIA practitioners, social performance teams, government regulators, the international finance community, NGOs and affected community representatives to benchmark performance in relation to the management of social issues arising from projects.

1.3.1 Key assumptions and elements

Box 1 outlines the key assumptions about SIA practice which are fundamental to the effective assessment and management of impacts.

Box 1: Underlying assumptions of SIA[21]

- **Prediction**: Many of the potential social impacts of planned developments can be anticipated.
- **Modification and alternatives**: Alternatives of any planned developments can be considered or plans modified to reduce their negative social impacts and enhance their positive impacts.
- **Mitigation**: Full consideration of potential mitigation measures is appropriate in all cases.
- **Sustainable Development**: SIA can be an integral part of the development process ensuring sound development alternative(s) rather than merely trading off costs and benefits.
- **Action oriented:** Findings of a well-conducted SIA can be used to provide practical guidance and recommendations to proponents and governments.
- **Alignment and coordination:** Considering impacts holistically in relation to community and government planning and preferred futures and the activities of other developers in a region can identify synergies and opportunities to coordinate with others or jointly manage, monitor and mitigate where appropriate.
- **Proportionate:** Effort and resources invested into the SIA should be commensurate with the risks and potential impacts.
- **Rigor:** Accepted social science methods, used appropriately by suitably qualified professionals and, where practicable using multiple data sources, provide well-substantiated results that are a valid basis for informed decision-making.
- **Intangible impacts:** Unlike many economic and environmental impacts, social impacts cannot be fully quantified and measured as they have intangible and subjective dimensions which must also be assessed.
- **Transparency:** Project affected people need full information about the proposed development, methodology and data sources to understand the basis for SIA findings.
- **Varied forms of knowledge**: Local knowledge and experience and acknowledgement of various local cultural values provide important input to any assessment.
- **Non-coercive:** There should be no use of violence, harassment, or intimidation in connection with the SIA or implementation of a planned project.

Leading SIA practice includes systems and strategies to both minimise adverse impacts and enhance the benefits associated with major developments for project-affected communities (see Box 2 for a summary of key elements of leading SIA practice).

Box 2: Elements of leading SIA practice[22]

Leading practice SIA is based on systems and frameworks that include the following elements:

- **Inclusiveness:** identifying and involving the full diversity of potentially affected people
- **Equity sensitivity:** fundamentally considering equity issues with particular attention paid to impacts on vulnerable and under-represented groups

[21] Franks (2012), p. 8.
[22] Adapted from Franks (2012) and Kemp et al (2013).

- **Lifecycle approach**: identifying and proposing responses to social impacts at all stages of development projects from inception to completion
- **Long term legacy**: outlining long-term development outcomes that reach beyond the life of the project and consider future generations
- **Human rights due diligence**: identifying, preventing, mitigating and accounting for project impacts on legal, traditional and human rights of local communities.
- **Ongoing engagement**: regularly engaging with project affected people, communities and government, seek active community participation in decision-making, fostering coordination, and partnering with local stakeholders to address issues of concern and mutual interest
- **Materiality:** prioritising issues and public concerns that are of most significance and relevance
- **Social investment and community development**: building the capacity of communities to minimise dependency on major projects and face future changes resiliently.
- **Coordination of cumulative impacts and social investment strategies**: jointly coordinating with multiple proponents and government in a region the management, monitoring and mitigation of cumulative impacts of development and associated social investment activities.
- **Continuous improvement, adaptive management and flexibility**: systems for actively responding to changing circumstances and increased knowledge of impacts and updating predictions

1.3.2 Cumulative Impacts

The alignment of activities with regional and/or community planning objectives, consideration of cumulative impacts of multiple projects and meaningful community participation in decision-making are important elements of leading SIA practice. The aim of cumulative impact assessment and management is to keep the total effects of all stresses at what are generally considered to be 'acceptable' levels (although defining 'acceptable' can be problematic in itself, as this can vary between stakeholder groups) and to enhance opportunities through multi-party co-ordination.[23] Depending on the scale and significance of the project, cumulative impacts can be identified and assessed as part of environmental impact assessments (EIA), SIA, regional or strategic assessments, or may be the subject of a focused study devoted to identifying and responding to cumulative impacts.[24]

Stakeholder participation and decision-making in the SIA process is crucial for improving the quality of the assessments and, ultimately, achieving social acceptance. The SIA process will bring most benefits to local communities and project-affected people when it is supported by a participatory engagement approach (see Box 3 for definitions and key differences between communities, stakeholders, rights-holders and project-affected people).[25]

[23] Franks et al (2010a), p. 2; IFC (2013).
[24] Franks et al (2010a), p. 23.
[25] Kemp & Owen (2013).

Box 3: Communities, stakeholders, rights-holders and project-affected people

Community refers to a grouping of people who have some sense of shared identity, beliefs and values, some shared interactions and some common social and political institutions.[26] The concept can be defined geographically, by proximity to an operation and political or resource boundaries, or socially, as a grouping of people with common interests.[27]

The general assumption is that people live and work in communities, which are therefore a primary focus in SIA.[28] Local communities are groups of people who live and/or conduct activities in close geographical proximity to the operation or within a surrounding area defined by a political or resource boundary. Regional communities live and/or conduct activities in wider geographic areas that may be impacted by the development.

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.[29]

Rights-holders are individuals and groups whose legal or traditional rights may potentially be impacted by a development. For example, in the Australian context the Native Title Act gives native title holders a right to access and use their traditional lands and to negotiate over future use of these lands. Arguably, rights holders are entitled to a greater voice in the assessment and approval process than those whose rights and interests are unlikely to be directly affected by a development. All people are rights-holders under international covenants and are entitled to a certain standard of well-being.[30]

Project-affected persons/people encompass any person, group or organisation that is directly (or in some significant way) affected by a project's activities.[31]

The above groups are not mutually exclusive and a person can belong to any combination of them simultaneously.

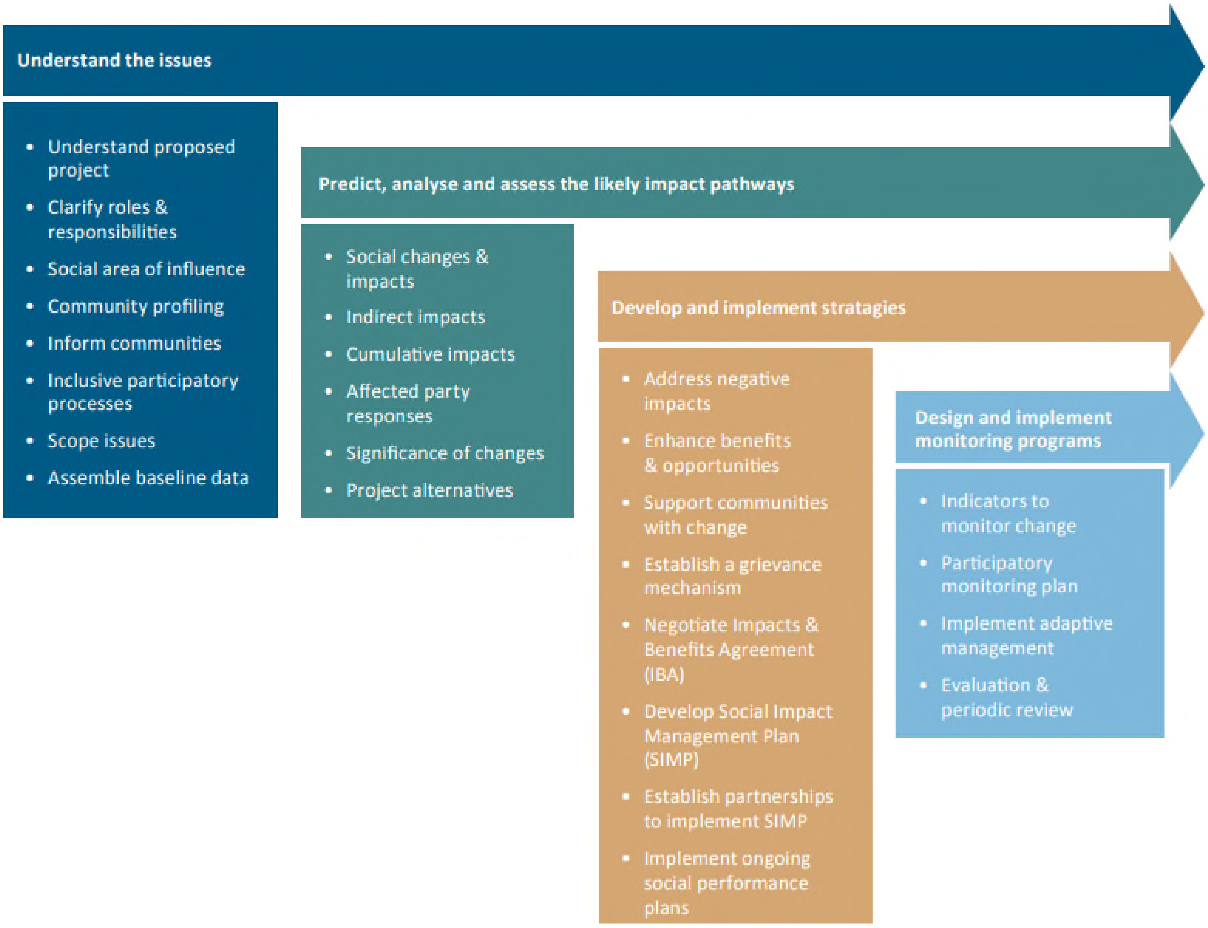
1.3.3. Components of leading practice SIA

The SIA process is a composite of numerous activities or tasks. The selection of activities to be undertaken should be tailored depending on the requirements of each project (see Figure 1 for a list of 26 activities).[32] Activities are carried out using a wide range of qualitative and quantitative social research methods and tools devised for SIA practice.[33] The selection of methods is dependent on what needs to be measured and on the broader SIA objectives. An integrated approach that combines several methods and tools provides

[26] Vanclay et al (2015), p. 76; IFC (2014), p. 137.
[27] IFC (2014), p. 137.
[28] Vanclay et al (2015), p. 76.
[29] IFC (2007); Kemp et al (2013); Vanclay et al (2015), p. 86.
[30] Kemp et al (2013); Vanclay et al (2015), p. 92; Boesen & Martin (2007).
[31] The World Bank (2012); Vanclay et al (2015), p. 91.
[32] For further detail on each activity, see Vanclay et al (2015), pp. 36–63.
[33] A kit of social assessment tools and methods, published by the World Bank, provides additional detail and comprehensive guidance on tools and methods in SIA. See Rietbergen-McCracken & Narayan (1998).

the most comprehensive and reliable prediction of impacts and associated mitigation and management strategies. Trained social scientists employing social science methods often provide the best results.[34]

Figure 1: The phases and activities of SIA[35]

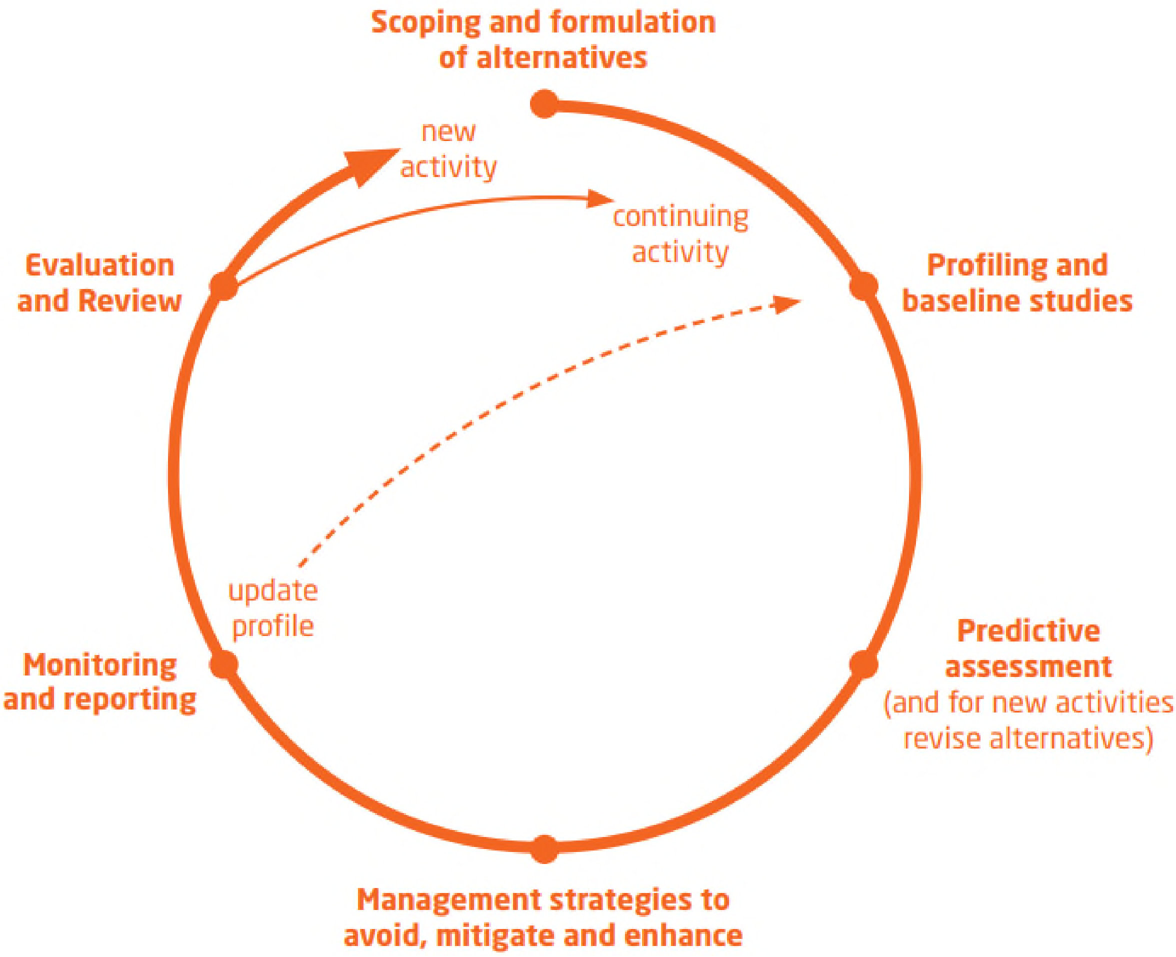


SIA is most effective as an iterative process across the lifecycle of developments, rather than a one-off activity at the outset of project development.[36] Leading practice involves the application of management systems and strategies to monitor, report, evaluate, review and proactively respond to change throughout the life of the project which, in the case of resources projects, extends to closure.[37] Under the adaptive participatory management approach, SIA is considered to be a learning process, in which initial assumptions and preliminary understandings need to be regularly updated based on new data and analysis. It requires update and validation informed by on-going consultation with project proponents

[34] Sustainable Business Initiative (2015).
[35] Vanclay et al (2015), p. 7.
[36] Franks (2012).
[37] Franks et al (2009).

and other stakeholders. The SIA process, based on an adaptive participatory management approach, can be arranged conceptually into distinct but iterative phases (see Figure 2).[38]

Figure 2: The phases of SIA within an adaptive participatory management approach[39]



1.4 Issues Specific to Shale Gas Development

Hydraulic fracturing of shale gas is a form of unconventional gas mining. The Northern Territory's (NT) onshore gas is predominantly shale gas trapped in shale rock, which requires hydraulic fracturing. Assessing the social impacts of hydraulic fracturing requires an examination of the ways in which social, psychological, health and political change processes associated with shale gas developments are impacting, and are likely to impact, the daily lives, beliefs, values and community dynamics of the residents in this region.

The social impacts of shale gas development have been studied. Evidence from North America suggests that despite the different technologies used in shale gas development and evolving characteristics of natural resource extraction, communities are experiencing many

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[38] Franks (2012).
[39] Franks (2012), p. 6.

of the same social impacts documented in earlier 'boomtown' studies that focussed on different resource commodities, including conventional gas.[40]

Extractive projects (mining and oil & gas) have common features which set them apart from other large-scale development projects. In particular, these projects:

- are very sensitive to market volatility with boom and bust cycles causing rapid up and downscaling;
- involve many uncertainties about the projects with the size and configuration of the project emerging progressively and incremental expansion of the project as additional resources are discovered or accessed, which can substantially change the characteristics of impacts;
- are often associated with significant impacts over an extended period; and impacts changing across the project lifecycle (exploration, construction, operation, closure);
- often create significant legacy issues related to post-closure landscapes and other socio-economic legacies such as the ongoing maintenance of project-sponsored infrastructure, an oversupply of housing, and where there has been economic dependence on the project, a narrow skills base; and
- are increasingly located in rural and remote areas meaning that small communities and Indigenous people are particularly vulnerable to negative impacts.

There are also unique sets of features associated with different types of extractive projects. Whereas mining activities are geographically contained in the vicinity of a deposit, and the mine operator has legal rights over the lease area, onshore oil and gas extraction is geographically dispersed, and surface rights holders may use land in co-location with oil and gas production. For example, gas well pads can be located on grazing properties or farms.

Although not exclusive to extractive projects, some social changes generated by major developments are particularly pronounced (in part because of the characteristics of the 'receiving environments') and warrant detailed assessment of impacts. While this is not comprehensive list, these generally include changes in:

- population, housing and/ or land availability and affordability;
- social division between 'newcomers' and 'old-timers'
- unemployment and income levels;
- traffic flow and patterns;
- noise levels, the quality and quantity of water, and air quality; and
- the character and identity of a community and people's well-being that can have a more significant impact than any material or tangible changes.[41]

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[40] Schafft et al (2014); Council of Canadian Academies (2014).
[41] Franks (2012).

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While shale gas development may provide significant, albeit varied economic benefits, it can also place stress on communities in relation to:

- community services - such as policing, health and emergency preparedness due to the ‘boomtown’ effect;
- quality of life and well-being - due to the combination of diverse factors related to the alienation of land, construction of new infrastructure, perceived threat to water quality, additional truck traffic and noise, loss of rural serenity and anxiety about unknown impacts;
- health and safety - issues related to truck traffic and the sudden influx of a large (predominantly male) transient workforce.
- psychological impacts - from physical stressors, such as noise, and non-physical stressors such as disempowerment, perceived lack of trust in the industry and government.

These factors are particularly relevant to the NT context and the ability of Aboriginal people to maintain their traditional way of life. In Canada, for example, several First Nations have expressed concerns about the possible impacts of shale gas development on their quality of life and their rights.[42] In the NT, proposed shale gas development may occur largely in the traditional territories of Aboriginal people who depend on the local environment for food and water and whose culture may be particularly affected. Specific monitoring of impacts on Aboriginal peoples’ physical and mental health, social well-being, quality of life and ecological systems on which they depend, is therefore essential. This includes not only direct impacts of shale gas development on health, communities and cultures, but also indirect and long-term impacts of intrusion into traditional territories and economic and social activities.

The type, frequency, and severity of social impacts are highly dependent on the scale and pace of different phases of development and on the physical, economic and social environments in which shale gas development takes place. People living in proximity to areas that experience rapid and large-scale development of gas production using fracking are particularly at risk in terms of social impacts. Research on the social impacts of fracking highlight the importance of having a robust and comprehensive monitoring system in place *before* significant shale gas development occurs. SIA should also evaluate short-term, cumulative and long-term social impacts, and consider mechanisms for addressing social needs of vulnerable populations.[43]

[42] Ibid.
[43] Council of Canadian Academies (2014), p. 150.

1.4.1 Industry standards

The International Petroleum Industry Environmental Conservation Association (IPIECA) is the peak international body for sustainability issues in the oil and gas industry. Its membership includes: the Australian Institute of Petroleum, the World Petroleum Council, BHP Billiton, BP, Shell, ConocoPhillips, Inpex, Petronas, Santos, and Woodside among others. *A Guide to Social Impact Assessment in the Oil and Gas Industry* provides managers of existing oil and gas operations or new projects with an understanding of how to make the best use of SIAs.[44]

IPIECA members are committed to:

- Contribute to sustainable development by providing safe and reliable energy in an environmentally and socially responsible manner
- Conduct their operations and activities in accordance with applicable law related to environmental and social issues and ethical business practices
- Seek to improve their performance in addressing environmental and social issues
- Develop, share and promote implementation of sound practices and solutions with others in industry
- Engage with stakeholders, taking into account their expectations, concerns, ideas and views, and work with government and nongovernment organizations (IPIECA, 2008).

1.5 Complementary Documents, Plans and Strategies

Leading SIA practice is supported by jurisdictional benchmarks and guidelines, and complemented by plans, strategies and processes that are typically undertaken as part of, or in parallel with, the SIA process.

1.5.1 Social baseline assessments

Leading SIA practice is based on rigorous, methodical and detailed social baseline assessment of the social environment before the project. The baseline data become a reference point, along with other benchmark values, against which potential impacts can be anticipated, change measured and future situations compared. The baseline study should include conditions and trends at the project site and along the supply chains including places where the associated service activity is located. It often includes secondary data but should be supported by both quantitative and qualitative primary data from recent on-the-ground research.[45] The reliability of SIAs can be jeopardised by suboptimal baseline data caused by the lack of rigour with respect to methodology, sources and assumptions.[46] Inconsistencies

[44] IPIECA (2004).
[45] The Queensland Government (2013).
[46] Pope et al (2013).

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in methodology, scope and depth of SIAs are most pronounced in jurisdictions which lack specific terms of reference, such as guidelines or benchmark standards.[47]

Quantitative data can be accessed from the Australian Bureau of Statistics, longitudinal census data, various government agencies and online data portals. Qualitative data may be sourced from stakeholder engagement activities, community development strategies, plans and other research. The type of information required in a baseline assessment includes:

- community history and culture;
- population;
- workforce participation, employment and diversity profile;
- housing and accommodation;
- education and training;
- business, industry and economy;
- income and cost of living;
- social infrastructure;
- technology and communication services;
- community health and safety;
- transportation and access; and
- other, including socio-economic advantage and resilience, relevant economic modelling and cumulative impact data.

Quantitative and qualitative data captured in the development of the social baseline study should be compared, aligned and analysed using appropriate social science research methods like triangulation, and cause and effect analysis.[48]

1.5.2 SIA guidelines

The scope of SIA differs from country to country, depending on the institutional arrangements that are in place. Some governments publish SIA guidelines, which usually outline the underlying principles and purpose of an SIA and the role of the stakeholders; followed by a description of the SIA process along with detailed guidance for preparing the SIA. Examples from several jurisdictions can be accessed via the following links: The European Commission (guidelines, guidance), Greenland, New South Wales, Northern Territory and Queensland.

SIA guidelines often provide detailed technical guidance that addresses the application of SIA at the project level and at all project phases. They can improve the quality and utility of SIAs for these projects and related processes (e.g. social baselines and social management plans) by providing:

- criteria for the inclusion of the interests and values of stakeholder groups in the planning process;
- information to project proponents about SIA process and expectations;

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[47] Howitt (2011); Michella & McManus (2013).
[48] The Queensland Government (2013)

- assistance to all parties – proponents, community, regulators and key decision makers – to enable more effective use of SIA information and processes; and
- assurance that community engagement and participation are enshrined as important features of all SIA-related activities.

The availability of a guidance document does not necessarily correlate to leading or good practice.[49] In fact, there is concern in many jurisdictions over the poor quality of impact assessment guidance information and over the difference between guideline requirements and actual practice (e.g. how well is SIA actually regulated). The tendency in some guidelines to advise that appropriate tools and processes should be selected by practitioners to suit context and circumstances may be inadequate for practitioners who lack the experience and expertise to make such judgments. In those instances, more detailed operational guidance is needed on how to make sound methodological choices and select the best available methods.[50] There is also a need for regulators to have sufficient level of expertise in order to understand what they are looking for in an SIA.

1.5.3 Social management plans

Social management plans (SMPs) describe management actions that can be taken at each stage of a project to avoid or mitigate social impacts and maximise benefits.[51] Over the past decade, SMPs have emerged as a vital link between impact assessment, ongoing management and proactive response to social and community issues. SMPs may be developed in partnership with regulatory agencies, investors and community, and identify the responsibilities of each party in the management of impacts, opportunities and risks. Governments and finance institutions, such as the IFC, increasingly use SMPs as requirements for project approval and finance.[52] SMPs are usually supported by management plans that outline how specific impacts of a project, such as resettlement, community health and safety or cultural heritage, will be managed.[53]

SMPs provide the facility to coordinate project activities with service and infrastructure planning by government. They also provide an opportunity to link activities with local and regional planning processes and, if developed with reference to the management plans of other operations, can assist in predicting and managing cumulative impacts, a key component of any consideration of impact assessment effectiveness.[54]

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[49] Morgan (2012); Adelle & Weiland (2012).
[50] Noble et al (2012).
[51] SMPs are also referred to as social impact management plans, environmental and social management plans, social and labour plans and environmental and social action plans.
[52] See IFC Performance Standard 1. International Finance Corporation (2012).
[53] Vanclay et al (2015).
[54] Franks et al (2009).

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1.5.4 Strategic and regional assessments

Over the past two decades considerable progress has been made by extractive companies in improving the environmental and social track record of large extractive projects, and the tools available to plan and manage them in a sustainable manner. Traditionally EIA and, more recently, SIA, has been the mechanism of choice to address these issues at the planning stage. However, while EIA/SIA provides a clear practical framework for evaluating the environmental and social effects of specific projects, it is typically focused on a single proposed development rather than an analysis of the wider environmental and social impact of development activity throughout a region. It is not designed to address strategic decisions which often influence the actual development of a country or a region or decisions related to a project entry. Increased attention has thus been given to new assessment types more suited to address strategic environmental, social and economic issues at national and regional level.[55]

Strategic assessments are assessments done at the scale of a policy, plan or program, while regional assessments may be at the scale of a minerals or resource province, catchment, or political jurisdiction. Strategic and regional assessments may be undertaken during, or prior to, the establishment of a new type of industry, extraction method, or exploitable resource. The advantage of such approaches is that they:

- facilitate the early identification and resolution of potential issues when there is the flexibility to make changes;
- provide an opportunity for longitudinal and comparative research;
- may more effectively identify existing and potential cumulative impacts;
- may explicitly link assessment to regional planning and reporting; and
- can establish baseline and regional datasets that assist the development of region-wide monitoring efforts.[56]

A strategic assessment can be the most appropriate form of assessment for regions involving multiple stakeholders or complex, large-scale actions. Strategic assessments are often promoted as a method to more effectively account for cumulative impacts because they are:

- broader in spatial and sometimes temporal extent;
- they may make explicit regional standards, thresholds, and links to land use planning; and

[55] Wagner & Jones (2004).
[56] Franks et al (2010a).

- they often establish regional databases, protocols, management systems and tools for implementation (e.g. the definition of thresholds and methods for allocation within limits).[57]

In some jurisdictions, government-led strategic and regional assessments may establish the conditions for future development and reduce or remove the requirements for project-specific impact assessments prior to regulatory approval, if the proposals meet the conditions outlined in the assessment. Such an approach has obvious benefits for business as it can:

- lead to better delivery of social infrastructure and services, as well as better environmental outcomes;
- provide certainty for development proposals;
- reduce the potential for consultation fatigue;
- reduce the regulatory burden and shorten the approvals process;
- avoid the duplication of project level assessments; and
- inform developers about the environmental and social context in which they operate.[58]

In Australia, a lack of legislation enabling or requiring strategic assessment may explain a lack of widespread practice [59]

2. Regulatory Framework in the Northern Territory

2.1 Social Impact Assessment

SIA is widely practised internationally (usually as part of EIA) as a contributing study that is considered as part of the regulatory approval process for extractive projects. In federal systems of government, oversight and enforcement of compliance with environmental and SIA regulation is commonly at the sub-national (e.g. state or provincial) level. Under the Australian federal system, the regulation and development of natural resources (including project approval and assessment) are primarily the responsibility of state and territory governments. Consequently, SIA is almost exclusively defined under state and territory based schemes.

In the Australian context, there are significant differences between the approaches taken by the various states and territories, although assessments in all cases form part of the EIA process. As a component of EIA, SIA retains aspects of its earliest conceptualisation as a subset and subordinate form of EIA in which social issues are often not adequately

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[57] Ibid.
[58] Ibid.
[59] Marsden 2013

addressed (see Box 4 for more detail).[60] Similar to other Australian jurisdictions, SIAs in NT are focused on predicting impacts related to a specific project and are integrated within EIA, as part of the project approval process.

Box 4: key issues to consider when SIA is a subset of EIA

When SIA is included as a subset of EIA as commissioned by the proponent, a common objective is to produce a document for the EIA that will warrant that development consent is granted. Such practice can be characterised by a lack of integration between SIA and the ongoing and adaptive management of social and economic issues once a project commences and after an operation closes.[61] A recent study demonstrates that the role of the SIAs in the EIA programmes and reports is minor: measured in number of pages, the assessments account for three to four per cent of the total.[62]

When integrated within EIA, SIA tends to focus on the predictive aspects rather than incorporate the participatory component.[63] In the NT, as in many other jurisdictions, a requirement for community engagement only applies *after* an initial development application has been submitted. Research shows that this approach is generally procedural and often lacks substantive impact.[64] A once-only snapshot of the social environment as a baseline does not address the requirement for ongoing social relations, nor for adaptive management of issues as they arise throughout the life cycle of the project.

The *Environment Protection and Biodiversity Conservation Act* 1999 (*EPBC Act*) is the Commonwealth's key environmental legislation. The *EPBC Act* is focussed on the protection of matters of national environmental significance (MNES). MNES of most relevance to the NT include listed threatened species and communities, listed migratory species, Ramsar wetlands and national heritage places. Protected matters also include water resources in relation to large coal mining and coal seam gas developments (the 'water trigger'),[65] but *not shale gas developments*. Thus, shale gas developments currently do not require approval under the *EPBC Act* (unless there are other protected matters involved) and are currently only subject to approvals under relevant state or territory legislation.

Environmental (and social) approvals in the NT are regulated under the *Environmental Assessment Act* (*EA Act*) and the *Environmental Assessment Administrative Procedures* (*EA Administrative Procedures*).[66] The *EA Act* and associated procedures commenced in 1984 and have not been subject to significant amendment since that time. The *EA Act* and the *EA Administrative Procedures* establish the framework for the assessment of potential or anticipated environmental impacts of proposed developments. The *EA Act* defines 'environment' as "all aspects of the surroundings of man including the physical, biological,

[60] Esteves et al (2012); Prno & Slocombe (2012).
[61] Franks et al (2009); Esteves et al (2012).
[62] Suopajärvi (2013).
[63] O'Faircheallaigh (2010); Gillespie & Bennett (2012).
[64] João et al (2011).
[65] Power & Tomaras (2016).
[66] See http://www.austlii.edu.au/cgi-bin/viewdb/au/legis/nt/consol_act/eaa294/.

economic, cultural and social aspects."[67] The NT Environmental Protection Authority (NT EPA) administers the *EA Act*. The NT EPA is an independent authority established under the Northern Territory *Environment Protection Authority Act*. The NT EPA consists of a Chairperson and four appointed members who can provide expert advice in relation to a range of environmental, economic and social issues. The roles and functions are set out in the *EA Act*, the *Environment Protection Authority Act* (*EPA Act*) and the *Waste Management and Pollution Control Act* (*WMPC Act*) and these include compliance and enforcement activities.

Proponents are required to develop assessments commensurate with the scale and complexity of their proposals as determined in the NT EPA terms of reference for an Environmental Impact Statement (EIS) or Public Environmental Report (PER).[68] The assessment of projects under the *EA Act* may require the preparation of an Economic and Social Impact Assessment (ESIA) and an accompanying Economic and Social Impact Management Plan (ESIMP). An ESIMP generally forms one component of a broader Environmental Management Plan (EMP).[69]

The generic NT *Guidelines for the Preparation of an Economic and Social Impact Assessment* provide a basis for proponents to prepare assessments of social impacts of development proposals and accompanying ESIMP. The guidelines provide advice to proponents on the NT EPA's expectations for the assessment and management of social impacts of development projects assessed under the *EA Act*. The guidelines are aimed at assisting proponents in achieving the following objectives:

- documenting the economic and social impacts of a proposed development on the locality and region;
- mitigating negative economic and social impacts on the locality and region;
- encouraging development of new and/or expansion of existing businesses in the locality; and
- fostering sustainable development and community wellbeing.

The guidelines are limited to generic matters relating to economic and social assessment and do not address sector or proposal-specific issues that may be of significance. The guidelines require that social assessment is based on consultation with and involvement of the community, and that it includes:

- a description of local and regional social environment;

[67] Ibid.
[68] A decision on the appropriate permitting process for new project proposals is initiated by the proponent's submission of a Notice of Intent (NOI) to the NT EPA. If the NT EPA determines that assessment under the EAA is required, the agency must also determine the appropriate level of assessment (EIS or PER).
[69] The Northern Territory Government (2015), p. 5.

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- a development proposal;
- potential social impacts;
- measures for maximising social benefits and minimising social costs; and an ESIMP, which establishes the roles and responsibilities of the proponent, government, stakeholders and the community in mitigating and managing impacts throughout the life of a project.[70]

2.2 Key Gaps and Recommendations

The current regulatory framework for SIA in the NT does not match leading practice standards outlined in Section 1 (Box 2). This section addresses three key identified gaps in the NT's current SIA framework and outlines recommended reforms which may lead to improved regulatory system (see Table 2).

Table 2: Summary of key gaps and recommended reforms in the NT's SIA framework

Gaps	Recommendations
The EPA's roles and functions are set out in three separate pieces of legislation.	While retaining the NT EPA's independent role, setting out its roles and functions in one piece of legislation would reduce uncertainty and ambiguity, and would strengthen the regulatory system.
Cumulative impact assessment remains under-developed.	Strategic assessment should be utilised as a method to more effectively account for cumulative impacts and improve the approval pathway for potential shale gas developments.
ESIA guidelines are generic and lack industry relevance and sector-specific guidance.	Guidelines should be developed specifically for mining, petroleum production and extractive industry development, which can lead to better quality and utility of SIAs for these projects and related processes.

1. Setting out the EPA's role, function and objectives in three separate pieces of legislation has contributed to a degree of uncertainty about its core remit. Communities usually have greater confidence in environmental assessment outcomes and approval processes when there is independent authority acting as a check and balance against capture by sectoral interests in the system. Reducing ambiguity, while retaining the EPA's independent role, would strengthen the environmental regulatory system by increasing clarity and certainty. It would also increase system efficiency without undermining the environmental standards.[71]

2. Cumulative impact assessment remains under-developed in the NT, as in most jurisdictions in Australia and elsewhere. Cumulative impact assessment requires greater cooperation between proponents operating in the same area, and the involvement of

[70] Ibid.
[71] Hawke (2015).

regional authorities.[72] In both New South Wales and Queensland, impact assessment procedures require proponents to address cumulative impacts. In practice these requirements are specified in the terms of reference or assessment requirements of the impact assessment. Strategic assessment (see section 1.5.4) should be utilised in the NT as a method to more effectively account for cumulative impacts and improve the approval pathway for potential shale gas developments.[73] An independent agency, in this case the EPA, would be best suited to administer and regulate strategic assessment of shale gas development in the NT. Well executed strategic assessment of shale gas development at the planning stage would be beneficial in the NT context, as it can:

- remove the need for further environmental impact assessment later in the development approval process;
- resolve high level trade-offs between development, environmental and other values in a transparent way;
- provide certainty about which areas are suitable for development;
- establish the performance requirements and outcomes to be achieved from multiple developments in a region;
- establish clear requirements that projects need to meet and remove the need for detailed assessment of particular issues at the project level;
- be a useful means for improving baseline data and making it available to Governments and proponents; and
- facilitate future Commonwealth accreditation under the *EPBC Act* strategic assessment provisions, which if achieved, would streamline Commonwealth/Territory decision making.[74]

3. The NT ESIA guidelines provide a basis for project proponents in the NT to prepare estimations of social impacts of development proposals and accompanying ESIMP. However, the guidelines are generic and, as such, lack industry relevance and sector-specific guidance. Some leading practice jurisdictions (e.g. New South Wales) have developed SIA guidelines specifically for mining, petroleum production and extractive industry development.[75] Sector-specific ESIA guidelines for proponents should be developed in the context of broader strategic assessment process. Sector-specific SIA guidelines can take into account the different phases of exploration, development, production and post-production in the life cycle of the industry. If developed, such guidelines can lead to better quality and utility of SIAs for these projects and related processes (see section 1.5.2).

[72] Morgan (2012); Esteves et al (2012).
[73] Hawke (2015).
[74] Ibid.
[75] The New South Wales Government (2017).

3. Developing a SIA framework for shale gas development in the Northern Territory- key considerations

3.1 Macro-factors

3.1.1 Australian natural gas in the global market

Australia is divided into three natural gas markets due to the geographical isolation of the western and northern markets from the large eastern market. Natural gas production is therefore either consumed within each market or exported as liquefied natural gas (LNG).[76] In 2015, Australia became the world's second-largest LNG supplier after Qatar, supplying 12% of globally traded volumes. In 2016, Australia's share in global LNG supplies increased to 17%.[77] Australian LNG exports increased by 52% in 2016 and will continue to increase throughout 2017 and 2018 as new projects are brought on line. Australia is forecast to rival Qatar as the world's largest LNG exporter by 2021.[78]

LNG accounts for the bulk of recent resources and energy investment in Australia. It is Australia's third-highest goods and services export behind iron ore and coal. Australia was the first country to have had seven LNG projects under construction at the same time since the A$200 billion investment boom entered its full swing in 2007 and 2008. However, the global LNG industry has changed dramatically over the past decade. Most of the projects were commissioned at the height of the commodities boom, when the oil price was near the US$100/barrel mark and demand showed no sign of easing. The overriding sentiment, which has been exacerbated by the decline in the price of oil since 2014, is that most of Australia's new LNG projects are not competitive globally and are costlier than competitors in North America or Africa.[79] While record-breaking, the simultaneous construction of seven new LNG projects with a combined capacity equal to 25% of current global LNG demand has been described as "one of the worse investment cases of the last decades in the oil and gas sector."[80]

The future sustainability and profitability of Australian LNG exports are predicated on a high oil price and a voracious appetite for natural gas in Japan, China and South Korea, Australia's major current and future customers. Global LNG export capacity is forecast to increase by 45% between 2015 and 2021, and 90% of additional capacity will come from the US and Australia. The oversupply in global LNG markets is already causing fierce competition among suppliers as substantial volumes of lower-cost LNG move into Asian markets. As a consequence, Australian projects at the high end of the supply curve are increasingly

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[76] Vivoda (2017).
[77] GIIGNL (2017).
[78] Vivoda (2017).
[79] McKinsey & Company (2013).
[80] Maugeri (2014).

vulnerable.[81] Moreover, since oversupplied market conditions are likely to persist well into the next decade, it is unlikely that any undeveloped natural gas resources, such as in the Beetaloo Sub-basin, will become economically viable.

3.1.2 Boom-bust cycles and resource dependency

Research has found that dependence on extractive industries as the primary economic driver can affect a region's longer term economic growth. Extractive industries can have a 'crowding out' effect on resources (both physical and human) which may limit opportunities for growth in other industries. A review of literature found that resource-intense economies also tend to have greater income inequality and higher levels of conflict or social division.[82] Expanding extractive industries will draw labour and resources from other industries and from other places. This period of rapid growth usually includes an influx of workers, new infrastructure to accommodate them and upgraded local services and is sometimes referred to as a 'boom' period. In a 'boom' period, local prices for goods and services are often inflated, placing additional strain on those not participating in the extractive industries. Many of the most visible social impacts are experienced in the 'boom' period.

Extractives industries, and particularly the petroleum sector, are characterised by price volatility arising in international markets. When prices fall, extraction can be slowed and infrastructure 'moth-balled' until the prices rise again. Workers' contracts may be terminated or renegotiated for lesser wages and local content spending may fall. The industry response to a drop in commodity price can be swift and communities may feel the economic effects quickly. This 'bust' period can be associated with an oversupply of housing and services as the high level of demand experienced during the 'boom' drops off. 'Bust' scenarios can be mitigated. There are increasing examples of businesses, communities, states and nations who have successfully avoided the full effects of a 'bust' period. This involves planning ahead, deliberately saving a proportion of the proceeds that may accrue for future use, and using the period of growth to foster alternative industries and economic diversity.

3.1.3 Native Title and Land Tenure

Australia's First Nations peoples have common law rights to their traditional land and waters established by the commonwealth *Native Title Act* in 1993. Where it has been legally recognised, native title gives Traditional Owners (TOs) the right to live and camp in an area, conduct ceremonies, hunt and fish, collect food, build shelters and visit places of cultural importance. Shale gas development activities in NT are likely to occur on land that is subject to the *Aboriginal Land Rights Act* (*ALR Act*) or *Native Title Act*, making TOs and other Aboriginal people who live on this land, key and direct stakeholders in any SIA.

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[81] IEA (2016).
[82] Stevens (2003)

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The *Native Title Act* is likely to affect most applications for petroleum titles due to the extent of native title interests in land in the NT. Aboriginal people who hold, or have claimed, native title rights over land will have to be consulted about proposed activities on the land. In the NT, fracking is labelled as petroleum mining and regulated by the NT *Petroleum Act*. As stipulated in the *Petroleum Act*, all petroleum exploration permit applications are subject to the right to negotiate process, which requires negotiation with registered native title holders or claimants in order to obtain consent for future activities.[83]

There are four main types of land tenure in the Northern Territory:

- Crown land;
- Freehold;
- Aboriginal freehold; and
- Pastoral leasehold.

As elsewhere in Australia, crown land in the NT refers to all land which is “remaining” that is not freehold title and is still held by the Crown. Crown land is regulated by NT Crown Lands Act and is vested in the NT government. The government may give another person the ability to manage or control that land. Freehold land implies that the government has passed all interest in the land, other than sub-surface resources and water, onto the owner. An example of freehold land is the average house block in a city or town. Crown land and freehold land are not affected by native title.[84]

Most land in the NT, outside of townships, is either pastoral leasehold or Aboriginal freehold land over which native title rights can exist. Pastoral leasehold is land which is owned by the government and leased to a private individual or company for pastoral purposes. This may include cattle grazing, crop growing or pastoral based tourist activities. Pastoral land is subject to native title.[85] Aboriginal freehold land is unique to the NT as it does not exist in any other state or territory in Australia. It came into being in 1976 when the *ALR Act* was passed, converting former Aboriginal reserves into permanent Aboriginal freehold. Aboriginal freehold land is inalienable freehold title, meaning it cannot be sold. It is referred to as 'schedule one' land, and is formally held by an Aboriginal land trust. Any application to explore for petroleum on Aboriginal freehold land has to be negotiated through the process laid out in the *ALR Act*. Grant of an exploration licence or permit on Aboriginal freehold land can only go ahead after consultation with the TOs through their representative land council, and an agreement reached. The TOs have the right to refuse access to their land or refuse permission for exploration.[86]

One problem with this approach is that only TOs who have been formally identified and validated (i.e. ‘qualified’) and whose ownership of land has been formally recognised under the *Native Title Act* have rights to negotiate the terms of an agreement with a resource

[83] The Northern Territory Government (2017a).
[84] The Northern Territory Government (2017b).
[85] The Northern Territory Government (2017c).
[86] The Northern Territory Government (2017d).

company. They too, are the only people who have rights to royalty payments or other benefits arising from the agreement. Additionally, unlike under *ALR Act*, the *Native Title Act* does not give TOs powers to stop development taking place. The social impacts of a shale gas industry are geographically spread (in comparison to those associated with a discrete mine site) and are likely to affect a number of different Aboriginal groups and families. Not all of these will have formal TO representation, or for various reasons, they may not be included in a share of the benefits. Thus under the current consent mechanisms, particularly those based on the *Native Title Act*, there is the potential for significant inequality between those affected and those receiving compensation and benefits. This in turn could lead to increased social unrest and potentially conflict, both intra-community and conflict aimed at other entities, such as the company or government. The strategic and participatory approach to SIA recommended in this report is an attempt to address this inequality, as there is a focus on community benefits and capital building, with the process of developing strategies to mitigate negative impacts and enhance positive impacts being open to all.

The main consideration surrounding land tenure is that different tenures require different forms of 'consent' in order for project activities to proceed without interference or interruption from dissatisfied stakeholders. Types of 'consent' range from broader community acceptance to individually negotiated agreements with pre-identified, or 'qualified' communities (see Table 2).[87]

In the NT, a 'shared land use' policy is in place, which supports the exploration and mining of minerals on all land tenures, including pastoral land. The strategic approach recommended in this report emphasises regional planning and it may be that this policy should be reviewed to allow the designation of high value agricultural lands, areas of heightened sensitivity (such as where there may be conflict over land ownership and recognition) and 'no go zones' for shale gas development

Table 3: Land tenure in the NT and types of 'consent'

Land tenure	Type(s) of 'consent'	Principles/Pathways	Challenges
Crown Land (about 50% of land mass - ***which includes*** 44% pastoral lease)	'Contingent' consent [88] Often (mis)understood as a 'social license to operate'[89].	Community acceptance on the basis that net social benefits outweigh the harms. As long as the balance is such, the project is more likely to be supported by the public and their representatives in the public service and government.	Relies on estimation of <u>net</u> benefit or harm when impacts are known to be unevenly distributed. The 'voice of many' can over-ride the voice of those directly impacted.

[87] O'Faircheallaigh (2007). 'Qualified' communities are those who have been through a formal process of identification and verification as being Traditional Owners of land under the *Native Title Act* 1993 (Cth).
[88] Levi (1997, p.8) in Owen and Kemp (2012).
[89] Owen and Kemp (2012).

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Freehold (0.5% of land mass)	Land Access Agreements Includes a right to object to the granting of an exploration permit through written submission - no right to refuse access to permit holders	Over-riding public good Fair compensation for surface rights holders Not within 200m of dwelling	Capacity to negotiate a fair compensation package varies between individuals. Landholder unaware of rights and obligations
Aboriginal freehold (about **50%** of land mass)	Exploration and Mining Agreements with relevant Land Council Free Prior Informed Consent	Includes a right not to permit activities Indigenous Land Use Agreement UN Declaration on the Rights of Indigenous Peoples	**Excludes those not identified as 'qualified' from benefit sharing** [90] A bilateral agreement not conducive to cumulative impact assessment or collaboration with other 'development' partners
Pastoral leasehold (44% of land mass)	Land Access Agreements Includes a right to object to the granting of an exploration permit through written submission - no right to refuse access to permit holders Indigenous Land Use Agreement- where land held under Native Title	Negotiation of compensation and conduct agreements	'Compensation' for damages in excess of normal operations only

3.1.4 Historical context: unique to the NT

Any attempt to understand social impacts or social change in NT communities as a result of shale gas development must consider the complex and fraught history of government interventions and policies designed to bring about social change and economic development in these communities. This includes awareness of an ongoing legacy of trauma, grief and loss among Aboriginal people - the cumulative impacts of colonisation, dispossession of and removal from traditional lands, discrimination and paternalistic social policies. Particularly, the expulsion of Aboriginal people from cattle stations in the 1960s concentrated the Aboriginal population of a large area onto the traditional country of a few, and this has brought with it social complexity as family groups strive to both maintain their individual cultures and identities and live harmoniously together.[91]

Additionally, in order for Aboriginal families to claim rights to traditional land and water, and have those rights recognised under the Commonwealth *Native Title Act* 1993, they must be able to demonstrate a continuous connection with the land through regular access and traditional cultural practices, from one generation to the next. Commonwealth Native Title policy, while having the objective of empowering Aboriginal people by granting legal rights of traditional ownership, has the additional effect of encouraging Aboriginal families to live in very remote areas, or 'on country', mostly without access to treated water, energy or

[90] Stevens (2003)

[91] Ross (1990)

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sanitary services and with very few opportunities for employment. Being able to access, utilise and care for 'country', thereby maintaining a connection to traditional land and practices is vitally important to many Aboriginal people (regardless of whether they are formally recognised as TOs). Any fragmentation or degradation of the landscape translates directly into social and cultural impacts.

Despite recent approaches to social and economic policy that are more holistic and inclusive of Australian Aboriginal and Torres Strait Islands people and culture, there remain significant inequalities in health and well-being between Aboriginal and other Australians, most of which are shaped by the disadvantaged social and economic conditions in Aboriginal communities.[92] The implication for SIA is a learned mistrust of projects that promise improved social and economic outcomes. For SIA and social performance practitioners, impact mitigating and social investment strategies must be developed with active involvement by Aboriginal people.

3.1.5 Social (non)-acceptance and lack of trust in the oil & gas industry

In 2014, a global survey of perceptions of corporate social responsibility (CSR) in business found the oil and gas industry to be one of the least trusted sectors, second only to the tobacco industry. Of 24 countries surveyed, Australia had the highest level of mistrust of the oil and gas industry (equal with France, which in 2011 became the first country to ban 'fracking').[93] Correspondingly, a high proportion of Australians thought that the oil and gas industry needs more regulation (only China had a higher proportion of people who think this).[86] To some extent, this widespread mistrust is influenced by a growing global 'anti-fracking' sentiment, found to be prevalent in Australia and Canada, although 'loudest' in the UK.[86]

In the 2014 global survey, the issues that people were most concerned about in relation to the oil and gas industry were prices and affordability, closely followed by environmental impacts. An accompanying media analysis found high levels of concern about environmental impacts, particularly in relation to fracking.[86]

Despite oil and gas companies in Australia mostly reporting good relations with the communities in which they operate, and the industry has co-existed with both agriculture and tourism industries in Australia for decades, there appears to be a rising wave of mistrust in the onshore oil and gas industry at the national (and international) level.

[92] Osborne, Baum and Brown (2013)
[93] Globescan (2014)

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3.2 Localised factors- the unique circumstances of the NT

A fit for purpose SIA framework has to consider localised factors such as:

- the remoteness of communities;
- cultural diversity;
- the time and cost involved in travelling long distances to consult with communities;
- sparse populations (can create problems for anonymous participation, data collection);
- mostly undeveloped, natural/cultural landscapes;
- the under-representation of Aboriginal people in Census and statistical data; and
- seasonal access only to some places.

The NT is unique in relation to several social and economic parameters. The NT, which is about one sixth of the Australian land mass is home to only 1% of the Australian population (about 245,000 people). Around 60% of the NT population lives in the capital city of Darwin, 20% of the population live in regional centres such as Alice Springs, Katherine and Tenant Creek, with another 20% living in remote communities. Access to some remote communities can be limited by road and weather conditions. Almost a third of the NT population is Aboriginal, compared to the national average of 3%.[94] About 50% of land in the NT is held in Aboriginal freehold (see Table 2) which includes a right to permit or not to permit access and resource development.

Without the population and associated development pressures of other jurisdictions, Northern Territory landscapes have remained in a mostly 'natural' state, and therefore have important 'wilderness' and amenity values. More importantly, in terms of SIA, NT landscapes are embedded with cultural meaning for Aboriginal peoples (both Traditional Owner groups and others), and the significance of this meaning is often not documented or captured in the domain of science. For example, 'song lines' are believed to be unseen pathways across the landscape that tell and reinforce Aboriginal stories of creation and place, as well as individual identity. The interruption of song lines is believed to have tangible consequences to those connected to the story it tells. This cultural interconnection with the biophysical landscape places Aboriginal people at potentially greater vulnerability to the impacts of shale gas development, as environmental impacts can also be felt as social and cultural impacts.

A description of the Beetaloo Sub-basin as a case study region, and the challenges these unique NT factors presented in developing a social risk assessment, are contained within the Beetaloo Sub-basin Case Study Report.

[94] The Northern Territory Government (2017e)

4. SIA Framework for Shale Gas Development in the Northern Territory

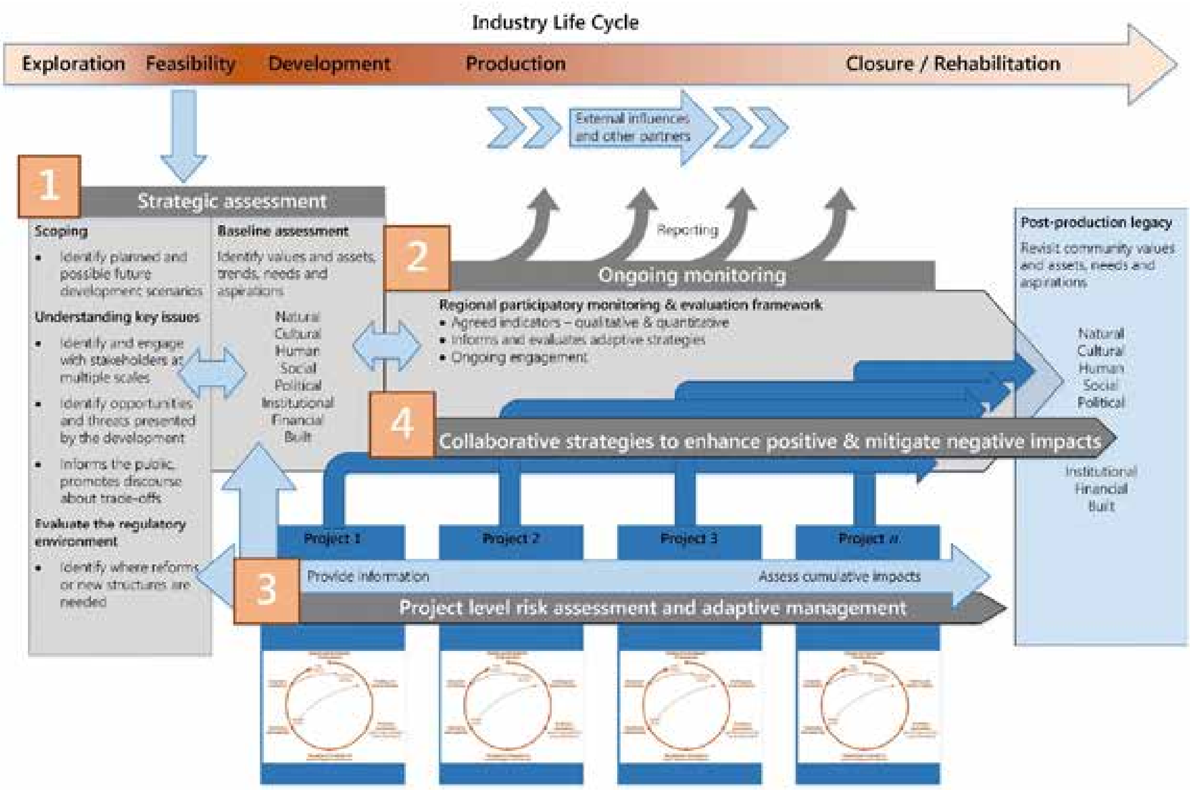
Leading practice SIA involves identifying and managing the social issues that arise from development activities. This includes the effective engagement of potentially affected communities in participatory processes of identification, assessment and the development of strategies to manage social impacts. Although SIA is still used as an impact prediction mechanism and as a decision-making tool in regulatory processes to consider the social impacts of a project in advance of a permitting or licensing decision, it has an equally important role in contributing to the ongoing management of social impacts throughout the whole life-cycle of the project (in this case, the development of a new industry), from conception to post-closure.[95]

The shortcomings of relying on project-based SIAs as a subset of an EIS process have also been discussed. Project-based SIAs rarely adequately account for cumulative impacts that arise after the main construction period is over, or for the impacts of several projects or several industries operating in the same region.[96] The following sub-sections describe a fit-for-purpose SIA framework for shale gas development in the NT that takes into account the life-cycle of the industry, the likelihood of multiple projects, and the complex and data-poor nature of the receiving environment.

A conceptual model of the framework is shown in Figure 3 on the following page and explained in the following sections.

[95] Vanclay *et al*. (2015).
[96] Witt *et al*. (2017).

Figure 3: Conceptual model of a Framework for social impact assessment for a shale gas industry in the Northern Territory, Australia.



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4.1 SIA Framework: An industry life-cycle approach

SIA is generally required by regulating authorities to assess the potential impacts of a project before implementation. The primary focus of impact assessment generally to date has been on predicting impacts that will occur in response to a distinct project, activity or other proposed action. As governments and proponents are bound to deal first with impacts of most significance or urgency, impact assessment has often focussed on the impacts that occur in the most intensive phases of development, namely the ‘construction’, or ‘development’ phase.

It is recognised, however, that social impacts can begin as soon as new information becomes available, as various actors begin to compete to define, influence and respond to the opportunities and threats that may be presented by the project.[97] Impacts can also continue after the development or activity has ended, particularly where former ‘booming’ communities face a downturn, and local businesses must adjust to a smaller and changed clientele, as is now the experience in some Queensland towns. What is needed is a framework that:

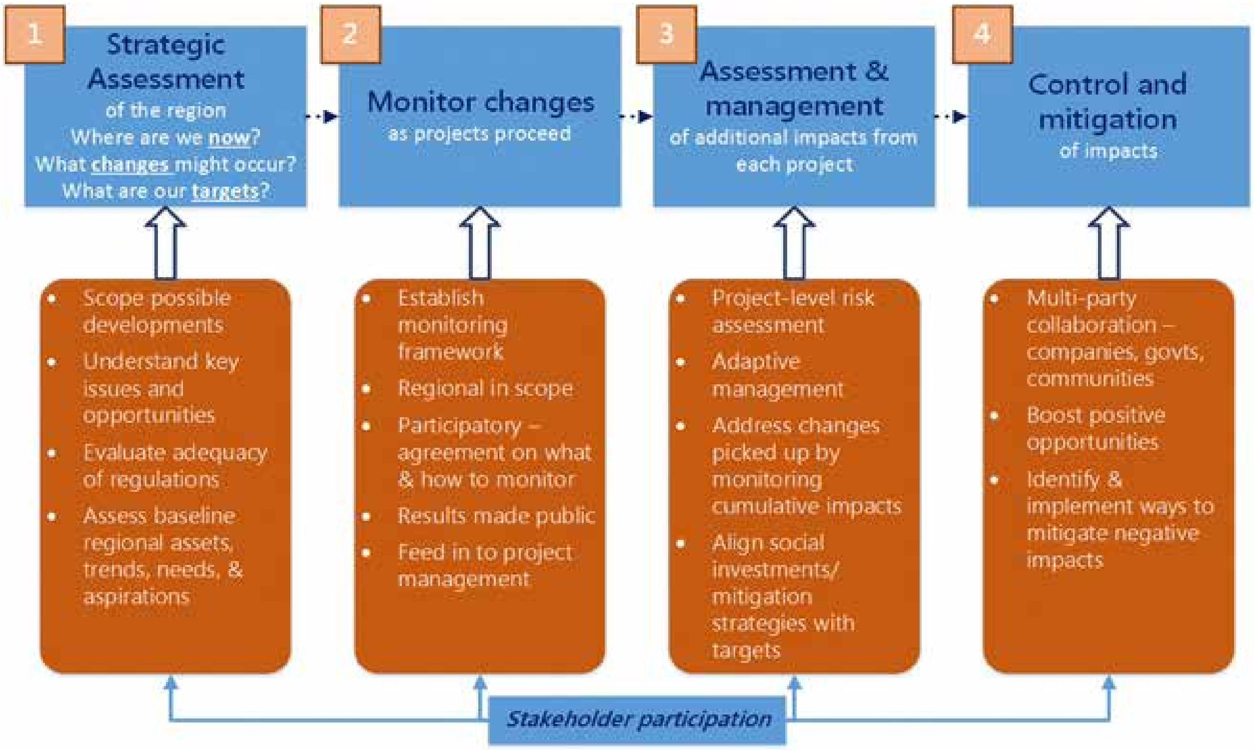
- can identify and respond to impacts that occur across different stages of development;
- can account for a paucity in statistical social and economic data in remote and Aboriginal communities;
- is culturally sensitive;
- can identify strategies to maximise benefits and minimise disturbance that are aligned with the needs and aspirations of affected stakeholders;
- can inform a more strategic and collaborative approach to development of the region; and
- can engage all affected individuals and communities in identifying and managing the impacts without placing undue burden on them.

The conceptual framework presented in Figure 3 holds all the components of a leading practice SIA framework for shale gas development in the NT. The figure shows details of what is needed within each component. Figure 4 is a distilled version of the conceptual framework emphasising the four key steps needed for its implementation.

The steps are explained further in the following sections.

[97] Gramling and Freudenburg (1992).

Figure 4: The implementation steps of the SIA framework



3:

4.2 Step 1- A strategic approach

The SIA framework developed here places project-level SIA within a strategic context. We recommend a NT government- led strategic assessment be conducted in the early stages of industry development, once feasibility has been established (that is, an adequate resource base has been proven and considered economically viable), acknowledging that even before then, social impacts will have been felt. This strategic SIA could be done as part of a larger Strategic (Environmental) Assessment, under the Terms of Reference for a Commonwealth/Territory *Strategic Assessment Agreement* under the Commonwealth *Environmental Protection and Biodiversity Conservation (EBPC) Act* 1999 or from within NT processes if reforms were made. Such assessments are currently underway for offshore gas development in the Northern Territory and in South Australia, and were completed for the terminated Browse LNG project in Western Australia. The latter included a strategic social impact assessment, with specialised assessments of cultural and economic values. Strategic assessment is a single overarching assessment that allows for the integration of social, economic and environmental considerations. Given that environmental values and conditions are linked strongly with Aboriginal culture, pastoral production, tourism and social values in the NT, this type of assessment seems most relevant.

The first strategic challenge that a government faces is whether to allow the industry to go ahead and develop the resource or to leave it in the ground. This is a decision that needs to be arrived at through a transparent and inclusive process, which will improve the quality of decision making as well as build community acceptance for the industry. There may also be occasions where the environmental or social and cultural context is too sensitive, or where insufficient scientific evidence exists on the potential negative impacts of development. In these cases, the choice is made more complex by the high levels of uncertainty involved (see lessons from the South African shale gas strategic assessment in section 5.3).

The objective of the strategic assessment proposed here is to generate and disseminate the information needed to make a decision about allowing development that is consistent with the public interest. That information will also enable a planned approach to development, rather than allowing market forces to predominantly determine the scale and pace of development, as has been the case in Queensland and in the US.

While there will be a high degree of uncertainty at this early stage, there is a clear need to gather and provide relevant and reliable information about the industry and its potential impacts, to reduce uncertainty to a socially acceptable level. It is important not to 'pretend to know everything' or to try and 'buy' social acceptance through the promise of jobs, infrastructure and economic benefits, but to promote a measured and informed public discourse about the changes the industry could bring. The strategic assessment stage involves four key components: (1) **scoping** - identifying possible future development scenarios and their trade-offs; (2) **understanding key issues** - identifying opportunities and threats presented by the development to a range of stakeholders, and stakeholders' concerns; (3) **evaluating the regulatory environment** - identifying any regulatory reform, or new governance structures needed; and (4) **baseline assessment** - identifying values and assets, trends, needs and aspirations for potentially affected regions.

In the context of NT's shale gas industry, much of this work has been initiated and carried out by the Independent Scientific Inquiry Panel. The strategic assessment would ensure a transparent and inclusive process (as the Inquiry has sought to). The substantial body of information gathered in this initial step then becomes the starting block for an ongoing, open-access repository of social and industry-related data that is updated and expanded regularly as monitoring and project-level reports come in (Step 2).

4.2.1 Scoping and boundary setting

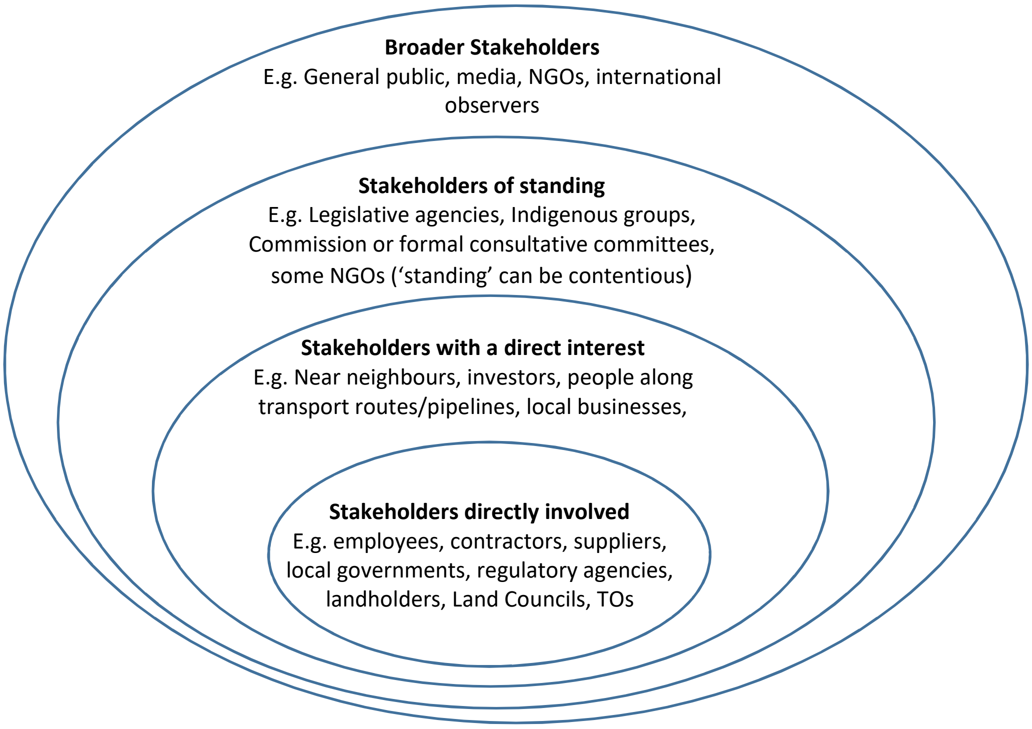
Firstly, the strategic assessment would seek to understand the scale and scope of proposed development. This would be done by collating information from the individual companies about where and how they intend to proceed, and how they might respond under different circumstances. The body overseeing the strategic assessment (who may be an independent unconventional gas regulatory Authority or the existing NT EPA) could have powers to request such information (similar to the GasFields Commission in Queensland). Companies are hesitant to report this information publicly in the early phases of development as development scenarios can change. They may also not wish to divulge their strategies to other gas companies for loss of competitive advantage. The industry-specific information will inform the setting of meaningful and practical geographic boundaries for the subsequent studies, which might be in terms of geological basins or sub-basins, administrative boundaries, or by 'impact' zones. The industry information is also used to identify planned and possible future development scenarios.

4.2.2 Understand the key issues

With an understanding of what the proposed development might 'look like', the next step is to identify and understand the issues and trade-offs involved under different development scenarios, including identifying the people and organisations who may be affected.

The stakeholder engagement component of this step is critical, and should follow leading practice stakeholder engagement methods with skilled personnel. We recommend using a 'nested' approach to identifying directly and indirectly affected stakeholders, stakeholders with standing, and interested parties, as illustrated in Figure 4. Information about the concerns and interests of these stakeholders could be organised at local, basin, Territory, National and global scales.

Figure 5: Stakeholder identification by nature of interest and impact.



Providing information and promoting discussion about the industry, its activities and the trade-offs involved is of crucial importance in the early stages. In Queensland, a lack of freely available, trusted information about the onshore unconventional gas industry in terms of the technology used, its requirements for labour, services and resources, and the types of opportunities and impacts it could generate, created a discursive space for controversy and conflict, despite multiple, lengthy EIS and government reports. With the paucity of locally relevant information, those who wanted to know more about the industry looked to experiences and practices from elsewhere, often with little regard to important contextual differences, such as geology and hydrology, technological advances, institutional arrangements and population characteristics.

In the US, the National Wildlife Federation prepared a series of documents to help people engage in decisions about the oil and gas industry. *Fuel for Thought: a citizen’s guide to participating in oil and gas decisions on your public lands* outlines the life cycle of a well, environmental impacts, the legal framework in place, the roles and responsibilities of regulating bodies, as well as how to be ‘an effective advocate’.[98] While this document takes a clearly anti-fracking perspective, it nevertheless provides a good example of the type of information people require in order to hold an informed opinion about shale gas industry in their local area.

[98] National Wildlife Federation (2008), p.30.

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4.2.3 Regulatory assessment

A strategic assessment of the industry would also evaluate the regulatory and approvals processes in place and identify reforms that may be needed. In the NT, such an exercise has been done in the 2015 Hawke Review and by the Environmental Defenders Office (EDO) Report to the Inquiry Panel. Challenges remain in gaining different types of 'consent' (outlined in Table 2), and especially those relating to 'fairness' in Land Access Agreements and benefit sharing arrangements[99]. The emphasis on setting a robust regulatory regime is deliberate. Previous parliamentary and scientific inquiries into the impacts of a shale gas industry (using hydraulic fracturing) in Australia have concluded that the risks are manageable *provided the industry is properly regulated*.

This component would also look at and consider existing and new governance structures. The NT EPA is an independent Authority that already oversees the project approvals process. This structure could be enhanced to provide it with capacity to perform additional roles in compliance, performance monitoring and reporting as well as providing independent facilitation services to aggrieved landholders and gas companies. In Queensland, the GasFields Commission was established in July 2013 (during the peak of the construction phase of the projects) with powers and functions set out under new regulations, the *Gasfields Commission Act* 2013. Its main functions were to act as an intermediary to facilitate better relationships between landholders, communities and the onshore gas industry. It also plays a key advisory role and has powers to request information from both government departments and gas companies. In 2017, the role of the Gasfields Commission was reviewed, and in light of ongoing disputes between landholders and gas companies, the *Land Access Ombudsman Bill* 2017 was passed to establish an independent, impartial body to facilitate the resolution of disputes in relation to land access, conduct and compensation, and make good agreements, where alleged breaches or additional impacts have occurred.

The enhanced or new structure would oversee the ongoing monitoring program, the repository of data (with powers to request data as required) and facilitate the necessary industry collaboration in relation to cumulative impacts. They may also request that companies work together when engaging with local communities in order to reduce the impacts of 'consultation fatigue'.

4.2.4 Baseline Assessment

Possibly the largest component of the strategic assessment is the collation of baseline data (as this report is about SIA, we focus on social and economic baseline data, but the same approach would be taken for environmental baseline data, particularly where they relate to environmental values with social and cultural significance, possible health impacts, or those

[99] Note that in Queensland, the majority of land access issues were in relation to freehold land, but that is likely to be quite different in the NT where Aboriginal Freehold Land and Pastoral leases are the main land tenures

over which there is widespread concern). Baseline data would usually be collected by consultants as part of a project-based EIA-driven SIA. The shortfalls of this approach for a shale gas industry in NT have been discussed in section 2.3. However, for this step to be taken by a governing body and not by a project proponent is a new development and would require new governance structures and an enduring funding model, linked to the life-cycle of the industry.

The initial baseline data collected would be for regions and/or local communities where development is imminent and would involve significant participation by local residents. Regional baseline data would also be collected. This baseline data would include identification of stakeholder values, and current assets in different types of capital 'stocks', as well as assessing trends, and aspirations for these stocks. We recommend using the Community Capitals Framework (CCF), which is well-established in community development literature and practice.[100] The CCF measures community development in relation to seven types of capitals including:

- **natural** - e.g., the condition of place-specific elements, biodiversity, amenity, beauty;
- **cultural** - e.g., traditional knowledge and languages, rituals and festivals, heritage;
- **social** - e.g., networks, trust, norms of behaviour, giving, neighbourliness, cooperation;
- **human** - e.g., skills, knowledge, health, abilities, leadership;
- **political** - e.g., influence, having a voice, self-determination;
- **financial** - e.g., credit, savings, income, assets; and
- **built** - e.g., infrastructure, housing, roads, sewerage, sports facilities, lighting.

It may also be useful to add:

- **institutional** - e.g. community organisations, the effectiveness of local and regional institutions.

As census and other statistical data is limited or flawed for many of NT's remote communities (they tend to under-represent the Indigenous population), the collection of baseline data for these capitals must be a participatory process. Another leading practice model developed by CSRM and the UQ Centre for Coal Seam Gas is of relevance in this context: the UQ Boomtown Toolkit and its supplementary Annual Reports on Queensland's Gasfields Communities. The UQ Boomtown Toolkit outlines a tested approach to identifying community assets and values, and importantly, for identifying indicators for measuring those values that are meaningful and relevant to multiple stakeholders. For example, using collaborative methods to identify indicators that the industry needs for compliance and monitoring social impacts, that the community agree represent their concerns, values and aspirations and that government want to track in order to monitor cumulative impacts and regional development outcomes. For remote NT communities, social indicators may need to be 'bespoke', and more qualitative. They may require local 'data stewards' to report

[100] Emery and Flora (2006).

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changes in bespoke indicators on a regular basis. For example, an indicator of household wealth might be how many funerals/cultural events are attended in a year, rather than economic measures of disposable income. This 'shared measurement' approach is being promoted as leading practice in program evaluation and has clear relevance to impact assessment in data-poor regions.

The baseline assessment would identify initial stocks of capitals, but also trends, where possible and importantly identify local and regional goals and aspirations in relation to these capitals. This information can be used by project proponents, who would still need to submit a comprehensive social risk assessment for the approvals process that outlines how their proposed activities would impact either positively or negatively on the community capitals stocks, and the strategies they propose to take to either enhance or mitigate them.

4.3 Step 2: Regional participatory monitoring & evaluation framework

In 2009 CSRM identified leading practice in SIA as having in place regional and systems level monitoring for resource regions, particularly where social and economic impacts extend well beyond the geographic location of a single operation, and where there are interacting impacts from multiple extraction activities. [101] In late 2016, the Queensland Government released the draft Queensland Gas Action Plan which attempts to translate ongoing community concerns about and challenges within the gas industry into actionable items.[102] A key action item is the development of an online, open-access data repository for a range of industry-related information, including monitoring and compliance data. This is seen as a positive action for building trust in the industry, which is essential for building and maintaining public acceptance.

An additional value of the ongoing, participatory regional monitoring and evaluation database is that it reduces the risk of 'consultation fatigue' as multiple proponents seek information to inform their social risk assessments. In CSRM's experience in Queensland's gas fields communities, multiple and extensive consultation events (from EIA/SIA consultants, resource companies, governments, media and researchers) placed high demands on peoples' time and caused additional stress at a time of rapid change and mixed emotions. As the 'boom' period ended, so did the outside interest. Unsurprisingly, local people reported feeling 'forgotten' and 'abandoned' by many of the consulting agencies.

The idea of the online database is that it becomes an open-access resource for information. Each project-level risk assessment would be uploaded and any new indicators and data about communities would be added to the database. Ideally, communities themselves could provide data and upload data updates to the relevant indicator timeline. This would give communities ownership of the data. As the UQ Boomtown Toolkit has demonstrated, the

[101] Franks *et al*. (2009)
[102] Queensland Government, Department of Natural Resources and Mines (2016).

data can also be used by communities for funding applications, to allocate resources, to argue a need for investment, or purely to advocate themselves and their assets.

In addition to the open-access resource, there would ideally be a mechanism for periodic reporting out of key information, with accompanying analysis and interpretation of findings. This is important for industry transparency and to build and maintain trust in the industry as reported in the accompanying Report on a Social Licence to Operate. This reporting work is best done by an inter-disciplinary and purpose-specific research institution, such as the University of Queensland's Centre for Coal Seam Gas (CCSG), or CSIRO's Gas Industry Social and Environmental Research Alliance. UQ's CCSG already produces Annual Reports for Queensland's Gasfields Communities, which are widely used by local and state governments, CSG companies and community groups.

The identification and management of cumulative social and economic impacts remains a key issue in Queensland gas fields communities. A comparison of social impacts of CSG development as predicted in an individual company's EIS/SIA and those identified in a study of cumulative socioeconomic impacts in the Surat Basin highlighted the importance of coordination across impact assessment studies in the region so that strategies contribute to an overarching monitoring framework.[103] A strategic and regional approach to cumulative impact assessment enables gas companies to form partnerships with other companies, service providers and communities, for negotiated and agreed community development outcomes. Strategies for social impact mitigation or enhancement can then align with existing community development programs and be targeted toward the needs and aspirations of local communities. The monitoring framework is designed to enable adaptive responses. Each project would provide information about their intentions for future development. This would allow industry forecasting and amendment to the initial development scenarios generated in the strategic assessment. The lifespan of the monitoring framework should last throughout the lifecycle of the industry, which is about 40-50 years. However, the frequency of data updates would be flexible and determined by institutional capacity, sequential development of projects, and transitioning of projects to another phase.

While this is an ideal model, it is recognised that it places additional burden on government resources, particularly in the early phases of strategic assessment, before any royalties from resource production have been generated. A lower cost version may be to create the online data repository, have all data from project-based EIS/SIAs uploaded, with conditions in place for any future projects in the region to collaborate and adapt to new information. The monitoring framework would set the agreed indicators to be monitored, with flexibility to be able to adapt to emerging issues as they arise, but responsibility for the data updates,

[103] Witt *et al*. (2017)

once the baseline is established, would be shared by the gas companies and local communities (similar to the UQ Boomtown Toolkit).

Additionally, the NT government could recover costs for the strategic assessment/fund ongoing assessment by increasing the cost of a petroleum license (PL). Currently, a company applies for an exploration permit under the *Petroleum Act* 1984 (NT), administered by the Department of Primary Industry and Resources, Energy Directorate, at a cost of A$5,280.[104] Once a resource is found, even if still being assessed for commercial viability, the gas company can apply to convert the exploration permit into a production-retention license (PL) (valid 5 years) at a cost of A$3,967.[97] Increasing the cost of a PL for companies would ensure that gas companies contribute to the up-front costs of initial and ongoing impact assessment.

The main function of the ongoing collaborative monitoring framework is to provide a structured mechanism for collaboration and adaptive management, and facilitate processes for capturing learning that leads to continuous improvement (lacking in most other jurisdictions). Importantly, it also allows for coordinated responsiveness to other influencing factors, both from within the gas industry, such as price fluctuations, and externally, such as biosecurity alerts.

4.4 Steps 3 and 4: project-level risk assessments and collaborative strategies

Under the SIA framework proposed here, each project would still submit an SIA with a comprehensive risk assessment that would consider:

- the whole life cycle of the project and the types of activities involved in each phase;
- the people or groups of people likely to be affected (with attention to vulnerable groups);
- the likely social impacts - both positive and negative;
- the significance of the impacts in terms of likelihood, severity, ability to be mitigated/enhanced;
- likely effects of mitigation and enhancement strategies (in relation to baseline assessment of capitals and aspirations for these capitals, but also in relation to strategies that may already be in place by other projects in the region); and
- assessment of residual risks;
- standardised reporting out.

An industry-specific project life-cycle SIA risk assessment might resemble the example in Table 4. Strategies for enhancing positive outcomes and mitigating negative impacts should be targeted towards the aspirations and needs of communities identified in the strategic

[104] Australian Government, Department of Industry, Innovation and Science (nd). Australian Business Licence and Information Service (ABLIS), Petroleum - Exploration Permit - Northern Territory

assessment and should be in partnership with community organisations and institutions. This approach to risk assessment is demonstrated in the Beetaloo Sub-basin Case Study Report.

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Table 4: An example of an industry specific, life-cycle approach to social risk assessment

Phase	Activities	Groups affected	Positive and negative impacts		Likelihood/ Significance		Strategies	Residual risk	Indicators
Exploration	Permits Land Access	Landholders TOs	Stress, time burden Inequity Misuse of royalty	Compensation Royalty payments	High,	High	Code of conduct, clear legislation, fact sheets	low	Number of complaints
	Roads Well pads Construction	Landholders TOs Tourists/camper	Traffic, dust, noise, light, visual amenity Workers	Road upgrades Local spending Housing/services	High, low		Water trucks Consultation on placement of roads	low	Traffic counts
	Roads	Commuters Travellers Landholders Transport	Disruption to travel Disruption to stock	Better connectivity Better access, improved roads Job opportunities	high	mod			
	Drilling, fracking	Landholders Local residents	Noise, light, stress	Provide sand, services	high	mod			
Development	Construction Pipelines Well pads Water treatment		Influx of workers Traffic- HVs	Job opportunities Additional housing	high				
Operations	Stimulation Some drilling Waste mgt. Infrastructure maintenance		Light, noise Dust Traffic	Local content					
Closure	Rehabilitation		Loss of employment						
Post-project/ Legacy									

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The social baseline data would be used from the strategic assessment baseline data and updated or expanded to suit the EIS/SIA requirements. This minimises the need to collect baseline data multiple times directly from communities, which contributes to consultation fatigue. At the same time, stakeholder engagement processes will be critical in prioritising concerns and developing workable agreements for mitigation or enhancing strategies. Indicators for measuring the community capitals, as recommended in Section 4.2.4, would have been established in the strategic assessment. All project-based EIS/SIAs should use the same set of indicators to assess impacts and monitor change.

The SIAs here should follow leading practice as shown in Figure 2 where the phases of SIA, including profiling, impact assessment and strategy development are developed within an adaptive participatory management approach.

4.5 Implementation of the SIA Framework in the Northern Territory

4.5.1 Strategic Assessment

The NT is considered to have significant shale gas reserves[105] that could potentially generate a number of shale gas development and related infrastructure projects, including infrastructure (such as roads, pipelines and waste facilities) and processing. There are currently no regulatory requirements or provisions for undertaking a strategic SIA in the NT, although the need for an overarching strategic assessment of the industry has been proposed in current NT regulatory reforms (the 2015 Hawke Report), and by the Environmental Defenders Office (EDO) in their submission to the current Independent Inquiry into Hydraulic Fracturing by the Panel.

There are two possible pathways for initiating a strategic assessment. One pathway is for the NT government to approach the federal Minister for the Environment to consider entering into a Strategic Assessment Agreement with the NT under Part 10 of the *EPBC Act*, or other assessment under a bilateral agreement or Part 8 of the EPBC Act. The Commonwealth Environment Minister has a broad discretion to allow a Strategic Assessment and regarding its content. The NT government would first need to define a specific development area (such as the Beetaloo Sub-basin) and outline a 'program' for shale gas development in that area. The federal Minister will consider whether there are matters of national environmental significance (MNES) as defined in Part 3 the *EPBC Act* potentially affected, as these are the only triggers for Commonwealth government involvement. In the NT, there are few listed MNES, and there is very little scope for social or cultural impacts to trigger the *EPBC Act*.

If the Minister decides that the proposed program would require multiple approvals under the *EPBC Act* or that the program would potentially impact landscape scale MNES, then the Territory and Commonwealth governments enter a Strategic Assessment Partnership and

[105] APPEA (2017)

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negotiate appropriate Terms of Reference for social, environmental and other specialist impact assessments (such as cultural impacts assessment).

Once the strategic assessment has been completed and if the 'program' for development has been approved by the federal Minister, then this would include 'approved actions' (such individual gas projects, waste treatment facilities, associated infrastructure) that can begin without the need for further *EPBC Act* approvals.

The main limitation on Strategic Assessment under Part 10 of the *EPBC Act* is that it is limited to the impacts on matters of national environmental significance MNES protected under Part 3 of the Act. There are currently few listed MNES in the NT. While matters of national cultural heritage significance can also trigger the *EPBC Act*, places of significance need to be listed on the National Heritage List. Traditional Owners can apply to have their significant places included on the list, with no changes to the ownership of those places. The Australian Heritage Council makes an assessment of the nominated places and advises the Minister for the Environment whether or not the Council assesses that it has national heritage values. The Minister makes the final decision about which places are included in the National Heritage List.[106]

If at some stage the *EPBC Act* was to be amended to extend the application of the 'water trigger' (see Section 2.1) from coal seam gas to shale gas projects, then all projects would need to be assessed to the requirements of the *EPBC Act* and a Commonwealth strategic assessment would be warranted.

Another limitation of a Commonwealth led strategic assessment and approvals process is that the current federal government has clearly stated its position as being in favour of shale gas development in the NT, to the point of putting pressure on the NT government to lift the moratorium. The strong and public pro-shale gas development position of the federal government could be seen to influence the Minister's discretion in relation to the approvals process.

The second and more flexible pathway is to amend existing NT legislation to provide for strategic assessment of proposed development, where a specific area and program for development has been identified. An NT led strategic assessment would not be limited to impacts on MNES. The Terms of Reference for a strategic assessment could be decided on a case by case basis and could give more weight to the outcomes of social and cultural impact assessments. The main benefit of this approach is that it could enable an independently led

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[106] Indigenous heritage is also protected through the Commonwealth's *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* and the *Protection of Movable Cultural Heritage Act 1986.* http://www.environment.gov.au/epbc/publications/epbc-act-indigenous-stakeholders

impact assessment, thus mitigating the potential for issues of perceived bias, such as we identified as a limitation of the Commonwealth led strategic assessment.

Under the strategic assessment approach, baseline studies for impact assessment are no longer undertaken by project proponents or their subcontractors but are overseen either under the *EPBC Act* Strategic Assessment management body (a group within the NT Government) or, if NT legislation is reformed to include a strategic assessment mechanism, the process would likely be overseen by the existing NT EPA. Having baseline studies conducted and overseen by an independent, or government body (and not the proponent, with a vested interest in having their project approved, or the government, gives legitimacy to the baseline studies and helps builds trust in the approvals process. However, this also places the burden of cost onto the public purse. Proponents should contribute to the costs of these studies and the government can recover costs by placing a levee or additional fees onto the cost of a petroleum production license (PPL).

Social baseline assessments should be undertaken by trained and experienced social scientists/SIA practitioners, who also have an understanding of the industry activities associated with the different phases of shale gas development. Such specialised expertise can be found in at least two existing research institutions, including the Centre for Coal Seam Gas at the University of Queensland (UQCCSG) and CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA). While both these research institutions rely partly on gas industry funding, researchers work under strict organisational codes of conduct and national guidelines for the ethical conduct of research. A similar centre could be established in the NT at Charles Darwin University or other local institution.

The baseline assessments for the SIA framework proposed here most closely resemble those undertaken by the UQCCSG/CSRM for cumulative social and economic impact assessment, in that they would involve generating timeline charts for a tailored set of locally meaningful indictors. This approach is most relevant to the NT because it allows Aboriginal communities to choose their own set of indictors rather than relying on Census data, which may be of little relevance to their specific circumstances. In this method, communities are able to participate in the development of indictors, data collection and reporting, and the design of mitigation strategies that are 'outcomes-focussed' for their needs and aspirations. This requires some local institutional capacity and leadership, which may need to be fostered. Local governments should have participatory community planning documents prepared that outline local values and assets that people would like to see protected, those they would like to see enhanced and issues they would like to see resolved.

The ongoing participatory monitoring program outlives the strategic assessment and approvals stage and so needs a more permanent governance structure than can be provided for in the Commonwealth *EPBC Act* Strategic Assessment Agreement. However, the NT EPA already has an ongoing role in compliance auditing of approved projects, and could take on the oversight of the ongoing monitoring program, as well as providing regular independent updates on the social (and environmental, economic) performance of the industry. The NT EPA is also well placed to receive complaints about cumulative impacts that go beyond the scope of any single project or company.

4.6 Reforms needed to enable the NT Shale gas SIA Framework

To be operational, the proposed framework would require some structural innovations. These include:

- introduction of mechanisms for strategic assessment, either through reforms proposed in the 2015 Hawke Report, or possibly a Strategic Assessment Agreement under the *EBPC Act* 1999; a strategic assessment is needed to decide if the industry should go ahead and if so, under what conditions;
- establishment of an independent authoritative body, which can include enhancement of the existing NT EPA, or the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEM), with powers to request information from and to facilitate the collaboration between individual gas companies, and between gas companies, government agencies (including local government), communities and landholders;
- establishment of a long-term participatory regional monitoring framework, overseen by the independent authoritative body, with secure funding (raised from industry levees, costs of PPLs) and able to endure multiple election cycles; and
- periodic and standardised reporting out to communities on the social, economic and environmental performance of the industry through an independent source, either the independent body or a specialised research institution; this includes information from the monitoring of key indicators, an industry-wide complaints and escalation process (the experience of CSG in Queensland was that each of the CSG projects reported complaints under different themes, that made it impossible to gauge industry performance).

5. Lessons learned from SIA experiences in Queensland and elsewhere

5.1 The Queensland experience

The Queensland GasFields Commission recently published a report outlining their key learnings from the Queensland experience of coal seam gas development.[107] While we emphasise the distinction between coal seam gas (CSG) and shale gas technologies, the lessons learned about social and economic impacts from the development of an unconventional gas industry in Queensland are relevant in the NT context. These are outlined below and discussed in relation to associated research findings.

[107] QGFC (2017).i8

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5.1.1 Lessons about Land Access

A key lesson from Queensland is to have a clear legislative framework for Land Access in place that clearly outlines the rights and obligations of land and tenure holders, and the rights and obligations of gas companies. This may not be a salient issue in the NT as most of the land issues in Queensland arose on freehold land. However, to avoid potentially high levels of confusion and anxiety among rural landholders, as misunderstandings may arise over private property rights and the rights of gas companies, clear Land Access legislation is recommended.

Queensland's *Land Access Code*, published in 2010 and amended in 2016, provides best practice guidelines and specifies mandatory (i.e., minimum) conditions for the conduct of petroleum lease holders (i.e., gas company personnel) on private property. The Code aims to establish compensation arrangements and support effective communication and working relationships, such as entry notices provided to the landholder by the gas company, the need for conduct and compensation agreements (CCAs) or an agreed alternative, the right of the landholder to restrict access to certain areas, a dispute resolution process, and compensation for costs incurred in negotiation of a CCA. The Queensland Government has also recently announced that the position of a Land Access Ombudsman will be created in 2018. The development comes from an independent review of the Queensland Gasfields Commission that identified the need to improve the negotiation of agreements and resolution of disputes between landholders and gas companies.

5.1.2 Lessons about coexistence

The ability to farm productively and sustainably on a property where gas operations are occurring has been referred to as 'co-existence'. The term has been popularized by the CSG industry, but many landholders do not agree that the term 'co-existence', which infers consent and mutualism, properly describes their circumstances. Researchers at UQ's Centre for Coal Seam Gas studied the relationship between agriculture and the gas industry with the dual focus of understanding 'co-existence' and how to facilitate it, and measuring the impacts of gas industry operations on agricultural businesses. The study identified three elements that are crucial for successful and improved co-existence:

- interactions between landholders and companies should be characterized as business to business interactions, (that implies a more level playing field than the traditional business to individual conception) and as such, be guided by a business ethic of respect, cooperation and adaptation;
- that adequate information is accessible to inform negotiations, and
- that third parties such as government representatives and professional advisors play an important role in building capacity and ensuring consistency.

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5.1.3 Lessons about strategic planning for industry lifecycle

In Queensland, four major players were simultaneously exploring the feasibility of developing their gas tenements for LNG export, three of which went ahead with it within months of each other. This is similar to the NT where multiple companies are at different stages of exploration and feasibility testing. While the prospect of developing shared infrastructure was canvassed in Queensland, the different projects' timeframes, along with the underlying competition to be the world's first CSG-to-LNG exporter, meant that collaboration between the different projects did not materialise.[108] In terms of social impacts:

- some landholders had multiple pipelines crossing their land and had to negotiate with different companies;
- communities were being consulted in relation to four different EIS processes;
- SIA strategies were not well linked with local government planning; and
- local governments did not have the capacity to review multiple EIS documents, or the time to review their local planning documents.[97]

The lessons learned from Queensland point clearly towards the need for greater industry collaboration in relation to SIA and particularly the management of cumulative impacts arising from multiple projects. The management of social impacts needs to be more responsive so that the significant social investment by gas companies can be better coordinated and aligned with local community needs and aspirations. Such lessons have been captured in the SIA Framework proposed here, where individual SIA risk assessments and social investment strategies are integrated within a regional, collaborative monitoring and evaluation instrument. This includes clear planning for gas field closure and rehabilitation, and legacy planning that leaves communities with assets and strengths to transition to a new economy once the industry has exited the region.

5.1.4 Lessons about workforce accommodation and housing

One of the most far-reaching social impacts arising from CSG development in Queensland's Surat Basin occurred in relation to housing supply and demand, associated price fluctuations and subsequent responses by homeowners, investors, developers, governments and companies. This issue may not be as relevant for some of the smaller NT communities, where housing supply and demand as determined by free market forces. However, the larger centres that act as regional 'hubs', and where gas-related activities may be centred, could be subject to the same types of fluctuations in demand for housing, if accommodation for the construction phase workforce is not managed early and well.

As workers initially arrive in communities, they occupy temporary accommodation (motels, company -provided camps, campgrounds and sometimes rental housing), preferably those

[108] Queensland Gasfields Commission (2017)

that provide house-keeping and meals. The ‘second wave’ of workers, associated with company staff in regional offices (who are more likely to stay for longer time periods), tends to occupy rental houses, or may choose to purchase property. Rents are driven upwards as demand grows, placing financial stress on lower and fixed income families who may be pushed to smaller, or lesser quality housing, or forced to move away altogether. Higher rents trigger property investor interest and house sales and sale prices are also pushed upwards. New housing developments proceed to capture the demand for housing, from investors and renters. This can result in an oversupply of housing once the temporary workers have left. The switch from a relatively stable rural community of long-term residents to one which has high rental accommodation and a more transient population can be distressing for those who remain.

The lesson is for local governments to be proactive and prepared, and take a long-term view on the issue of housing development, so as not to be responding to short-term fluctuations only. The construction workforce is temporary and requires short-to-mid-term accommodation, not permanent housing - unless population growth is anticipated and housing development is a long-term goal.

5.1.5 Lessons about opportunities for local businesses

Local businesses will vary in their capacity to service the gas industry. The speed at which the industry can progress can be an obstacle for some businesses unable to respond quickly. Communicating information to local businesses about pre-qualifications and other requirements for contracting, should be done early in the life-cycle of the industry to allow local businesses time to prepare. A single registry of contractors/suppliers should be established for the industry with standardised procurement processes. Local businesses must be prepared to meet the high occupational health and safety (OH&S) and accreditation standards required by multinational companies in the industry- for some local businesses, this will require a ‘different way of doing things’. Some local businesses in Queensland found this ‘cultural shift’ initially difficult, but also personally as well as financially rewarding.

Businesses based in larger regional centres could be expected to be more capable of handling the rapid rise and rapid decline of the industry’s construction period in a given area. Businesses in more rural areas can tend to lack the necessary connectedness and ability to adapt, and innovative problem-solving skills.

In Queensland, hiring and retaining staff was also difficult for local businesses as employees moved to the high-paid jobs in the gas sector. High rents also meant it was difficult to recruit people from other areas unless accommodation was part of the employment package.

5.1.6 Lessons about cumulative impacts

Current regulatory guidelines in Queensland state that the SIA must assess cumulative impacts resulting from the proposed project and other developments regionally. However, proponents are only required to mitigate impacts that are directly attributed to their own project. Furthermore, the guidelines state that mitigation measures are not required for existing issues and legacy issues that are not attributed to the project in question.[109] The cumulative impact assessment sections of SIAs and SIMPs from the Surat Basin projects state that there is no common, accepted method for conducting a cumulative impact assessment. A study by UQ's CCSG/CSRM was commissioned to specifically design a methodology for assessing and addressing cumulative socioeconomic impacts of CSG development. This study culminated in collaborative and participatory regional assessment framework that has been internationally acclaimed (see the UQ Boomtown-Toolkit). The UQ Boomtown Toolkit methodology forms the basis for the ongoing participatory monitoring component of the SIA Framework proposed here as leading practice for cumulative SIA.

5.2 The US shale gas experience

The US shale gas 'revolution' was characterised by its rapid pace of development and provides a cautionary tale. In the over-riding agenda to become self-sufficient in energy supply as quickly as possible, social impacts of development were largely overlooked (until there was local backlash) and regulatory frameworks were largely insufficient (until they were challenged and amended).[110] A review of the risks posed to communities from shale gas development in the US identified four key areas of risk:

- rapid industrialisation of communities (boom and bust);
- uneven distribution of costs and benefits from the development;
- community conflict; and
- social-psychological stress and disruption.[111]

The most effective responses to the negative social impacts of shale gas development were led from the community-county level. These required the development of community-scale consensus-based decision making processes.[112] The need to assess local institutional capacity was identified in the proposed SIA framework baseline assessment. In the NT, local governments may need to establish participatory planning processes and prepare planning documents that reflect the views and aspirations of local residents if development were to go ahead.

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[109] Queensland Government, Department of State Development, Infrastructure and Planning (2013).
[110] Brasier *et al*. (2014)
[111] Jacquet (2014)
[112] Environmental Law Institute and Washington & Jefferson College, Center for Energy Policy and Management (2014)

5.3 South Africa's Strategic Environmental Assessment for shale gas development- building trust

South African government, through Cabinet and various other decision-making institutions, has made high-level public commitments to shale gas exploration. The potential future economic and energy security benefits of a large resource of natural gas in South Africa could be substantial; as are both the positive and negative social and environmental issues of establishing a domestic gas industry in the Karoo region. In order to make well-informed decisions and help ensure that decisions will be broadly accepted by stakeholders as credible and legitimate, the government commissioned a Strategic Environmental Assessment (SEA) for shale gas development. The key aim of the project was to develop an integrated decision-making framework which will enable South Africa to establish effective policy, legislation and sustainability conditions under which shale gas development could occur.

There were three project phases over the 24-month period:

- *The Conceptualisation and Methodology Phase*. The objectives were to set-up and implement all project management structures, convene the project governance groups, recruit authors and experts to the Multi-Author Teams and release a Draft Approach Report at the end of Phase 1 for expert review. This document was also made available to the public on the website.
- *The Scientific Assessment Phase*. This was the component of the study where the scientific assessment by the Multi-Author Teams for all Strategic Issues took place. At the end of this phase Draft and Final SEA reports were released for expert and public review. The expert review included peer-reviews from international experts.

The Decision-Making Framework Phase. The final phase translated the outputs from Phase 2 into operational guidelines and decision making frameworks. It was undertaken by the Project Team in close consultation with the various affected Departments. It commenced with initial drafts after the delivery of the first draft of the Assessment report, and ended with final drafts after the delivery of the final Assessment report.
The Project Teams were separated between Phase 2 and 3. The experts involved in Phase 2 were not asked to make decisions about the development of shale gas. Rather, they were asked to give an informed opinion on the consequences of different options. The decisions were to be made by mandated government authorities, who have contracted the science councils to help them in formulating the framework and content of such decisions. The assessment process culminated in November 2016, with the publication of a 1,400-page final report entitled *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks*.[113]

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[113] Scholes et al (2016).

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The extensive report identified a number of potentially significant social risks, particularly related to increasing social division and inequity between already marginalised populations and those better positioned to capture opportunities from the shale gas industry.

Building public trust remains a key issue for the industry to ensure it has community acceptability, both in South Africa and in other jurisdictions. It is too early to determine whether the exercise resulted in greater trust in government and industry and broader public acceptance of shale gas development in South Africa. However, the scientific rigour, detail and transparency associated with the assessment exercise, without a doubt, provided a significant contribution to that effort.

5.4 Lessons learned from Canada

The Council of Canadian Academies was asked by the federal Minister of Environment to assemble an expert panel to assess the state of knowledge about the impacts of shale gas exploration, extraction and development in Canada. In response, the Council recruited a multidisciplinary panel of experts from Canada and the United States to conduct an evidence-based and authoritative assessment supported by relevant and credible peer reviewed research. In 2014, the Expert Panel on Harnessing Science and Technology to Understand the Environmental Impacts of Shale Gas Extraction (the Panel) published a 292-page report entitled *Environmental Impacts of Shale Gas Extraction in Canada*.[114]

One of the Panel's main findings was that, relative to conventional gas, the greater scale of development and concentration of infrastructure required to produce shale gas imply increased land impacts and land use conflicts; the only effective way to manage such cumulative effects is at the regional, not local, scale.[115] The Panel noted that management of cumulative effects requires effective implementation of strategic impact assessment processes. At the same time, the implementation of a regional strategic impact assessment to reduce cumulative effects of shale gas development requires a significant investment in human and financial resources.[116]

The Panel also found that shale gas development poses particular challenges for governance because the benefits are mostly regional whereas adverse impacts are mostly local and cut across several layers of government. Engagement of local citizens and stakeholders was identified as a key element of an effective framework for managing risks posed by shale gas development. Accordingly, the Panel stressed that public engagement is necessary not only to inform local residents of development, but to receive their input on what values need to be protected, reflect their concerns and earn their trust.[117] As experience in several U.S. states and Canadian provinces has shown, the manner in which local people are engaged in

[114] Council of Canadian Academies (2014).
[115] Ibid, p. 205.
[116] Ibid, p. 128.
[117] Ibid, p. xix.

decisions concerning shale gas development is an important determinant of their acceptance of this development. Moreover, public acceptance is situation-specific: practices that are acceptable in one situation may not be in another. Therefore, the Panel recommended that a public engagement strategy needs to reflect these differences and be oriented to local context, capacity and concerns.[118]

In the Canadian social and political context, shale gas development must recognize the importance of addressing First Nations' treaty rights, interests and concerns. The legal relationship between the Crown and First Nations is defined by the courts through clarification of the existing Aboriginal and treaty rights. Many First Nations are uncomfortable with tripartite negotiations between the provincial, federal and First Nations governments because they see such negotiations as a derogation of the bilateralism established when the treaties were first negotiated. First Nations argue that the cumulative impacts of past authorisations for resource development in Canada have infringed on their Aboriginal and treaty rights. Specifically, they point to instances in which the Crown assigned certain procedural aspects of consultation to proponents and asked for amendments to project plans to avoid impacts on Aboriginal and treaty rights.[119] The Panel stressed that the impact of First Nations' opposition to other major resource development in Canada indicates that the effect that Aboriginal resistance or support on future shale gas development cannot be overemphasised.[120] As many of the known commercially accessible shale gas deposits in Canada are in accepted or claimed traditional territories, the Panel recommended that First Nations need to be consulted meaningfully and early in any shale gas development process, in full respect of their Aboriginal and treaty rights.

5.5 Lessons about Good Practice Agreement Making and Free Prior Informed Consent (FPIC)

5.5.1 Good Practice Agreement Making

In the NT, with large areas of land held in Aboriginal freehold tenure, the concept of free, prior and informed consent (FPIC) provides leading practice standards for negotiating with Indigenous people. There are few cases in the world where the full FPIC process has been undertaken successfully with associated positive outcomes. In the Australian context, one resource company experienced in negotiating agreements on Aboriginal land is Rio Tinto, who work by the following principles for good practice.

[118] Ibid, p. 208.
[119] Ibid, p. 31.
[120] Ibid.

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Box 5: Rio Tinto's Guidelines for Successful Indigenous Agreements [121]

A successful Agreement:

- Is perceived by all parties as voluntary and not imposed on the parties;
- Involves all of the people who can demonstrate themselves to be the land-connected peoples;
- Has been negotiated by legitimate representatives;
- Sustains implementation and performance over time, even when there are changes in company personnel and leadership;
- Acknowledges potential price fluctuations of commodities over the life of the agreement;
- Stands the test of time and is reviewed and amended as necessary, with the full support of all parties;
- Is able to be changed and improved (if all parties agree) when things are not working and supports joint adaptation and problem-solving when challenges arise;
- Has clear commitments and benefits for both parties and focuses on long-term rather than short-term goals;
- Delivers on agreed commitments and builds in incentives for all parties to ensure that agreement commitments are upheld;
- Involves agreement-making processes, content and implementation approaches that are consistent with human rights principles;
- Proactively considers future generations;
- Is based on a genuine relation of trust between parties so that the agreement implementation is driven by its spirit and intent, not the legal references;
- Provides flexible frameworks for working together rather than rigid formulas for individual action;
- Acknowledges the importance of cultural heritage and an understanding of legacy and historical issues and their effect on religious responsibilities, spirituality and culture;
- Benefits the community as a whole rather than particular individuals.

5.5.2 Lessons from Papua New Guinea

One example of an effective (and documented) agreement process is the Ok Tedi copper and gold mine in PNG. While the context was highly contentious and problematic (communities had to choose between the mine closing with no alternative income to support development and the mine continuing to pollute the river, but with an income stream), an agreement was negotiated with Indigenous people that is generally thought to provide positive outcomes. The mine was continually polluting the river after a tailings dam collapsed in 1984 and is known as an environmental disaster. There were a series of legal challenges over the environmental impacts. An FPIC process was entered into to decide whether the mine should continue or not. The outcome was the Community Mine Continuation Agreements. The lessons from this process were that it was a consultative and inclusive process in a very difficult context, but the process was also transparent in that it was well documented.

[121] Rio Tinto (2016)

6. Conclusions and Recommendations

CSRM conducted a review of academic and leading practice literature on SIA, a review of the regulatory environment for SIA in the NT, and distilled lessons learned from case studies of similar developments elsewhere in order to develop a leading practice SIA framework for potential shale gas development in the NT. From these reviews, we have identified the key components needed in a leading practice SIA framework for shale gas development in the NT, gaps and opportunities in the current NT regulatory environment for leading practice SIA and lessons learned from similar developments elsewhere that are relevant for the NT.

Key Findings

Key components of a leading practice SIA Framework for shale gas in the NT

1. ***Strategic assessment*** for a program of development that clearly identifies the goals of the program and defines the optimum scale (and pace) of development in terms of balancing economic, social and environmental impacts at local, Territory and national scales.

2. A ***strategic, adaptive, industry life-cycle approach*** that aligns individual projects and their outcomes with the long term objectives of the NT *Economic Development Framework* and enables adaptive responses to community values and aspirations.

3. A ***platform for communication, coordination and collaboration between multiple projects*** in order to identify and respond to cumulative impacts, minimise the 'footprint' of the industry in the placing of associated infrastructure (including workers 'accommodation) and maximise long term social and economic benefits to local and regional communities.

4. In recognition of the unique circumstances of the NT, an inclusive and participatory process that pays particular attention to ***human rights issues***, and the rights and vulnerabilities of Indigenous peoples

5. An ***independently led, participatory*** social baseline assessment, using 'agreed indicators' to measure baseline values and assets (we recommend using the community capitals framework). The indicators should be selected in consultation with local people and stakeholders. Proponent-led collection of baseline data for their prospective area of operation and the wider region tend to emphasise snapshots and predictions. It is less attuned to the monitoring and tracking of trends that are essential to adaptive management, especially in a region with scant information about the receiving social environment. This is especially concerning where multiple projects may proceed.

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6. ***Participatory, ongoing monitoring*** of changes in the indicators. This includes periodic (annual or biennial) 'ground-truthing' of indicator data through interviews with local people to understand the lived experience of impacts and sustainability outcomes.

7. An ***independently led community engagement*** program with affected stakeholder groups to discern the significance of potential impacts and to co-develop acceptable and appropriate mitigation and enhancement strategies.

8. The SIA framework should contribute to an ***open data policy*** with ***regular reporting*** on the social, economic and environmental performance of the shale gas industry

10. Each additional project should provide an adaptive SIA risk assessment that specifically addresses ***cumulative impacts*** and its contribution to the development program's objectives.

Gaps in the current NT regulatory environment for SIA

1. There are currently no mechanisms for strategic assessment (including strategic SIA) under NT regulations, although implementing strategic assessment has been accepted as a recommendation in a review of environmental assessment policy (the 2015 Hawke Report).

2. There is scope for a strategic assessment under the Commonwealth *Environmental Protection and Biodiversity Conservation Act (*EPBC Act*) 1999*, where matters of national environmental significance (MNES) may be affected. A map of protected matters[122] shows there are few matters that would trigger the EPBC Act in the NT. However, if the current 'water trigger' for coal seam gas and large coal projects was to be extended to include shale gas development by the Commonwealth government, all NT projects would be required to gain EPBC Act approval.

3. SIA is required only as a subset of an environmental impact assessment, and as such, has the potential to be undervalued in the approvals process.

4. While generic guidelines exist, there are no industry specific guidelines for conducting an SIA in the NT where there is a uniquely high proportion of Aboriginal people and interests.

5. There are currently no requirements or guidelines for cumulative impacts assessment.

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[122] Australian Government, Department of the Environment and Energy, (2017) Protected Matters Search Tool http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

Relevant lessons from similar developments elsewhere

1. The scale and pace of development determines the significance of social impacts, so too does the pre-existing / pre-project social, economic, political and cultural environment.

2. The terms of 'co-existence' between shale gas and agricultural (or other industries) needs to be negotiated on a case by case basis.

3. Social impact mitigation strategies should not be bilateral agreements (e.g. government placing conditions on operators), nor overly prescriptive (e.g. operator must construct 50 new houses). Instead, they should involve local communities (and other key stakeholders who have a role to play) and be aligned with their aspirations and needs and be 'outcomes-focussed'.

4. The social impacts of shale gas development are unevenly distributed. Those with capacity and information can prosper while inflexible or vulnerable groups can suffer.

5. Social impacts, such as impacts on local social cohesion, and psycho-social stress, arise well before there is 'a project', and these are often not adequately addressed in SIA processes.

6. There is low trust in the onshore unconventional gas industry worldwide. Trust is time-consuming and difficult to earn but quickly and easily lost. In developed countries like Australia, mass media can have a large influence on the process. But not to lose sight of the importance of managing these relationships at the ground level, especially in remote areas.

7. Local institutions need to be strengthened (ideally prior to development occurring) to address the challenges and harness the benefits that the industry can bring. SIA needs to identify existing levels of capacity within these institutions and those that would need attention.

8. Negotiations with Aboriginal Traditional Owners (TOs) should be inclusive and transparent (on agreement). General informed consent is insufficient. Details of activities should be negotiated in recognition of rights to self-determination and to ensure these groups fully understand the terms of the project and the impacts, benefits and management strategies. The placement of each well and associated infrastructure should be negotiated on a case-by-case basis with local TOs in avoid any culturally sensitive places, and 'sacred sites' as identified by the Aboriginal Areas Protection Authority (AAPA). The process for such negotiations should be fully documented.

Recommendations

1. Initiate mechanisms for strategic environmental assessment of a specific program of shale gas development (e.g. Beetaloo Sub-basin) in either NT regulations (as recommended in the 2015 Hawke Report), or in partnership with the Commonwealth government in a Strategic Assessment Agreement under the *EPBC Act*.
2. The Terms of Reference for strategic environmental assessment should include various specialist assessments, including cultural impact assessment. Due to the interconnectedness of Aboriginal peoples and their culture with environmental condition, predicting the significance of social (cultural) impacts (particularly for Aboriginal people, but also pastoral leaseholders) requires the integration of social, environmental, economic and cultural assessments.
3. Consult with the Commonwealth Department of the Environment and Energy in relation to possible amendments to the 'water trigger' under the *EPBC Act* to apply to shale gas projects, as it does for all coal seam gas and large coal projects. If the 'water trigger' were also to apply to shale gas projects, then Territory assessment processes must align with Commonwealth assessment requirements to avoid duplication.
4. Establish or enhance an independent Authority (separated from government decision making) for the oversight of the strategic assessment, baseline studies and ongoing monitoring and reporting, as well as for social and environmental compliance auditing. This could be the existing NT Environmental Protection Agency to avoid structural complexity and the fragmentation of decision making that has confounded the effective regulation of the industry in other jurisdictions.
5. Collaboration and coordination between projects, and between gas companies, government and community organisations is necessary for effective identification, assessment and responses to cumulative impacts. A platform for such collaboration (such as a multi-stakeholder working group) would ideally be linked with the ongoing monitoring platform and come under the jurisdiction of the same independent Authority.
6. Third parties should be able to report grievances, or perceived breaches of conditions to the independent Authority where grievances relate to cumulative impacts and issues beyond the scale of project-level grievance mechanisms.
7. The costs of undertaking independent baseline studies (usually conducted by project proponents) should be recovered to an extent from project proponents (who would no longer have to do them individually, but who would use the available data in their risk assessments) by increasing the cost of the petroleum production license (PPL) for operators and/or by charging an annual levee or fee for use of the baseline data and ongoing monitoring and reporting platform.

8. Produce clear guidelines and simple fact sheets for negotiating Land Access Agreements in different tenure types that outline the rights of both the landholder and the project proponent. Considerable stress and negative impact has been associated with misunderstood land rights and perceived disrespect for attachments to, and interests in land.
9. Identify strategies to build local institutional and business capacity early. To best capture the potential economic benefits of shale gas development, adequate lead-time and institutional, business and individual capacity is required.
10. Negotiations with Aboriginal Traditional Owners (TOs) should be inclusive and transparent (on agreement). General informed consent is insufficient. Details of activities should be negotiated in recognition of rights to self-determination and to ensure these groups fully understand the terms of the project and the impacts, benefits and management strategies. The placement of each well and associated infrastructure should be negotiated on a case-by-case basis with local TOs to avoid any culturally sensitive places, and 'sacred sites' as identified by the Aboriginal Areas Protection Authority (AAPA). The process for such negotiations should be fully documented.
11. Royalty payments should not be exclusive to TOs, but a community benefits trust, or other fund designed to distribute economic benefits to regions should be established. (e.g. 'Royalties for Regions' schemes such as in Queensland and Western Australia).
12. Perceptions or evidence of negative impacts on the spiritual wellbeing and social cohesion in Aboriginal communities should be given high priority in risk assessment, as personal safety could be at risk.

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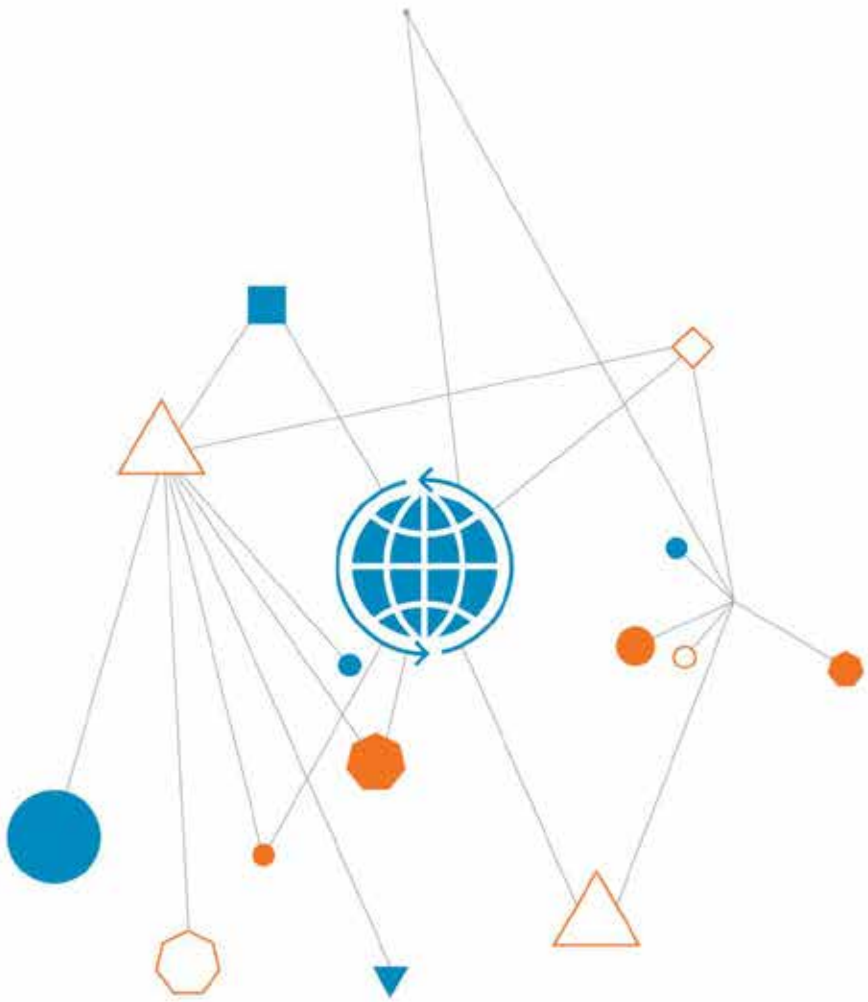
Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

Beetaloo sub-basin Social Impact Assessment Case Study

17 January 2018



When you think with a global mind problems get smaller

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Scientific Inquiry into Hydraulic Fracturing in the Northern Territory

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17 January 2018

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Executive summary

The independent scientific panel (the Panel) undertaking the Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs and Associated Activities in the Northern Territory (the Inquiry) commissioned a two-part scope of work to assist its deliberations on the social impacts of an unconventional gas industry in the Northern Territory. The scope of work comprised:

Part A Social Impact Assessment

- Develop a leading practice framework for the identification, assessment and management of the social impacts associated with the development of onshore unconventional gas in the Northern Territory.
- Undertake a high-level social impact assessment (SIA) that describes 'the type of potential social impacts, issues, concerns, risks and benefits that may arise from the development of the unconventional gas industry in the Beetaloo sub-basin on the Affected Communities'.

Part B Social Licence to Operate

- Describe and assess the concept, elements and issues surrounding a 'social licence to operate' (SLO), as it applies to the onshore unconventional gas industry in the Northern Territory.

A leading practice SIA framework was developed by The Centre for Social Responsibility in Mining (CSRM) of the University of Queensland (CSRM, 2017). The framework was used to undertake a high-level SIA case study (SIA case study) to assist the Panel to identify and assess the potential impacts on affected communities of an indicative scenario for development of an unconventional gas industry, including their likely significance and ability to be managed.

The CSIRO prepared a report on 'social licence to operate' (CSIRO, 2017) that provides the Panel with the key attributes of a community engagement program that will lead to a shale gas development company obtaining a social licence to operate in the Northern Territory.

Social impact assessment method

CSRM (2017) recommended strategic environmental (and social) impact assessment informed by project-independent baseline studies that are based on an adaptive participatory management approach. The strategic assessment would provide the framework for project-level assessments with project-level monitoring providing information to facilitate review and update of the strategic assessment.

CSRM identified the phases and activities of SIA, and how they relate to an adaptive participatory management approach. The typical phases and adaptive participatory management approach would typically take several years and involve extensive community and stakeholder engagement to understand social values, identify and explain potential impacts, and develop, explain, refine and reach agreement on appropriate responses, management measures and initiatives. This was not possible for the SIA case study which was conducted over a period of six months.

Adopting key elements of the approaches proposed by CSRM (2017), an approach that accounted for the limited time available for the SIA case study and limited information gathering was developed. The approach comprises three stages:

1. Compile social baseline (identify affected communities, define social catchments, identify social values and compile social profiles).

2. Identify and assess threats and potential impacts to social values.
3. Propose mitigation and identify opportunities for enhancing social values.

The Panel required the SIA case study to assess social impacts on ‘*the people or groups of people that are most likely to be impacted by the development of unconventional gas resources in and around the Beetaloo sub-basin… which may include, without limitation, community members, pastoralists, Aboriginal organisations and local businesses*’.

The geographical scale of the Beetaloo sub-basin necessitated grouping potentially affected communities into social catchments to reflect their relationship to the conceptual development, aid stakeholder engagement and enable an appropriate assessment of the social impacts of unconventional gas development. The following factors were used to define the social catchments:

- **Location and community links**: Centres with a population level that may indicate some potential for providing ‘local employment’ should sub-basin development proceed. Generally these communities are located outside of, but in proximity to, the Beetaloo sub-basin. Consideration of potential physical and cultural links are also important factors influencing grouping and the potential to experience shared perceptions of impact.
- **Logistics or support industry potential**: It is assumed that the development of an unconventional gas industry would require at least a moderate level of logistical and maintenance support. This could be a purpose-built area within the gas field or a facility located in the existing large towns north and south of the sub-basin that currently support industrial activity, for example Katherine, which currently provides support to the mining industry and RAAF Base Tindal and/or Tennant Creek, which provides support to the mining industry.
- **Dominant economic activity**: Pastoral operations constitute the principal economic activity within the Beetaloo sub-basin, with the Stuart Highway and to a lesser extent the Carpentaria Highway facilitating economic activity associated with tourism.

The affected communities and social catchments to which they were assigned are:

- Affected communities (urban): Katherine (town) and Tennant Creek.
- Affected communities (north): Barunga, Beswick, Mataranka, Jilkminggan, Minyerri and Ngukurr.
- Affected communities (central): Larrimah, Daly Waters, Dunmarra, Newcastle Waters and Elliott.
- Affected communities (east): Borroloola and Robinson River.

Social values of the affected communities were identified and verified through stakeholder engagement that involved two rounds of consultation. A total of 69 meetings were held with stakeholders. Table E1 categorises the stakeholders into key groups. Figure E1 provides the results of an analysis of the frequency of issues raised by stakeholders.

Table E1 Stakeholder consultation effort

Stakeholder category	No. of meetings	%
Government agencies and statutory authorities	7	10
Businesses and peak business organisations	11	16
Local Governments	6	9
Non-government organisations	6	9
Community organisations and residents	39	56

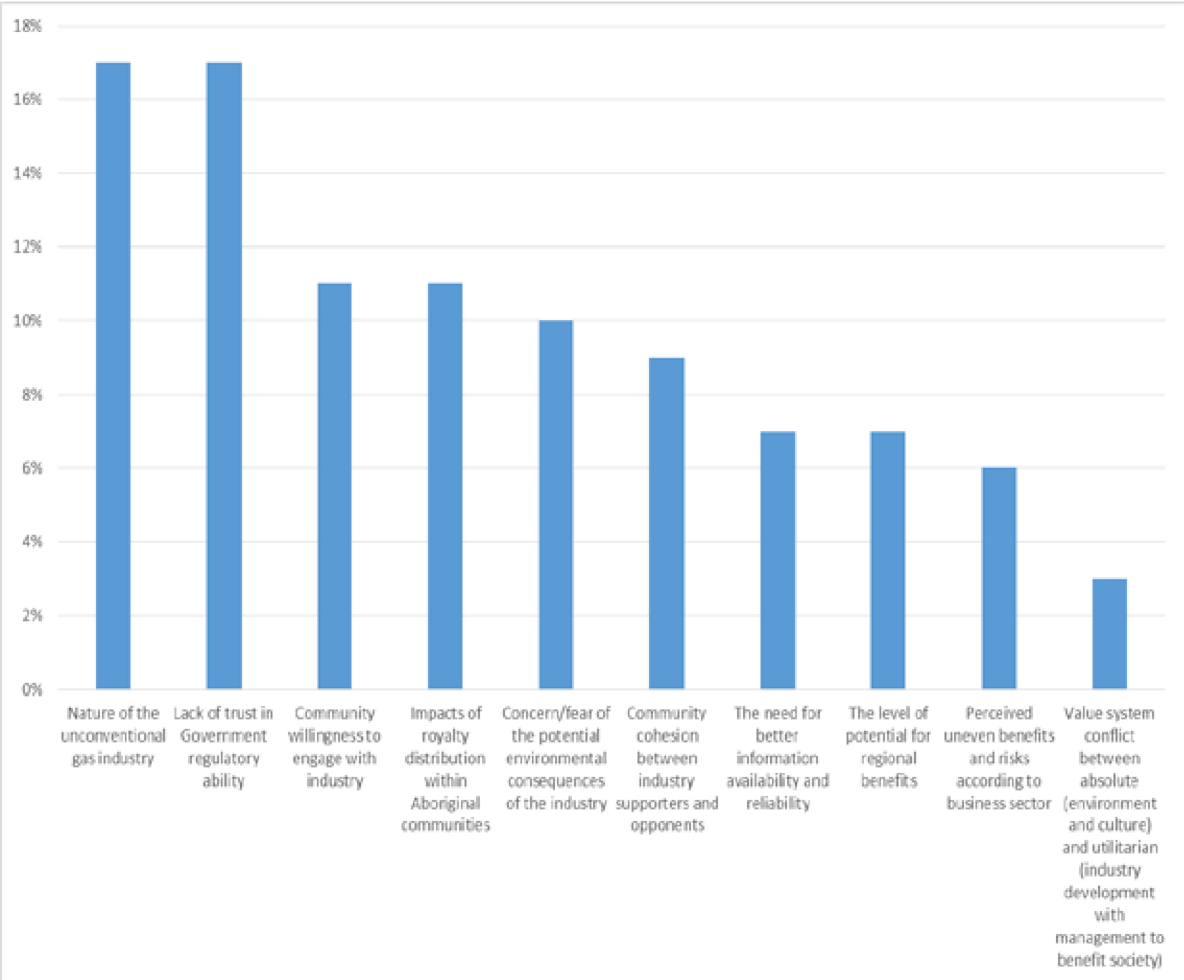


Figure E1 Ranking of issues expressed during stakeholder consultation

The issue – Nature of the unconventional gas industry – relates to community concerns that:

- The resources industries are short-term rather than long-term, and cyclical in nature.
- The impacts associated with development of a shale gas industry in the Northern Territory will be similar to those experienced with the development of the coal seam gas industry in Queensland.
- Industry is aloof from community concerns and has disregard for the social outcomes of their operations.

The identified social values, threats (or impact drivers) and potential impacts associated with unconventional gas development are set out in Table E2.

Threats to and impacts on the social values were assessed using the approach to risk management involving the assessment of likelihood of the threat occurring and the resulting consequence or impact on the social values. A risk matrix was used to determine the significance of the threats (and impacts) on the social values.

Table E2 Identified Beetaloo sub-basin social values, threats and potential impacts

Social value	Threat or impact driver (ID)	Potential impact
SV1 Liveable community	ID1A Rapid workforce influx to urban areas	Impaired community amenity
	ID1B Increase in heavy vehicle traffic on local roads	Reduced amenity, road accidents and increased vehicle maintenance costs
	ID1C Conflict between supporters and opponents of unconventional gas industry development	Conflict between community members
	ID1D Receipt of royalties by a subset of community members	Conflict between community members
	ID1E Concern over potential risk to groundwater quality	Anxiety about availability, access to and quality of water resources
SV2 Affordable lifestyle	ID2A Housing supply unable to meet spike in demand	Decreased housing availability and affordability
	ID2B Increased short-term rental costs	Decreased housing availability and affordability
SV2 Affordable lifestyle	ID3A Significant change in land use and industry development	Loss of 'outback' identity
	ID3B Perception of industry development heralding an era of 'industrialisation' of the landscape	Loss of 'outback' identity
	ID3C Perception that industry development approval is against majority community wishes	Decreased community engagement with local governance
	ID3D Concern with increased access to, and development risks on traditional country	Increased sense of cultural loss
SV4 Capacity for sustainable economic activity	ID4A Concern that long-term access to quality groundwater may be restricted due to industry development	Decreased investment in pastoral and horticultural enterprises
	ID4B Perception that 'outback' identity is compromised by 'major industrialisation' of the region	Decrease in tourist visitation
	ID4C Higher gas industry wage rates available to local residents drives competition for employees	Increased cost of labour for local businesses
	ID4D Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Local business closures

Socioeconomic context of Beetaloo sub-basin

The Beetaloo sub-basin is located between Katherine and Tennant Creek and covers an area of approximately 7,000 km^2. Land use in the Beetaloo sub-basin comprises Aboriginal land, pastoral leases, horticultural enterprises, oil and gas transmission infrastructure, a railway, and highway towns, cattle stations and remote Aboriginal communities. The Australian Defence Force operates RAAF Base Tindal located near Katherine.

Larrimah, Daly Waters, Newcastle Waters and Elliott border or are located in the sub-basin. The adjacent towns and communities of Katherine, Mataranka, Minyerri, Ngukkur, Borroloola, Robinson River and Tennant Creek are located outside the sub-basin. Figure E2 shows the location and extent of the Beetaloo sub-basin and location of affected communities.

The Beetaloo sub-basin has been explored since the 1980s. Figure 6.2 of the Panel's Interim Report shows the extent of unconventional shale gas exploration in the Beetaloo sub-basin which has comprised hydraulically fractured and non-fractured wells.

The Beetaloo sub-basin has seen almost no industrial development. Some affected communities have experience with development. For example, experience with mining development south of Ngukurr (iron ore) and at McArthur River (large-scale underground and open pit mining of lead and zinc). The installation of gas transmission and lateral pipelines through the sub-basin (Amadeus Basin to Darwin Pipeline in 1986; the Elliott Spur Pipeline in 1989, and the McArthur River Pipeline in 1995) that occurred 20 to 30 years ago is not readily recalled by community members. The current installation of the Northern Gas Pipeline from just north of Tennant Creek to Mount Isa is in an early stage of development, and a significant distance south of the Beetaloo sub-basin communities.

Economic activity is centred on agriculture development (pastoral operations throughout the sub-basin, horticulture south of Katherine and along the Roper Highway) together with Defense activity at RAAF Base Tindal, and tourism activity mainly servicing self-drive visitors. Regional service townships (Katherine and Tennant Creek) are located outside the sub-basin.

Obvious significant disparities in social status and living conditions between remote Aboriginal communities and regional service townships are evident. This has a significant influence on the potential for community members to capture potential benefits from industry development should it occur.

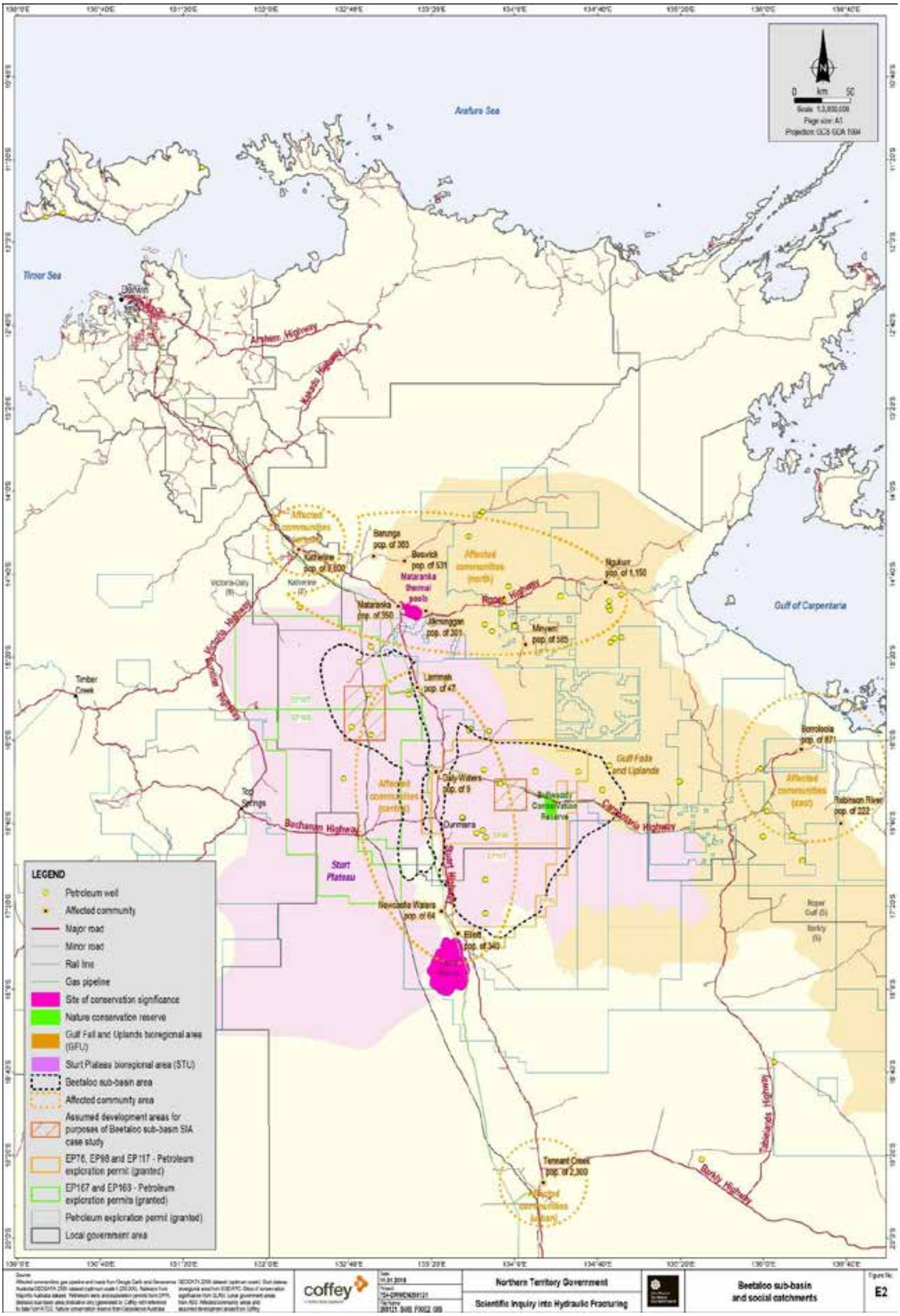
Community members have a reasonably high level of awareness (due to the activities of groups opposed to industry development) of historical issues surrounding the development of unconventional gas resources in other jurisdictions but not of the potential unconventional gas industry in the Northern Territory. The Inquiry's Interim Report (Inquiry, 2017b) acknowledged that levels of knowledge in Aboriginal communities about future development is inadequate.

Conceptual Beetaloo sub-basin development

A conceptual development was defined based on ACIL Allen's (2017) Shale WIND scenario which assumes a 260 well development with a 25 year production life.

The conceptual development assumes the moratorium on hydraulic fracturing will be fully lifted in 2018, allowing exploration, appraisal and pilot testing to proceed for a period of three to five years. Appraisal and pilot testing activities will confirm the technical and commercial parameters for development (e.g., gas availability and volume, cost of extraction, cost of gas processing, compression and transport, demand and wholesale price for gas, etc).

During the appraisal and pilot testing period environmental and planning approvals would be progressed with detailed design and construction of the gas fields and associated gas processing facilities commencing on receipt of territory and federal approvals. Shale gas production is assumed to occur for 25 years after which the production facilities and gas field infrastructure would be decommissioned.



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It was assumed that each project area would require gas field access roads, production wells and gas gathering lines, a gas processing and compression facility, export pipeline connection to the Amadeus to Darwin Gas Pipeline, accommodation facilities and an airstrip for FIFO worker transport during the construction phase for major facilities, such as the gas processing and compression facility.

Table E3 lists the key parameters for the conceptual development scenario adopted for the SIA case study. An indicative development timeframe is presented in Figure E3.

Table E3 Indicative project scenario parameters

Element	Scale
Approximate number of wells drilled per annum	10
Maximum number of wells in operation	257 (in 2042)
Number of well pads (8 wells/pad)	32
Length of gas field roads	55 km (1.7 km for each pad)
Length of gathering pipes	32 km
Area of disturbance (for pads, roads, gathering pipes and camps)	10.9 square kilometres (1,090 ha)
Area of disturbance for pipelines (Armadeus tie-in 50 km; Armadeus duplication 300 km; Northern Gas Pipeline duplication 622 km). It is assumed that the pipeline duplications are on similar alignments to existing pipelines)	Approximately 116 square kilometres (11,600 ha)
Average level of employment for well pad construction and field operations (including camp operations x 2)	250 to 300 persons
Estimated indicative level of local employment	Darwin: 65 persons Katherine: 70 persons Regional Northern Territory: 25 persons
Logistics support facility in Katherine industrial area	5 to 10 persons

It was assumed the peak construction workforce would be approximately 450 persons with 250 persons required for operation and maintenance of the gas field, gas processing and compression facilities and ancillary facilities. The workforce was assumed to be a combination of FIFO (from Darwin) and drive-in drive-out (DIDO) from Katherine and rural communities. Gas field workers were assumed to be housed in accommodation facilities located near transport hubs or at the gas fields while on shift. The accommodation facilities were assumed to be self-contained with medical and recreational facilities.

Construction workers who require specialist skills were assumed to be non-local, with the Northern Territory-sourced workforce drawn from the communities shown in Table E3. It was assumed approximately 70 persons would be locally sourced from the Katherine area, and that one third of these people (approximately 25) will have relocated to live in the area. This will result in a small population increase in the order of 80 persons (assuming 15 families of 4 persons and 10 couples with no children).

	2018	2019	2020	2021	2022	2023	2024	2025	2026	→	2041	2042	2043
Number of wells drilled per year		16			22	25	12	16	27	→	11	12	10
Number of producing wells			16		22	47	59	75	102	→	244	256	266
Number of wellpads being built		2		3	3	2	1	4	2	→	1	2	
Number of established wellpads		2	2		3	6	8	9	13	→	31	32	34
Development phases													
Moratorium lifted													
Exploration (initial 2014 to 2017; ongoing)													
Appraisal / small-scale pilot													
Planning and approvals (EIS and EPBC referral)													
Community engagement					Social programs and performance monitoring					→			
Gasfield design and construction													
Gas production										→			
Decommissioning and final rehabilitation (assumes 20 year well life)													

Figure E3 **Indicative development timeframe**

Social impact assessment

The affected community profiles revealed two groups of communities – regional centres with good levels of community infrastructure and services and those reliant on regional centres for such services. Katherine and Tennant Creek are regional service centres and were grouped for the purposes of impact assessment, as despite some differences they have similar characteristics in relation to the other affected communities. The outlying communities were grouped together as rural communities, as their size and remoteness from regional service centres is a key factor in their response to the identified threats.

Threats to social values where the significance is assessed as high or higher are shown in Tables E4 and E5.

Table E4 **Summary of high and higher threat significance for urban communities**

	Potential threat	Likelihood	Consequence	Assessed risk
ID1E	Concern over potential risk to groundwater quality	Almost certain	Moderate	High

Table E5 **Summary of high and higher threat significance for rural communities**

	Potential Threat (Rural)	Likelihood	Consequence	Assessed risk
ID1D	Receipt of royalties by a sub-set of community members	Certain	Major	Very High

	Potential Threat (Rural)	Likelihood	Consequence	Assessed risk
ID1E	Concern over potential risk to groundwater quality	Certain	Major	Very High
ID4A	Concern that long-term access to quality groundwater may be restricted due to industry development	Likely	Major	High

For urban communities, the key concern is the risk of impacts on groundwater resources (social value SV1) on which they rely wholly or partially for drinking water. This is likely heightened by the concerns regarding PFAS contamination of water resources in Katherine town and surrounding area. The potential for community discord due to divergent attitudes to risk held by supporters and opponents of unconventional gas development is considered material, particularly as the townships have relatively low populations.

For rural Aboriginal communities, including pastoral properties in the Beetaloo sub-basin area, the key threats are to social values SV1 and SV4, primarily due to the perceived environmental risk to both quantity and quality of groundwater due to hydraulic fracturing required to extract gas from the shale. Receipt of royalties in remote Aboriginal communities also has the potential to induce income disparity that may negatively affect relations between different traditional owner groups.

The remoteness of communities (influencing the time available to consult effectively) and the cultural diversity and differing world views of the major stakeholder groups – Aboriginal communities and pastoral leaseholders – were identified as particular challenges when undertaking both strategic and project-level SIA in the Beetaloo sub-basin.

The limited understanding of the nature of the unconventional gas industry, and of the technologies that would be deployed to extract gas and manage potential environmental and social impacts, as well as the distrust of governments and their capacity to regulate the industry effectively on behalf of all community members, amplify these challenges.

Notwithstanding, the identified threats were considered manageable, as evidenced by experience in existing onshore unconventional gas developments. Close collaboration between various industry groups and project proponents, government and the community will be required to ensure that responsibility for management and reporting on sub-basin level impacts is clear. Mechanisms for community feedback and response will need to be widely-known and effective as community knowledge with respect to the effective management of identified impacts will be an important component of an industry social licence to operate.

Social impact management programs are expected to include the following components, with additional components and activities likely to be identified when more detailed project descriptions are available and subject to a comprehensive project-level SIA.

Community

Key factors to be considered in the development of a community engagement strategy include:

- The need for community industry awareness campaigns, particularly for Aboriginal communities. This needs to be an ongoing process, as the development and deployment of improved technology is proceeding at a rapid rate.
- The requirement for implementation of robust land access protocols.

- The need to provide regular environmental monitoring results to communities in a transparent manner that builds community confidence and trust in the monitoring process.
- Participation in regular community forums with government and other industry participants to discuss industry issues. Responsibility for the design and leadership of these forums may rest with government and peak bodies, however to be successful they will require the participation of industry at a senior level.
- The implementation of a Grievance Management Program, including community access to an independent advocate if necessary.
- The need for monitoring of community and visitor sentiment on a structured basis to ensure that the views of all sectors are heard and considered.
- The development and implementation of a workforce cultural awareness program and a workforce code of conduct to contribute to ongoing positive and supportive community relations.
- The development and implementation, in consultation with government, of local content policies and programs to maximise opportunity for Northern Territory business input and development.

Workforce and housing

The management of potential housing issues needs considerable care to ensure that housing market distortions are avoided. Local planning needs to be based on realistic long-term employment levels. Factors to consider when developing local workforce recruitment and housing strategies include:

- The need to develop and implement a Workforce Accommodation Strategy with Local Government, with a view to integration with local procurement and logistics support strategies.
- The need for compliance with the Local Government planning scheme if considering the development of accommodation initiatives in urban areas.
- The need for ongoing monitoring of rental housing supply and vacancy levels to identify project-induced demand.
- The merits of implementing a rental support program for periods of high rental housing demand to ensure that low-income people are not priced out of the rental market.

Traffic

Project traffic management plans are generally effective in managing risks involved in the transport of personnel and materials required to develop projects provided that they:

- Identify risks to be managed on low-traffic local roads utilised by local community members.
- Ensure that there is a high level of traffic awareness and safe driver-behaviour requirements imparted to local community members.
- Provide for the training of project drivers and the monitoring and policing of driver behaviour.

Opportunities to enhance social values

The development of unconventional gas extraction in the Beetaloo sub-basin is expected to be gradual under the conceptual development scenario. A number of opportunities for the enhancement of social values, both in urban as well as rural communities, are likely under this scenario. These could include:

- The development of an increased capacity in logistics operations, and the establishment of an unconventional gas industry support base, initially in Katherine but potentially in other towns such as Tennant Creek if favourable conditions eventuate. This would lead to increased employment, training and a broadening of the skills base of the local workforce, and potentially a modest population increase should workers see Katherine or Tennant Creek as a desirable place to live.
- An opportunity, through local procurement of inputs for gas field development, to diversify the economic base of regional support towns through the attraction of new business ventures and the expansion of existing business ventures in construction, mechanical maintenance and industrial supplies.
- Collaboration between industry proponents may also provide an opportunity to establish regional support facilities, such as a worker accommodation village or an upgraded airstrip to handle FIFO transport, in proximity to a rural location (such as Daly Waters) where the opportunity for multi-use of the facility (such as for tourist accommodation) may expand and strengthen the economic base of the town.
- An opportunity, through gas industry supported activity, to deliver training and employment opportunity to residents of Aboriginal communities in the areas surrounding the Beetaloo sub-basin, building on employment and training activity that has been implemented as part of exploration work (undertaken by Pangaea and Origin Energy). This opportunity need not rely solely on the existence of Aboriginal Land Use Agreements (ILUAs) with TO groups, but be a product of a direct government policy to deliver benefits to rural communities. It must also be recognised that the poor housing conditions, in particular over-crowding, in remote communities is a particular barrier to employment retention and the ability to be fit-for-work at the commencement of a roster for community-based employees.
- Community input to gas field development plans provide an opportunity to plan infrastructure development such that communities may benefit (e.g., through improved access to particular sites of importance), as landholders could use gas field infrastructure to benefit property operations.
- Community involvement in regional environmental monitoring associated with industry development, through participation by natural resource management groups and Aboriginal ranger groups who already have demonstrated capacity. As well as providing employment opportunities, this could also act to increase community confidence in the transparency of company environmental management and monitoring programs.

The ability to capture these opportunities will require a collaborative approach to industry development by the Northern Territory Government, project proponents and representatives of the community, which aligns with the industry development approach outlined in the Northern Territory Government's Economic Development Framework[1] released on 20 June 2017. It would also be expected that initiatives aimed at enhancing community capacity to take advantage of opportunities that may be available through industry development would be developed and implemented during the strategic assessment phase, as recommended in the SIA Framework report (CSRM, 2017).

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[1] See https://edf.nt.gov.au/growth-sectors/energy-and-minerals

Issues to be considered in implementing the SIA Framework

CSRM (2017) identified leading practice SIA as comprising:

- Strategic, adaptive approach throughout lifecycle of development that addresses cumulative impacts.
- Communication, coordination and collaboration between industry participants.
- Independently-led, participatory social baseline assessment.
- Independently-led community engagement.
- Participatory, ongoing monitoring of social indicators and transparent reporting of results.

The SIA case study found that Aboriginal and other community members were highly sensitised to the potential impacts of an unconventional gas industry, particularly bio-physical impacts on surface water and groundwater, and impacts on their communities and values. Their concerns arise, in part, from a lack of detailed information about the potential unconventional gas industry and actual project proposals.

The Panel noted in its Interim Report (Inquiry, 2017b) that '*current knowledge by the Aboriginal community is inadequate, and as a consequence, this points to an emerging social risk with Aboriginal people becoming enmeshed in conflict between pro and anti-fracking groups'*. This was evident in the consultation undertaken for the SIA case study, where some Aboriginal communities expressed concerns that they were only getting one side of the story – from opponents to an unconventional gas industry – and not facts from technical experts who were not biased.

Engagement with Aboriginal communities must adopt a structured approach that incorporates the following activities:

- **Preparatory meeting(s)** (as done in the second consultation round) that identifies the Aboriginal community members who should be consulted, their needs to participate in the consultation, the issues to be discussed, and appropriate dates and times for the meeting(s).
- **Social values meetings** during which the Aboriginal communities' social values are identified and documented. Sufficient time must be allowed for the complex issues relating to Aboriginal communities to be explored and understood.
- **Awareness meeting(s)** in which the Aboriginal communities are provided with information about unconventional gas development in sufficient detail to enable them to understand how development activities relate to, and might impact on their communities and their values. This engagement should include discussion of what is, and is not negotiable with respect to engineering and technical aspects of unconventional gas development.
- **Project-specific meetings** in which Aboriginal communities are presented with a development proposal and detailed information about its environmental and social impacts. This engagement should allow sufficient opportunity and time for community members to have input to the development concept and management of its impacts.
- **Implementation meetings** in which Aboriginal communities are invited to participate in environmental review or other similar committees that provide ongoing forums for managing project-community relations, monitoring of environmental and social impacts, and implementation of environmental and social programs.

This framework, with refinement, will be equally effective with pastoral and regional service centre communities, noting that preparatory meetings may not be required where the stakeholder groups are well-known and accessible. Pastoralist interests must be considered in conjunction with the broader land management priorities and requirements of the Northern Territory Government due to the nature of their tenure.

Project proponents must have a relationship with the communities in which they operate or who they may affect. The relationship will be most successful where it is developed over time through the staged approach outlined above. The conduct of community engagement must therefore balance the need for independently-led consultation (to build confidence in the process and veracity of data) with company ownership of the relationship (to build credibility, a working relationship and ensure accountability). To be effective, community engagement must incorporate the project proponent, engineering and technical experts, community members and their representative bodies, and independent stakeholder engagement consultants.

Conclusion

Despite heightened sensitivity to the impacts of unconventional gas development due to a concerted campaign by opponents of industry development, information provided to communities in the second round of consultation was well received, confirming that awareness and education are key factors in working towards a ‘social licence to operate’.

Significant disparity exists between the regional service centres and remote Aboriginal communities due to their remoteness affecting access to services, their poor state of housing, limited access to a functioning labour market, and differences in health and education status. A key issue will be how affected communities realise opportunities from unconventional gas development when they are expected to be distant from the projects (and the impacts).

Affected communities’ key concerns are impacts on surface water and groundwater resources and the distribution of benefits. Concerns about water resources are likely heightened by the PFAS contamination in and around RAAF Base Tindal near Katherine and incorrect assumptions about water management based on coal seam gas development in Queensland. Community cohesion and wellbeing underlie Aboriginal community concerns about the equitable distribution of benefits.

Experience and lessons learned in unconventional gas development in other jurisdictions will enable identified threats and impacts to be managed using proven methods and strategies.

The SIA Framework and CSIRO’s guidelines for achieving a ‘social licence to operate’ will assist in overcoming community perceptions that an unconventional shale gas industry is:

- Short-term and cyclical in nature.
- Similar to the coal seam gas industry in Queensland, with similar impacts.
- Aloof to community concerns and has disregard for the social outcomes of development.

The strategic approach to compiling a social baseline proposed by CSRM (2017) will assist in identifying and managing cumulative impacts on the geographically dispersed and diverse communities.

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1. Introduction

The independent scientific panel (the Panel) undertaking the Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs and Associated Activities in the Northern Territory (the Inquiry) identified risks associated with hydraulic fracturing in its Background and Issues Paper (Inquiry, 2017a). They are: water, land, air, public health, impacts on Aboriginal people and their culture, social impacts, economic impacts, land access, and the regulatory framework. The Panel is required by its Terms of Reference to:

1. determine and assess the impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the associated activities;
2. determine whether additional work or research is required to make that determination;
3. for each risk that is identified, advise the level of impact or risk that is acceptable in the Northern Territory context;
4. describe the methods, standards or strategies that can be used to reduce the impact and risk to acceptable levels;
5. identify what government can do, including implementing any policy, regulatory or legislative changes, to ensure that the impacts and risks are reduced to the required levels; and
6. identify priority areas for 'no go' zones.

The Panel commissioned a two-part scope of work (Appendix B) to assist its deliberations on the social impacts of an unconventional gas industry in the Northern Territory. The scope of work comprised:

Part A Social Impact Assessment

- Develop a leading practice framework for the identification, assessment and management of the social impacts associated with the development of onshore unconventional gas in the Northern Territory.
- Undertake a high-level social impact assessment (SIA) that describes 'the type of potential social impacts, issues, concerns, risks and benefits that may arise from the development of the unconventional gas industry in the Beetaloo sub-basin on the Affected Communities'.

Part B Social Licence to Operate

- Describe and assess the concept, elements and issues surrounding a 'social licence to operate' (SLO), as it applies to the onshore unconventional gas industry in the Northern Territory.

1.1. Purpose of the case study

The preparation of a high-level SIA case study (SIA case study) aims to provide information that will assist the Panel to:

- Identify and assess the potential impacts on affected communities of an indicative scenario for development of an unconventional gas industry, including their likely significance and ability to be managed.
- Identify key issues to guide the approach to any future project-level SIA for inclusion in the SIA Framework methodology.

1.2. Purpose of this report

The Centre for Social Responsibility in Mining (CSRM) of the University of Queensland has proposed a leading practice SIA Framework (CSRM, 2017) for future development of an unconventional gas industry in the Northern Territory.

The SIA Framework proposes project-level SIA are guided by a strategic assessment informed by sub-basin wide baseline studies and monitoring programs. In the absence of sub-basin wide baseline studies and a strategic assessment, the SIA case study is a high-level project-level SIA of a conceptual development scenario.

This report documents the approach to and outcomes of the SIA case study of a conceptual unconventional gas development in the Beetaloo sub-basin using relevant aspects of the SIA Framework proposed by CSRM (2017).

2. Social impact assessment method

CSRM (2017) has proposed a leading practice SIA Framework for future development of an unconventional gas industry in the Northern Territory.

The key recommendations are strategic environmental (and social) impact assessment informed by project-independent baseline studies that are based on an adaptive participatory management approach. The strategic assessment would provide the framework for project-level assessments with project-level monitoring providing information to facilitate review and update of the strategic assessment.

CSRM identified the phases of SIA within an adaptive participatory management approach in Figure 2 of CSRM (2017) which is presented below as Figure 2.1.

The SIA case study is a discrete high-level assessment of a conceptual development and is therefore unable to implement the adaptive participatory management approach identified by CSRM (2017).

CSRM identified the phases and activities of SIA in Figure 1 of CSRM (2017) which are presented below as Figure 2.2.

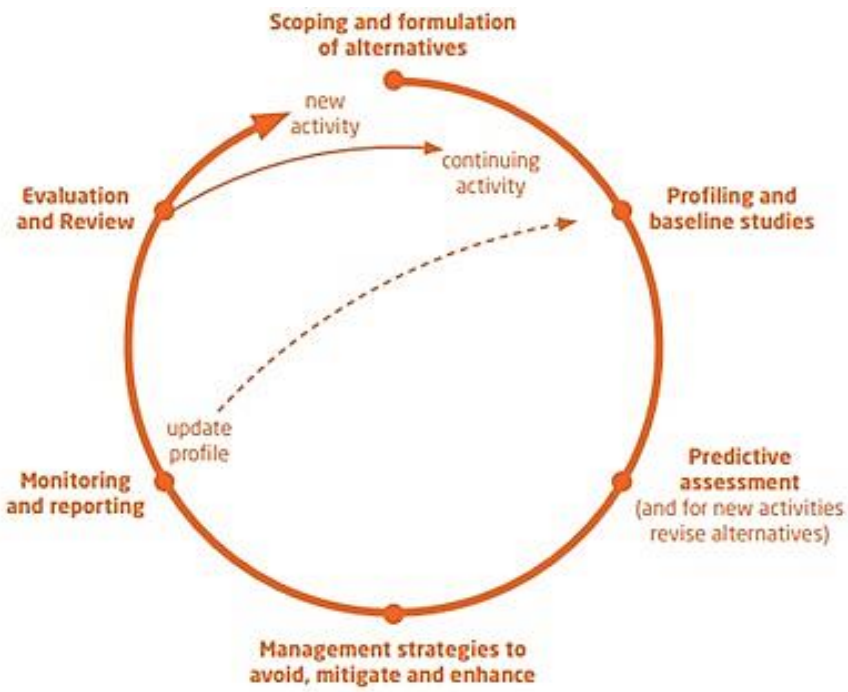


Figure 2.1 **The phases of SIA within an adaptive participatory management approach (CSRM, 2017)**

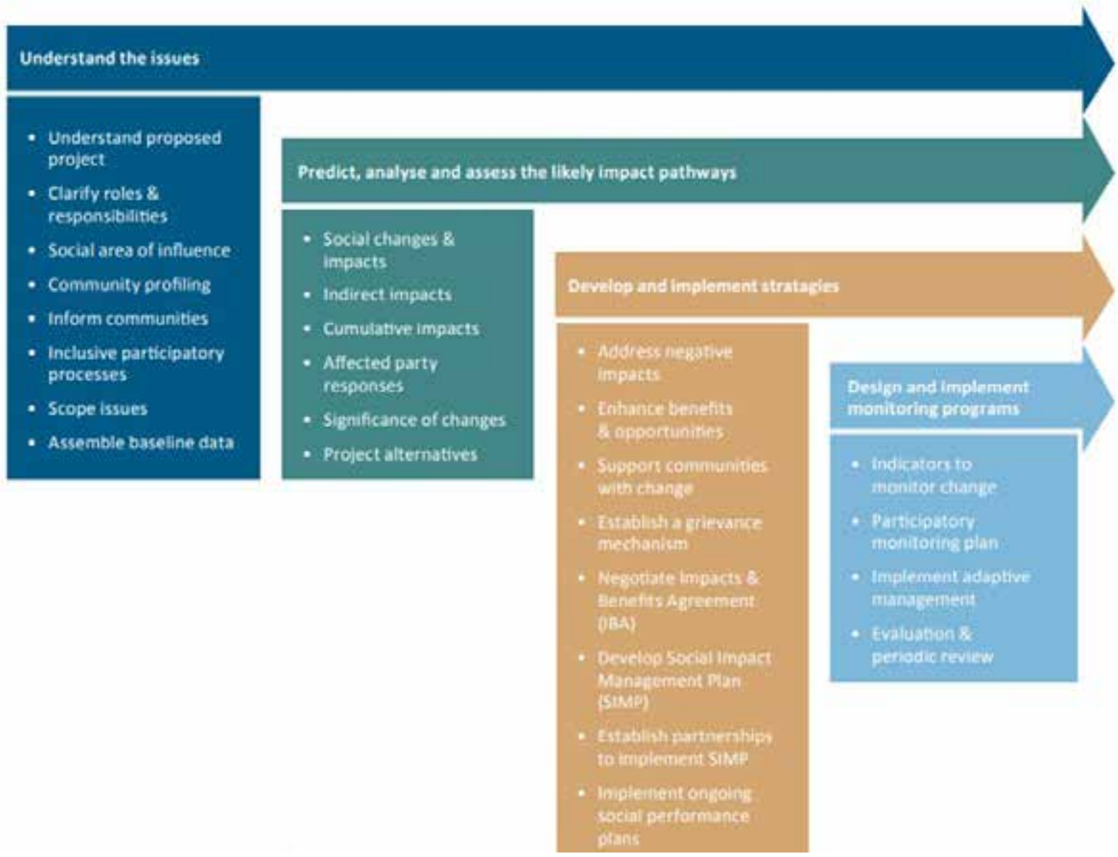


Figure 2.2 **The phases and activities of SIA (CSRM, 2017)**

A project-level SIA would typically take several years and involve extensive community and stakeholder engagement to understand social values, identify and explain potential impacts, and develop, explain, refine and reach agreement on appropriate responses, management measures and initiatives. This is not possible for the SIA case study which was conducted over a period of six months. The approaches identified in figures 2.1 and 2.2 were revised for the purposes of the SIA case study. The SIA case study was conducted in three stages. The relationship between this approach and those proposed by CSRM (2017) is set out in Table 2.1.

Table 2.1 Relationship of adopted and proposed SIA methods

Adaptive participatory management approach (CSRM)	SIA phases and activities (CSRM)	Beetaloo sub-basin SIA case study
Scoping and formulation of alternatives	Understand the issues	Conceptual development project description
Profiling and baseline studies		Compile social baseline
Predictive assessment	Predict, analyse and assess the likely impact pathways	Identify and assess threats and potential impacts to social values
Management strategies to avoid, manage and enhance	Development and implement strategies	Propose mitigation and identify opportunities for enhancing social values
Monitoring and reporting	Design and implement monitoring programs	Not applicable for case study
Evaluation and review		

The three stages adopted for the Beetaloo sub-basin SIA case study are:

1. Compile social baseline:
   - Identify affected communities based on conceptual development.
   - Compile social profiles on affected communities.
   - Define social catchments based on affected community profiles.
   - Identify social values held by communities and social indicators.
2. Identify and assess threats and potential impacts to social values:
   - Identify and describe threats to social values.
   - Assess risk of threats (and impacts on social values).
   - Describe impacts on social values.
3. Propose mitigation and identify opportunities for enhancing social values:
   - Propose strategies and measures for managing the identified impacts.
   - Identify and describe opportunities for enhancing social values.

The approach taken to each of these stages is described in the following sections.

2.1. Compile social baseline (Stage 1)

Affected communities were defined by the Panel as including community members, pastoralists, Aboriginal organisations and local businesses. Section 2.1.2 describes how the affected communities were identified. Section 2.1.2 describes how the affected communities' values were identified and

Section 2.1.3 describes the communities and stakeholders consulted to confirm the social values and understand potential social and economic impacts of unconventional gas development. Social profiles for a representative sample of the affected communities are presented in Appendix A.

2.1.1. Identify affected communities and define social catchments

Appendix A provides a detailed description of the rationale for categorisation of 'affected communities' which were grouped into social catchments, and the development of social profiles through a structured approach to assembling and assessing existing quantitative and qualitative information. The SIA case study identified four clusters (or social catchments) of 'affected communities' based on the following factors:

- **Location and community links**: Centres with a population level that may indicate some potential for providing 'local employment' should sub-basin development proceed. Generally these communities are located outside of, but in proximity to, the Beetaloo sub-basin. Consideration of potential physical and cultural links are also important factors influencing grouping and the potential to experience shared perceptions of impact.
- **Logistics or support industry potential**: It is assumed that the development of an unconventional gas industry would require at least a moderate level of logistical and maintenance support. This could be a purpose-built area within gas field or a facility located in the existing large towns north and south of the sub-basin that currently support industrial activity, for example Katherine, which currently provides support to the mining industry and RAAF Base Tindal and/or Tennant Creek, which provides support to the mining industry.
- **Dominant economic activity**: Pastoral operations constitute the principal economic activity within the Beetaloo sub-basin, with the Stuart Highway and to a lesser extent the Carpentaria Highway facilitating economic activity associated with tourism.

The four social catchments containing the affected communities (see Appendix A) are:

- Affected communities (urban): Katherine (town) and Tennant Creek.
- Affected communities (north): Barunga, Beswick, Mataranka, Jilkminggan, Minyerri and Ngukurr.
- Affected communities (central): Larrimah, Daly Waters, Dunmarra, Newcastle Waters and Elliott.
- Affected communities (east): Borroloola and Robinson River.

2.1.2. Identify social values

CSRM (2017) recommends using the community capitals framework (CCF) to understand baseline conditions and aspirations in affected communities. While this method is useful where there is a substantial body of secondary data to draw upon, experience in consultations with affected communities in rural areas has shown that dialogue with local people in relation to conditions and aspirations is enhanced when the discussion has centered on values, rather than capitals.

A social value is regarded as a quality of the area, potentially subject to project effects, for which community members have high regard, and that is conducive to individual or community well-being into the future. Community members generally consider and aggregate a number of community capital attributes and indicators when describing the status of a social value.

Diverse community interests require an approach that is understandable to the average community member, is capable of capturing their expressed needs, concerns and aspirations (integrating the various dimensions of their livelihoods) and promoting dialogue around the inevitable ‘trade-offs’ involved in seeking the betterment of life for individuals and the community.

Experience in other jurisdictions and in Aboriginal communities in the Northern Territory has found that the following four indicative social values are core values held by people in regional and remote communities:

- SV1 Liveable community.
- SV2 Affordable lifestyle.
- SV3 Community identity and spirit.
- SV4 Capacity for sustainable economic activity.

These values encapsulate the community capitals (CSRM, 2017) and the ‘values’ set out in IAIA’s International Principles of Social Impact Assessment (IAIA, 2003). The indicative social values guided interviews and engagement with local communities.

Their use supports a dialogue that becomes progressively broader when discussing the characteristics or indicators of the values with community members. Table 2.2 shows how these social values capture relevant information about the community capitals put forward in the SIA Framework, while Table 2.3 and Table 2.4 list key stakeholders expected to subscribe to or hold those values strongly, and tentative respective indicators of the values for urban and rural communities. In a participative baseline assessment process, dialogue with stakeholders and communities would refine the list of indicators, and identify the relevant importance of the social values.

The scope of work made specific reference to the list of values put forward by the International Association for Impact Assessment (IAIA). While all of these values have an overlap or relevance to the social values adopted for this case study, Table 2.5 indicates where the IAIA value may have a higher level of relevance to the case study social value.

Urban communities (Katherine and Tennant Creek) are townships with identifiable residential areas and business centres. Rural communities in this instance include Aboriginal communities and small open townships generally administered by a Regional Council.

Secondary baseline information and information and opinion sourced during community consultation was assessed to describe the characteristics of broad social values in communities, and the robustness or vulnerability of these social values to project-induced change. Community consultation also endeavored to elicit stakeholder receptivity and attitudes toward the development scenario proposed.

Table 2.2 Community capital relevance to social values

Social value	Community capitals							
	Natural	Social	Human	Cultural	Political	Financial	Built	Institutional
SV1 Liveable community	✓	✓			✓		✓	✓
SV2 Affordable lifestyle						✓	✓	✓
SV3 Community identity and spirit	✓	✓	✓	✓	✓	✓	✓	✓
SV4 Capacity for sustainable economic activity	✓	✓	✓	✓	✓	✓	✓	✓

Table 2.3 Urban community indicative social values

Social value	Key stakeholder	Possible indicators
SV1 Liveable community	• Community members • Local Government • Service providers (e.g. health, education, police, emergency services etc) • Civic organisations (e.g. service organisations, local community groups)	• Access to, and proximity of, quality services (health, education, aged care, childcare, retail etc) • Balanced demographic profile • Harmonious relationships, lack of conflict • Respect for law by community members • Adequate infrastructure that is well-maintained (housing, roads, airport, power, water & sewerage, telephone, internet) • Effective local governance • Opportunity for recreational, cultural and sporting pursuits • Safe social and physical environment
SV2 Affordable lifestyle	• Community members • Local Government • Business sector	• Cost of land and housing • Local Government charges • Income levels • Cost of food, power and other essential items
SV3 Community identity and spirit	• Community members • Community organisations (including churches and non-government organisations) • Local Government	• Level of volunteering and availability of assistance • Local celebrations • Recognition, preservation and promotion of heritage • Capacity to accommodate visitors • Perceptions of being able to influence community destiny • Employment share by industry
SV4 Capacity for sustainable economic activity	• Retail businesses • Service industries • Agricultural producers • Recreational and tourism businesses (including accommodation providers) • Producer organisations (e.g. NT Cattleman's Association; NT Tourism) • Regional development organisations • Local Government	• Viability, vitality and diversity of local industry • Workforce participation and employment • Job creation and retention of young people • Supportive business environment (e.g. availability of serviced industrial land, adequate zoning, provision of information on opportunities) • On-going environmental integrity (e.g. surface and groundwater, land degradation) • Willingness of business to invest

Table 2.4 Rural community indicative social values

Social value	Key stakeholder	Possible indicators
SV1 Liveable community	• Community elders and members, in particular women • Aboriginal organisations providing services • Local Government • Mainstream service providers (e.g. health, education, police, emergency services etc)	• Proximity and access to traditional country • Degree of satisfaction with management of traditional country • Respectful and harmonious relationships within and between communities (both Aboriginal and non-Aboriginal) • Access to service delivery (in particular health and education) that acknowledges and respects culture • Ability for extended family residence • Respect for law by community members • Adequate infrastructure that is well-maintained (roads, airport, power, water & sewerage, telephone, internet) • Effective local governance • Opportunity for recreational, cultural and sporting pursuits • Safe social and physical environment
SV2 Affordable lifestyle	• Community elders and members, in particular women • Aboriginal organisations providing services • Local Government • NT and Commonwealth Government	• Availability of adequate housing • Cost of housing • Income levels • Cost of food, power and other essential items
SV3 Community identity and spirit	• Community elders, members and affiliates • Aboriginal organisations • Local Government • Community organisations	• Recognition and promotion of cultural heritage • Perceptions of being able to influence community destiny • Existence of viable enterprise activity • Number and strength of Aboriginal organisations • Status of reconciliation with non-Aboriginal community • Level of volunteering and availability of assistance • Local celebrations
SV4 Capacity for sustainable economic activity	• Community elders and members • Aboriginal enterprises and organisations • NT and Commonwealth Government • Training providers	• Availability of employment opportunities • Aboriginal workforce participation and employment • Aboriginal business start-ups and ownership • Level of education achievement, including retention to Year 12 and post-school destinations

Table 2.5 Mapping of relevance of IAIA values to social values adopted for the Beetaloo sub-basin SIA case study

	IAIA value							
Adopted Social Value	**Way of life**	**Culture**	**Community**	**Political systems**	**Relationship to environment**	**Health and well-being**	**Personal and property rights**	**Fears and aspirations**
SV1 Livable community	✓✓✓	✓✓	✓✓✓	✓✓	✓✓	✓✓	✓	✓✓
SV2 Affordable lifestyle	✓	✓	✓✓	✓	✓✓	✓	✓✓	✓
SV3 Community identity and spirit	✓✓	✓✓✓	✓✓	✓✓✓	✓	✓✓✓	✓✓	✓✓✓
SV4 Capacity for sustainable economic activity	✓✓	✓	✓✓	✓	✓✓✓	✓	✓✓	✓

✓ ⇨ ✓✓✓ indicates increasing level of relevance

2.1.3. Stakeholder engagement

A targeted program of community consultation was undertaken to gain initial insights into the nature and status of social values (to consider whether this ‘values approach’ had merit for incorporation in the SIA Framework), and to assess community sentiment toward development (in relation to the potential impacts as well as opportunities that may manifest through industry activity).

Two rounds of consultation were done to inform the SIA. The first round comprised a semi-structured interview approach with individuals and small focus groups to establish an initial dialogue around baseline community attributes, the effects of implementation of the development scenario, social baseline research required for future project-level SIAs, and the concept of a Social Licence to Operate (SLO) as a measure of a community’s acceptance of the industry’s right to operate.

The second round of consultation comprised two meetings – a preparatory meeting and a consultation meeting to discuss the Beetaloo sub-basin case study. The preparatory meeting sought community advice on who should be consulted and an appropriate date and time, and explained what would be discussed. The consulted communities requested a list of questions/issues for which comment was sought. A list of questions was provided to the communities in advance of the consultation meeting. A formal presentation was prepared and given to the communities. It contained information about unconventional gas development, hydraulic fracturing and associated risks, potential impacts of unconventional gas development and the conceptual Beetaloo sub-basin development. A key focus of the consultation was providing communities with sufficient information to enable informed discussion of the social and economic issues and impacts associated with the conceptual development.

Consultation was undertaken with members of the following communities:

Affected communities (urban)

- Katherine
- Tennant Creek

Affected communities (north)

- Mataranka
- Minyerri
- Ngukurr

Affected communities (central)

- Elliott
- Daly Waters

Affected communities (east)

- Borroloola
- Robinson River

Northern Territory Government, local government, Beetaloo sub-basin exploration permit holders, primary producer and industry organisations, local businesses, community support organisations, and environmental groups were also consulted, including:

- Northern Territory Department of Business
- Northern Territory Environment Protection Authority
- Roper Gulf Regional Council
- Victoria Daly Regional Council
- Katherine Town Council
- Santos Limited
- Origin Energy
- Pangaea Resources
- APPEA
- Northern Territory Cattlemen's Association
- Katherine Mining Services Association
- Sunrise Health
- Katherine Landcare
- Northern Territory Environment Centre
- Lock the Gate
- Frack Free NT Alliance

In total, 69 engagement meetings were undertaken, as indicated in the Table 2.6 which categorises the stakeholders into key groups.

Table 2.6 Stakeholder consultation effort

Stakeholder category	No. of meetings	%
Government agencies and statutory authorities	7	10
Businesses and peak business organisations	11	16
Local Governments	6	9
Non-government organisations	6	9
Community organisations and residents	39	56

The key themes that emerged during consultation on the potential social and economic impacts of the conceptual development scenario substantially mirrored those that were evidenced during the Panel's public consultation. Analysis of the frequency of comments indicates a ranking of issues as shown in Figure 2.3.

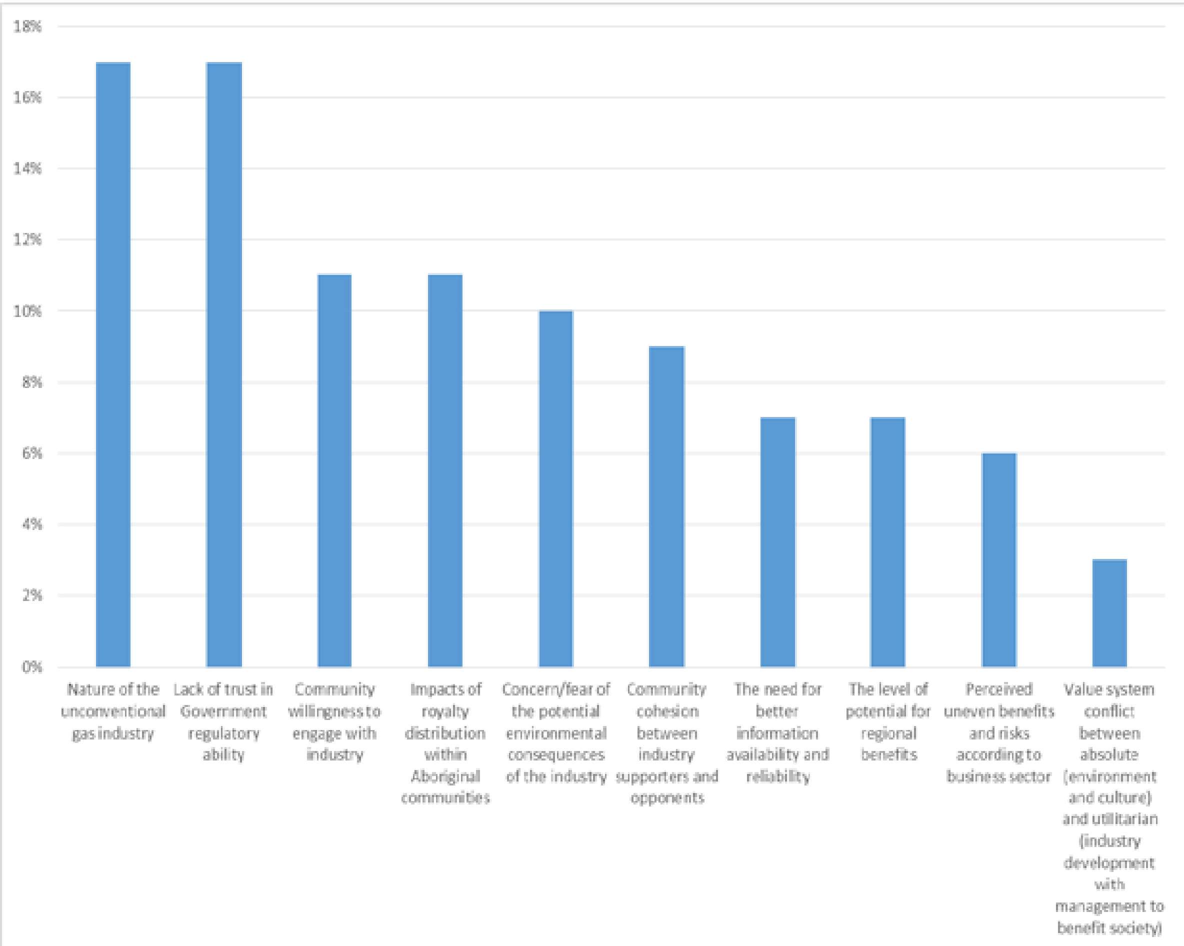


Figure 2.3 Ranking of issues expressed during stakeholder consultation

Factors contributing to the identification of these issues include:

- A perception that the resources industries are short-term rather than long-term, and cyclical in nature.
- Concern that the industry would dominate rather than co-exist with pastoralism and tourism.
- Assumptions about impacts drawing upon issues associated with the coal seam gas industry in Queensland.
- A view that industry was aloof from community concerns with a disregard for social outcomes of their operations.
- A perception that government regulators consistently place industry concerns above community concerns.
- Either a lack of interest or capacity for community to engage with industry.
- Negative observations of past distribution and expenditure of royalty income by some traditional owner (TO) groups.
- A high level of concern for the on-going integrity of groundwater sources, with the need for independent monitoring to ensure transparency.
- Awareness of past environmental issues in other jurisdictions through the activity of activists opposed to industry development.
- Minimal exposure to the views of, and dialogue with, technical experts, and concern that most information was only coming from groups opposed to industry development.
- An awareness of the occupational skills needed by the industry, and a perception that that would preclude a reasonable level of local industry involvement (and consequent community benefit).
- A belief in some quarters that measured consideration of the issues was not possible, with mainly the ‘loudest’ voices being heard and alternate views not being promoted.
- A belief that some industry sectors (e.g., construction and maintenance) would benefit at the expense of existing sectors (e.g., tourism services).

These views have been considered when assessing the significance of potential risks to social values.

2.2. Identify and assess potential impacts (Stage 2)

Team member’s knowledge of Northern Territory communities and of the typical activities involved in onshore unconventional gas development and operation were used in a brainstorming exercise to identify potential threats to social values and opportunities for enhancement of the identified social values.

This exercise considered the views of stakeholders expressed during consultation, the experience of impacts from other major development in the region, as well as the experience of projects in other environments with characteristics similar to the Beetaloo sub-basin communities. Potential threats to values and consequent impacts are shown in Table 2.7, with a description of the nature of threats presented in Table 2.8. Potential opportunities for benefits are discussed in Section 3.5.

The case study assumes a conceptual Beetaloo sub-basin development largely dependent on a skilled workforce sourced from outside the area and residing in project-supplied accommodation, which has medical and recreational facilities and services. Impacts on health services, education and as a result of crime in sub-basin communities are unlikely as a result of this development scenario and are not considered further in the SIA. These particular risks will not always be absent, as their existence will depend on the particular nature of the projects that advance to development.

Following the identification of threats to social values, the likelihood of the threat occurring and its consequence on the values were determined using risk assessment based on AS/NZS 31000:2009 Risk management – Principles and guidelines. Likelihood and consequence criteria used in the assessment are listed in Table 2.9 and Table 2.10 respectively, with the risk matrix shown in Table 2.11.

Table 2.7 Identified Beetaloo sub-basin community values, threats and potential impacts

Social value	Threat or impact driver (ID)	Potential impact
SV1 Liveable community	ID1A Rapid workforce influx to urban areas	Impaired community amenity
	ID1B Increase in heavy vehicle traffic on local roads	Reduced amenity, road accidents and increased vehicle maintenance costs
	ID1C Conflict between supporters and opponents of unconventional gas industry development	Conflict between community members
	ID1D Receipt of royalties by a subset of community members	Conflict between community members
	ID1E Concern over potential risk to groundwater quality	Anxiety about availability, access to and quality of water resources
SV2 Affordable lifestyle	ID2A Housing supply unable to meet spike in demand	Decreased housing availability and affordability
	ID2B Increased short-term rental costs	Decreased housing availability and affordability
SV2 Affordable lifestyle	ID3A Significant change in land use and industry development	Loss of ‘outback’ identity
	ID3B Perception of industry development heralding an era of ‘industrialisation’ of the landscape	Loss of ‘outback’ identity
	ID3C Perception that industry development approval is against majority community wishes	Decreased community engagement with local governance
	ID3D Concern with increased access to, and development risks on traditional country	Increased sense of cultural loss
SV4 Capacity for sustainable economic activity	ID4A Concern that long-term access to quality groundwater may be restricted due to industry development	Decreased investment in pastoral and horticultural enterprises
	ID4B Perception that ‘outback’ identity is compromised by ‘major industrialisation’ of the region	Decrease in tourist visitation
	ID4C Higher gas industry wage rates available to local residents drives competition for employees	Increased cost of labour for local businesses
	ID4D Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Local business closures

Table 2.8 Threat description

Threat (impact driver)	Description
SV1 Liveable community	
ID1A Rapid workforce influx to urban areas	The early construction phase of projects in rural areas is often characterised by a rapid workforce influx into urban areas of regional service townships. The size of this influx tends to decrease over time as construction accommodation camps are established closer to the building sites in the gas fields. In the early stages it can lead to effects such as a restriction on the availability of rooms in visitor accommodation, increased traffic on local streets, increased 'visibility' of industry workers in local venues, and local resident disturbance due to unfamiliar work hours (e.g., the early morning 'reverse warning beeper' issue in residential areas).
ID1B Increase in heavy vehicle traffic on local roads	Increases in the level of heavy vehicle traffic, on highways and through township areas, may impair amenity through the generation of noise and dust, as well as increase the number of traffic incidents leading to perceptions of compromised road safety. These perceptions will be reinforced should any need for increased road maintenance not be met in a timely manner.
ID1C Conflict between supporters and opponents of unconventional gas industry development	Polarised communities, characterised by strong feelings for and against industry development, subject to the influence of external advocacy groups, and where livelihoods are at stake, may be at increased risk of conflict between members. This could lead to avoidance behaviour between opposing groups, and potentially conflict in venues such as schools and sporting events. The effects may be felt particularly in smaller communities.
ID1D Receipt of royalties by a sub-set of community members	Within Aboriginal communities, the receipt of royalties by traditional owners can lead to increased tension, particularly if it results from an activity that does not have widespread support, and if the behaviour of recipients is not in accord with community norms (emphasising community rather than personal benefit).
ID1E Concern over potential risk to groundwater quality	Reliance on groundwater for domestic and agricultural use is widespread in the Northern Territory, and any activity that may potentially impair the quality or quantity of the resource is likely to evoke a high level of concern in communities, both urban and rural. This effect has been demonstrated through the community response to groundwater contamination with PFAS in the vicinity of Defence Force bases. This concern has the potential to influence water use behaviour (such as opting to consume bottled water only) that may compromise community liveability.
SV2 Affordable lifestyle	
ID2A Housing supply unable to meet spike in demand	A decision to base a workforce residentially (in lieu of a fly-in fly-out (FIFO) arrangement) may result in a spike in demand for housing. A lag in supply (either due to the rate of construction or a shortage of serviced land) to meet this increased demand may result in price rises in the short to medium term limiting the availability and inhibiting the affordability of housing for lower income local community members.
ID2B Increased short-term rental costs	A decision to implement a residential operation rather than FIFO may also increase demand for rental accommodation that may also result in increased costs in the absence of adequate supply. These increased costs may not be affordable to persons on lower incomes.
SV3 Community identity and spirit	
ID3A Significant change in land use and industry development	Extensive change in land-use may result in a change to community self-identification, which could have an effect on community spirit until the change is socialised or accepted. As an example, the community of Katherine underwent a step-change in identity with the re-development of RAAF Base Tindal together with the development of the Katherine East residential area, resulting in a threefold increase in population since the mid-1980s.

Threat (impact driver)	Description
ID3B Perception of industry development heralding an era of 'industrialisation' of the landscape	Highly visible land-use change to residents traversing a project area, associated with a single or multiple projects, may support a perception that the landscape is being 'industrialised'. This type of perception, if strongly held or persistent, may contribute to a change in community identity that is not welcomed by either long-term residents or businesses that depend on a particular perception (e.g., outback spirit or land of the 'never never') for sale of their services (e.g., tourism operators).
ID3C Perception that industry development approval is against majority community wishes	Where communities have a majority strongly-held position on the desirability or otherwise of industry development, the issue of a government approval that is not in accord with the majority position may have an adverse effect on community spirit due to the fostering of feelings that community wishes are being ignored, and that community control of their destiny, in which they have a significant stake, is being weakened.
ID3D Concern with increased access to, and development risks on traditional country	Aboriginal people continue to exercise traditions connected to sites across the landscape, notwithstanding that many of these sites are contained within pastoral leasehold land. Increased access by machinery and the development of infrastructure required for a gas project is likely to promote concern that inadvertent interference or damage to sites does not occur and create or add to a sense of 'cultural loss'.
SV4 Capacity for sustainable economic activity	
ID4A Concern that long-term access to quality groundwater may be restricted due to industry development	As an essential industry input, any threat, real or perceived, to the long-term sustainability of groundwater supply (either in quality or quantity) may have a detrimental effect on pastoral or horticultural property owners willingness to invest due to the uncertainty created by unconventional gas industry development.
ID4B Perception that 'outback' identity is compromised by 'major industrialisation' of the region	The development of an unconventional gas industry may be interpreted as the commencement of regional 'industrialisation', detracting from the image of the Northern Territory as 'Outback Australia', which in turn may act as a disincentive for tourists to visit the region.
ID4C Higher gas industry wage rates available to local residents drives competition for employees	Local employees with appropriate skills may be attracted to work for gas development companies where wages are typically higher. This may result in local businesses having to offer higher wages to compete, potentially driving up the cost of services to local customers who may have limited ability to pass on costs.
ID4D Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Increased gas industry demand for goods and services may not be able to be met by smaller local businesses, or may act to attract larger businesses to establish in the area. These businesses may establish a permanent presence, or may withdraw following a high demand construction period, and may out-compete local businesses affecting their ability to survive and grow.

Table 2.9 Likelihood criteria

Likelihood	Description
Almost certain (common)	Very likely to occur or be an opportunity at either a specific stage of the project lifecycle or more broadly
Likely (has occurred in recent history)	Likely to occur or be an opportunity at either a specific stage of the project lifecycle or more broadly
Possible (could happen, has occurred in the past, but not common)	Possible to occur or be an opportunity at either a specific stage of the project lifecycle or more broadly
Unlikely (not likely or uncommon)	Unlikely to occur or be an opportunity at either a specific stage of the project lifecycle or more broadly
Remote (rare or practically impossible)	Very unlikely to occur or be an opportunity at either a specific stage of the project lifecycle or more broadly

Table 2.10 Consequence criteria

Consequence category	Description
Critical (severe, widespread long-term effect)	Irreversible changes to social values of communities of interest or community has no capacity to adapt and cope with change.
Major (widespread moderate to long-term effect)	Long-term recoverable changes to social values of communities of interest or community has limited capacity to adapt and cope with change. Long-term opportunities emanating from the project.
Moderate (localised, short-term to moderate effect)	Medium-term recoverable changes to social values of communities of interest or community has some capacity to adapt and cope with change. Medium-term opportunities emanating from the project.
Minor (localised short-term effect)	Short-term recoverable changes to social values of communities of interest or community has substantial capacity to adapt and cope with change. Short-term opportunities emanating from the project.
Negligible (minimal impact or no lasting effect)	Local, small scale, easily reversible change on social values of communities of interest or communities can easily adapt or cope with change. Local small-scale opportunities emanating from the project that the community can readily pursue and capitalise upon.

Table 2.11 Risk matrix

	Likelihood				
Consequence	Remote	Unlikely	Possible	Likely	Almost Certain
Critical	Medium	High	High	Very High	Very High
Major	Medium	Medium	High	High	Very High
Moderate	Low	Medium	Medium	Medium	High
Minor	Very Low	Low	Low	Medium	Medium
Negligible	Very Low	Very Low	Low	Low	Medium

2.3. Manage impacts and enhance opportunities (Stage 3)

The third stage of the approach considers how and to what extent potential impacts can be managed and how opportunities for enhancing social values may be realised, recognising that remote Aboriginal communities in particular often face significant barriers to workforce participation and the development of commercial enterprises. Strategies for managing impacts are presented in Section 5.3 and opportunities for enhancing social values in Section 5.4.

3. Socioeconomic context of Beetaloo sub-basin

The Beetaloo sub-basin is located between Katherine and Tennant Creek and covers an area of approximately 7,000 km^2 (Figure 3.1).

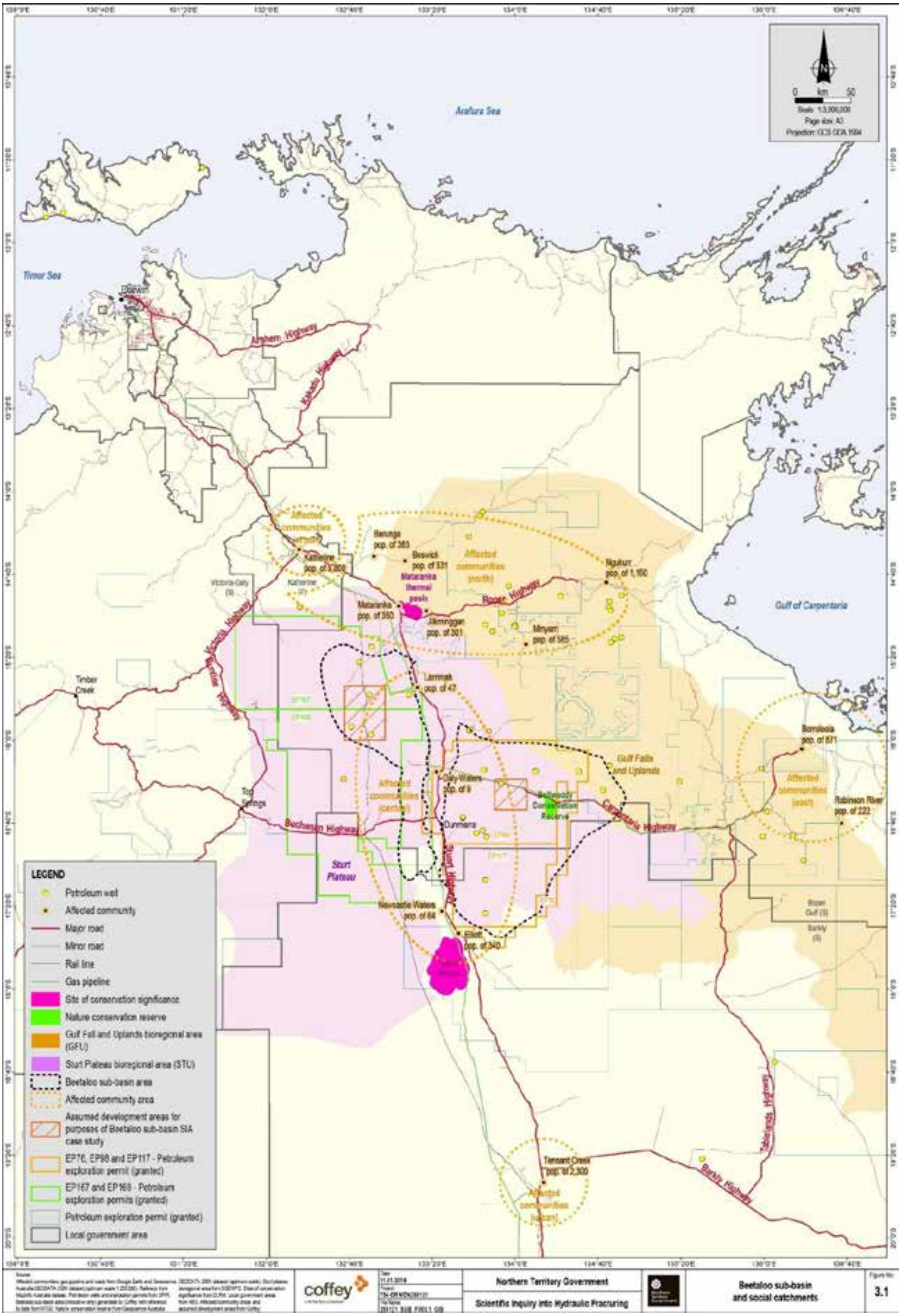
Land use in the Beetaloo sub-basin comprises Aboriginal land, pastoral leases, horticultural enterprises, oil and gas transmission infrastructure, a railway, and highway towns, cattle stations and remote Aboriginal communities. The Australian Defence Force operates RAAF Base Tindal located near Katherine.

The region is accessed by the Stuart, Roper and Carpentaria highways and community and station access roads. The Stuart Highway is a sealed dual-lane road. The Roper and Carpentaria highways comprise sealed and unsealed sections. All other roads and tracks are unsealed and may be subject to temporary closure during the wet season when rivers and creeks can flood. The Ghan Railway passes through the sub-basin, with The Ghan tourist train stopping at Katherine.

Larrimah, Daly Waters, Newcastle Waters and Elliott border or are located in the sub-basin. The adjacent towns and communities of Katherine, Mataranka, Minyerri, Ngukkur, Borroloola, Robinson River and Tennant Creek are located outside the sub-basin.

The Beetaloo sub-basin has been explored since the 1980s. Figure 6.2 of the Panel's Interim Report shows the extent of unconventional shale gas exploration in the Beetaloo sub-basin which has comprised hydraulically fractured and non-fractured wells.

Roper Gulf Regional Council is the local government authority for the northern part of the sub-basin. The southern part of the sub-basin is administered by the Barkly Regional Council, with Katherine administered by the Katherine Town Council. The Northern Land Council, an independent statutory authority established under the *Aboriginal Land Rights (Northern Territory) Act 1976* (Cwlth), represents Aboriginal communities within and adjacent to the sub-basin.



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The socioeconomic context for undertaking the SIA case study of the conceptual development in the Beetaloo sub-basin is characterised as follows:

- The Beetaloo sub-basin has seen almost no industrial development. Some affected communities have experience with development. For example, experience with mining development south of Ngukurr (iron ore) and at McArthur River (large-scale underground and open pit mining of lead and zinc). The installation of gas transmission and lateral pipelines through the sub-basin (Amadeus Basin to Darwin Pipeline in 1986; the Elliott Spur Pipeline in 1989, and the McArthur River Pipeline in 1995) that occurred 20 to 30 years ago is not readily recalled by community members. The current installation of the Northern Gas Pipeline from just north of Tennant Creek to Mount Isa is in an early stage of development, and a significant distance south of the Beetaloo sub-basin communities.
- Economic activity is centred on agriculture development (pastoral operations throughout the sub-basin, horticulture south of Katherine and along the Roper Highway) together with Defense activity at RAAF Base Tindal, and tourism activity mainly servicing self-drive visitors. Regional service townships (Katherine and Tennant Creek) are located outside the sub-basin.
- Obvious significant disparities in social status and living conditions between remote Aboriginal communities and regional service townships. This has a significant influence on the potential for community members to capture potential benefits from industry development should it occur.
- Community members have a reasonably high level of awareness (due to the activities of groups opposed to industry development) of historical issues surrounding the development of unconventional gas resources in other jurisdictions but not of the potential unconventional gas industry in the Northern Territory. The Inquiry's Interim Report (Inquiry, 2017b) acknowledged that levels of knowledge in Aboriginal communities about future development is inadequate.

4. Conceptual Beetaloo sub-basin development scenario

There are no firm development scenarios for the Beetaloo sub-basin. Several companies holding exploration permits in the area have expressed views on possible development pathways in their written submissions to the Inquiry. While there remain significant technical and commercial uncertainties to address prior to committing to development, for the purposes of the case study it has been assumed that initial development would occur to the west of Larrimah and to the east of Daly Waters, in the areas that have shown favourable exploration results, as shown in Figure 3.1. It is assumed the projects would be offset by three years.

ACIL Allen Consulting prepared a report, *The Economic Impacts of a Potential Shale Gas Development in the Northern Territory, Final Report to the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory*, October 2017 (ACIL Allen, 2017) that assesses the potential economic impacts of several development scenarios. The scenarios range from no shale gas production (baseline scenario) to accelerated production (shale gale scenario) under partial lifting of the moratorium on hydraulic fracturing and full lifting of the moratorium. The Shale WIND scenario assumes the moratorium is lifted and exploration and appraisal activities proceed, and lead to a moderate scale development. Based on industry submissions to the Inquiry this represents the most probable scenario if development was to occur and was adopted for the case study.

Using the information provided in ACIL Allen (2017) a number of assumptions were made regarding the scale and composition of the conceptual development. They are described in the following sections.

4.1. Conceptual development

The conceptual development assumes the moratorium on hydraulic fracturing will be fully lifted in 2018, allowing exploration, appraisal and pilot testing to proceed for a period of three to five years. Appraisal and pilot testing activities will confirm the technical and commercial parameters for development (e.g., gas availability and volume, cost of extraction, cost of gas processing, compression and transport, demand and wholesale price for gas, etc).

During the appraisal and pilot testing period environmental and planning approvals would be progressed with detailed design and construction of the gas fields and associated gas processing facilities commencing on receipt of territory and federal approvals. Shale gas production is assumed to occur for 25 years after which the production facilities and gas field infrastructure would be decommissioned. ACIL Allen's (2017) Shale WIND scenario assumes an approximately 260 well development.

It is assumed that each project area would require gas field access roads, production wells and gas gathering lines, a gas processing and compression facility, export pipeline connection to the Amadeus to Darwin Gas Pipeline, accommodation facilities and an airstrip for FIFO worker transport during the construction phase for major facilities, such as the gas processing and compression facility.

Table 4.1 lists the key parameters for the conceptual development scenario adopted for the SIA case study. An indicative development timeframe is presented in Figure 4.1.

Table 4.1 Indicative project scenario parameters

Element	Scale
Approximate number of wells drilled per annum	10
Maximum number of wells in operation	257 (in 2042)
Number of well pads (8 wells/pad)	32
Length of gas field roads	55 km (1.7 km for each pad)
Length of gathering pipes	32 km
Area of disturbance (for pads, roads, gathering pipes and camps)	10.9 square kilometres (1,090 ha)
Area of disturbance for pipelines (Armadeus tie-in 50 km; Armadeus duplication 300 km; Northern Gas Pipeline duplication 622 km). It is assumed that the pipeline duplications are on similar alignments to existing pipelines)	Approximately 116 square kilometres (11,600 ha)
Average level of employment for well pad construction and field operations (including camp operations x 2)	250 to 300 persons
Estimated indicative level of local employment	Darwin: 65 persons Katherine: 70 persons Regional Northern Territory: 25 persons
Logistics support facility in Katherine industrial area	5 to 10 persons

Figure 4.1 Indicative development timeframe

4.2. Transport and traffic

The most visible project activity for residents of rural communities will be transport to and from work sites. A number of assumptions were made regarding transport routes and traffic, as a detailed trip generation model is not available for the SIA case study.

The Stuart Highway will be used to access the gas fields in the Beetaloo sub-basin, most likely from the north but also from the south. The Carpentaria Highway will be used to access the eastern conceptual development. Regional roads such as Sunday Creek Road to the west of Larrimah and the Daly Waters to Cox River Road will be used to access the gas fields.

Heavy vehicles and light vehicles will be used to construct and operate the gas fields and gas processing and compression facilities. Heavy vehicle use will peak in construction when the major facilities are established. Light vehicles, buses and aircraft will be the predominant transport used in operation. Some heavy vehicle use will be required in operation to install new wells and maintain existing wells, and to service accommodation facilities and maintenance depots.

4.3. Workforce

The peak construction workforce is estimated at 450. The additional workers over that presented in Table 4.1 relate to the construction of gas processing and compression facilities.

The operation and maintenance workforce is estimated at 250. These workers will be engaged in drilling wells, installing gas gathering lines and constructing and maintaining civil works such as roads and well pads.

It is assumed that the workforce will use a combination of FIFO (from Darwin) and drive-in drive-out (DIDO) from Katherine and rural communities, and will stay in an accommodation facility while on shift. The accommodation facilities could be located close to a community near a transport hub (e.g., Daly Waters' airstrip) or collocated with gas processing and compression facility. The accommodation facilities will provide 24-hour medical facilities and support staff, as well as recreational facilities such as a swimming pool and gymnasium.

In order to consider local employment and population growth impacts, it has also been assumed that all gas processing and compression facility construction workers are non-local, with the Northern Territory-sourced workforce drawn from the communities shown in Table 4.2.

It is assumed approximately 70 persons would be locally sourced from the Katherine area, and that one third of these people (approximately 25) will have relocated to live in the area. This will result in a small population increase in the order of 80 persons (assuming 15 families of 4 persons and 10 couples with no children).

Table 4.2 Assumed workforce hire points

Workforce	Darwin sourced	Katherine sourced	Rural community sourced	Sourced in NT	Sourced outside NT
Pad construction (civil works, roads, etc)	50%	30%	20%	100%	-
Field operations (gas field technicians)	50%	50%	-	50%	50%
Camp operations (camp management, catering, accommodation support)	10%	50%	40%	100%	-
Annual average employment	65	70	25		

5. Social impact assessment

Unconventional gas development affects communities differently, with the differences relating to their capacity to absorb and adapt to the changes or impacts. Larger towns with more diverse communities and businesses have greater capacity than small and remote communities.

The SIA case study assessed the impacts of the conceptual development at two scales – the larger or urban communities and the small or rural communities, as follows:

- Urban communities comprises the Affected communities (Urban) catchment and the towns of Katherine and Tennant Creek.
- Rural communities comprises the Affected communities (North, Central and East) catchments and towns:
  - Affected communities (North): Barunga, Beswick, Mataranka, Jilkminggan, Minyerri and Ngukurr.
  - Affected communities (Central): Larrimah, Daly Waters, Dunmarra, Newcastle Waters and Elliott.
  - Affected communities (East): Borroloola and Robinson River.

This grouping is appropriate given the high-level assessment possible under the case study, where detailed information about specific communities is limited and extensive consultation over a period of years has not been possible.

5.1. Urban communities

A summary of the social values of urban communities is presented in this section along with an assessment of the potential threats to social values within those communities.

5.1.1. Social values

Table 5.1 summarises the social values identified for the urban communities of Katherine and Tennant Creek.

Table 5.1 Urban communities' social values

Social value	Indicator	Social value baseline summary
SV1 Liveable community	Access to, and proximity of, quality services (health, education, aged care, childcare, retail, etc) Balanced demographic profile Harmonious relationships, lack of conflict Respect for law by community members Adequate infrastructure that is well-maintained (housing, roads, airport, power, water and sewerage, telephone, internet) Effective local governance Opportunity for recreational, cultural and sporting pursuits Safe social and physical environment	Katherine town has a population of approximately 10,000. The Aboriginal population comprises approximately 28 per cent and migrates to and from the hinterland regions of Victoria-Daly and Roper-Gulf, while the non-Aboriginal residents tend to migrate to and from interstate (possibly heavily influenced by postings to RAAF Base Tindal). It is well-serviced by education facilities (five primary and two high schools), with adequate health facilities based at the Katherine Hospital (60 beds and 24-hour emergency) and Aboriginal health services (such as Sunrise Health and Katherine West Health) that support urban and rural clinics. There is a significant level of community services and residents have access to a broad range of community social and recreational groups. Infrastructure is adequate and well-maintained, and crime is generally not a major issue, though the itinerant nature of a segment of the population possibly contributes to higher levels of crime against persons and property from time to time. There are opportunities for sporting and recreational pursuits. Tennant Creek has a population of approximately 3,000 (2016 Census), indicating a slight contraction (2.2 %) from the 2011 Census counts, with a median age of 33. Aboriginal residents (51%) comprise the largest proportion of the younger age cohorts.
SV2 Affordable lifestyle	Cost of land and housing Local Government charges Income levels Cost of food, power and other essential items	The price of housing in Katherine and Tennant Creek is generally affordable, with 4% and 1.5% respectively of households with a mortgage where repayments are 30% or greater than household income, and with approximately 9% of households with rent payments greater than 30% of household income for both communities. House prices in Katherine appear to have peaked around the middle of 2015. Food prices at local supermarkets are in line with

Social value	Indicator	Social value baseline summary
		levels expected in remote areas where there is a significant freight impost.
SV3 Community identity and spirit	Level of volunteering and availability of assistance Local celebrations Recognition, preservation and promotion of heritage Capacity to accommodate visitors Perceptions of being able to influence community destiny Employment share by industry	Both Katherine and Tennant Creek have a strong sense of community identity. Katherine's identity is based around tourism and the nearby Katherine Gorge (Nitmuluk) landscape, as well as being seen as a vibrant regional centre providing pastoral and horticultural industry services and hosting a forward operational Defence base (RAAF Base Tindal). There are active arts and sports communities, with celebrations for NAIDOC Week and the nearby Barunga Festival in June each year. Tennant Creek has a long history of mining and a strong identification with large historic cattle stations on the extensive Mitchell grass plains of the Barkly Tablelands. There are an ongoing range of community events based on activities such as camp drafts and bush races, and the desert environment. Both Katherine and Tennant have volunteer rates, equivalent to the Northern territory average, at 17% and 16.8% respectively.
SV4 Capacity for sustainable economic activity	Viability, vitality and diversity of local industry Workforce participation and employment Job creation and retention of young people Supportive business environment (e.g. availability of serviced industrial land, adequate zoning, provision of information on opportunities) On-going environmental integrity (e.g. surface and groundwater, land degradation) Willingness of business to invest	Katherine has a developing and diverse economic base with vibrant sectors based on services to Defence, tourism, agriculture including horticulture, mining and logistics. Significant employment areas are public administration and safety, health care and social assistance and education and training reflecting the town's role as regional centre for public services. There is a supportive business environment with strong business development advocacy groups. Public investment (e.g., Defence) is strong and acts to even out the highs and lows of cyclical enterprises (e.g., mining). There is a seasonal labour market for tourism and pastoral enterprises, and some indication that there is a shortage of labour in the horticultural sector due to interest shown in Commonwealth Government supported guest worker schemes. With high numbers of people recorded as not in the labour force, this may indicate that further work could be done to strengthen links to the population in the hinterland areas. Attention would also need to be maintained on schooling performance, as the high school attendance rate appears to have dropped by 14% over the last three years. Key sectors of tourism, agriculture and horticulture depend on the confidence of operators in the integrity of the environment, and the ability for this to be monitored and measured. Principal industries serviced by Tennant Creek include mining, pastoralism and tourism. Important employment sectors are similar to Katherine, with public administration and safety showing a significant expansion in numbers over the last decade

5.1.2. Potential threats and their significance

Potential impacts to the identified social values are discussed in the following sections for each social value and threat (impact driver). The risk of the threats occurring and the associated consequences are assessed to provide an indication of the impacts that are likely to be significant should unconventional gas development proceed in a manner consistent with the conceptual development. The assessment is summarised in Table 5.2.

SV1 Liveable community

Impaired community amenity

ID1A Rapid workforce influx to urban areas

Given the location of the Beetaloo sub-basin project areas, a rapid influx of substantial numbers of workers to either Katherine or Tennant Creek is unlikely, though either community may be required to accommodate transiting workers, or any new workers associated with logistics support facilities that may be established there. Approximately 25 workers, with 55 dependents moving to Katherine is estimated. This may place some pressure on to existing accommodation providers, however there are well-developed measures that could be incorporated into a workforce accommodation strategy to mitigate any adverse effects.

Reduced amenity, road accidents and increased vehicle maintenance costs

ID1B Increase in heavy vehicle traffic on local roads

Should development of unconventional gas in the Beetaloo sub-basin occur it is certain that there will be an increase in the number of heavy vehicles on the Stuart Highway through Katherine if the logistics route is via Darwin. There may be some increase in traffic in Tennant Creek should a portion of supplies be sourced from southern states. While the increase in traffic (and associated noise and dust increases) is likely to be modest, there is some uncertainty in the absence of traffic models at this stage of development. The assessment of traffic for a redevelopment of the Mt Todd Gold Mine[2] provides some insights to transport and traffic impacts. The traffic study (2013) determined that there was substantial spare capacity in the road network, with the Stuart Highway operating at the highest Level of Service standard. The construction phase of the project was considered to possibly have 'short-term adverse effects through the addition of construction related traffic' which could appropriately be mitigated through the implementation of measures, such as a Traffic Management Plan'. The capacity of the Stuart Highway is expected to be sufficient to accommodate the conceptual development and infrastructure upgrades to accommodate gas development transport activity in urban areas would not be expected.

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[2] Vista Gold Australia Pty Ltd, Mt Todd Gold Project, Traffic and Transport Impact Assessment, GHD June 2013

Conflict between community members

ID1C Conflict between supporters and opponents of unconventional gas industry development

Development of an unconventional gas industry is a highly emotive issue in the Northern Territory, as evidenced by press reports of community concerns and positions expressed during stakeholder consultation. The likelihood of conflict is considered possible (as it has occurred in other jurisdictions) and the consequences could be moderate in smaller communities, leading to a weakening of social capital and negative perceptions of the community, as being a supportive and welcoming environment for both new and existing residents.

ID1D Receipt of royalties by a sub-set of community members

While Traditional Owners (TOs) may live in Katherine or Tennant Creek, and certainly use the centres for accessing services, there is unlikely to be a level of conflict or strained relationships that may affect liveability in townships of this size, unlike the potential situation in smaller remote communities.

Anxiety about availability, access to and quality of water resources

ID1E Concern over potential risk to groundwater quality

Regardless of the actual location of projects in the Beetaloo sub-basin, there is likely to be concern in urban areas in regard to future groundwater quantity and quality in the event of industry development, as the towns themselves, and the industry that they support, depend on groundwater to a significant extent. Evidence through stakeholder engagement and submissions to the Inquiry indicates a likelihood of almost certain and a consequence of moderate based on the perceived effects on industry, indicating a high risk rating. The distance of towns from the project areas and the ability to source further information through various methods (ranging from direct engagement with experts to use of the internet) warrants a consequence level of moderate rather than major.

SV2 Affordable lifestyle

Decreased housing availability and affordability

ID2A Housing supply unable to meet spike in demand

ID2B Increased short-term rental costs

While there could be expected to be some increase in demand for housing, the distance of the project areas from urban centres most likely will act to minimise the level and duration of any increased demand in the short term, and perhaps smooth demand over the longer term. Workforce sourcing assumptions indicate a relatively small population increase in Katherine. It is also the case that uncertainty surrounding industry development and its timing make it hard determine the likelihood of a market supply response to housing demand at this stage. There must be close collaboration between industry and Local Government in the development of a workforce accommodation strategy to ensure that decisions on housing investment account for a timeframe based on a sound understanding of workforce levels required during project development (construction) and operation and maintenance phases. There is a medium potential for impact of the affordability of urban lifestyles.

SV3 Community identity and spirit

Loss of ‘outback’ identity

ID3A Significant change in land use and industry development

ID3B Perception of industry development heralding an era of ‘industrialisation’ of the landscape

The involvement of urban communities in supporting unconventional gas industry development is likely to involve some level of workforce accommodation, and potentially the hosting of a logistics and support facility, both of which are within their existing capacity, and for which existing industry groups are working to attract. The location of these facilities, in existing relevantly zoned areas, is not likely to change the visible nature of the community, or convey impressions of heavy industrialisation of the landscape, as their appearance will be consistent with existing industrial support facilities. For these residents, travel on highways is also not likely to reveal landscape changes likely to evoke concern. Hence the significance of these potential changes on community identity is considered low.

Decreased community engagement with local governance

ID3C Perception that industry development approval is against majority community wishes

The highly sensitised nature of the community with respect to development of unconventional gas resources indicates that this perception is likely, with potentially moderate consequences where ‘community’ is seen to be a local entity rather than a more Territory-wide grouping. This may have a moderate effect on community identity and spirit where the ‘local’ community may see themselves as having impacts imposed on them for the sole benefit of the broader community. This sentiment was evident during a community consultation engagement where it was asserted that the remote communities were the only ones that ‘paid the price’.

Increased sense of cultural loss

ID3D Concern with increased access to, and development risks on, traditional country

While there will undoubtedly be some stakeholders in urban communities who identify strongly with maintaining the integrity of traditional country, the plural nature of the community and size of the Aboriginal population indicates that these concerns are unlikely to have a significant impact on the community identity and spirit of urban communities, particularly if development is remote from iconic natural areas and sites of historic or Aboriginal significance.

SV4 Capacity for sustainable economic activity

Decreased investment in pastoral and horticultural enterprises

ID4A Concern that long-term access to quality groundwater may be restricted due to industry development

This threat has widespread currency in the current environment, where there is a high level of uncertainty and lack of detailed knowledge of the broader nature of aquifers, and linkages in the groundwater system. The concern is exacerbated due to the ongoing investigation into PFAS contamination of groundwater in the Tindal/Katherine area. The limited information on the scope of potential development at this stage, and the awareness of the volumes of water required for the hydraulic fracturing process, promotes concerns about the long-term availability of water for pastoral and other agricultural purposes. The significance is assessed as moderate for residents of urban areas which service the pastoral and horticulture industry.

Decrease in tourist visitation

ID4B Perception that 'outback' identity is compromised by 'major industrialisation' of the region

Urban residents and visitors to Katherine in particular, are not likely to perceive the loss of 'outback' identity which is an integral component of the tourism experience. The significant development of mining operations in locations such as Broken Hill and north-west Queensland has not detracted from the 'outback experience', and the areas within the Beetaloo sub-basin proposed for development will have limited visibility to highway travellers. In time, the existence of unconventional gas industry operations may provide opportunity for enhancing the outback tourist experience, as happens in Roma in western Queensland. Hence the significance of this threat is considered low.

Increased cost of labour for local businesses

ID4C Higher gas industry wage rates available to local residents drives competition for employees

While this threat has been manifest in other gas development areas, it has been driven by the scale and rate of project development. Workers with specific gas industry skills will largely be drawn from other locations, and have remuneration determined by industry norms rather than by local conditions. Support workers in civil works occupations already largely work remotely from urban areas, and any shortages in labour supply are likely to be addressed through training programs as currently occurs. The significance of the threat is considered medium and amenable to capacity development programs.

Local business closures

ID4D Industry demand attracts external specialist enterprises to establish and draw business from local businesses

The manifestation of this threat is possible, dependent of the scale and timing of development. In the Surat Basin, Queensland there were instances of specialist suppliers of goods (such as safety equipment and tools) establishing in existing premises in local towns for the intensive construction phase, and then withdrawing once that phase (where there was a high level of procurement) was complete. That mode of operation was largely driven by the scale of the gas-field and infrastructure construction effort occurring at that time in the Surat Basin, where multiple projects proceeded concurrently. The potential impact significance is moderate in small remote towns, and should be recognised and addressed through the local procurement policies of project developers.

Table 5.2 Urban communities' social value threat assessment

	Potential threat	Pre-mitigated assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social value: SV1 Liveable community ***Impact: Impaired community amenity***				
ID1A	Rapid workforce influx to urban areas	Possible	Moderate	Medium	• Develop and implement a Workforce Accommodation Strategy with Local Government • Develop and implement a Workforce Code of Conduct • Monitor community and visitor sentiment in urban communities
	Social value: SV1 Liveable community ***Impact: Reduced amenity, road accidents and increased vehicle maintenance costs***				
ID1B	Increase in heavy vehicle traffic on local roads	Likely	Minor	Medium	• Project Traffic Management Plans • Community awareness campaigns, particularly for Aboriginal communities
	Social value: SV1 Liveable community ***Impact: Conflict between community members***				
ID1C	Conflict between supporters and opponents of unconventional gas industry development	Possible	Moderate	Medium	• Provide regular environmental and social monitoring results to communities • Implement regular community forums • Implement Grievance Management Program
ID1D	Receipt of royalties by a sub-set of community members	Unlikely	Negligible	Very Low	• Monitor community and visitor sentiment in urban communities

	Potential threat	Pre-mitigated assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social value: SV1 Liveable community ***Impact: Anxiety about availability, access to and quality of water resources***				
ID1E	Concern over potential risk to groundwater quality	Almost certain	Moderate	High	• Provide regular environmental and social monitoring results to communities • Implement regular community forums • Implement Grievance Management Program
	Social Value: SV2 Affordable lifestyle ***Impact: Decreased housing availability and affordability***				
ID2A	Housing supply unable to meet spike in demand	Possible	Moderate	Medium	• Develop and implement a Workforce Accommodation Strategy with Local Government
ID2B	Increased short-term rental costs	Possible	Moderate	Medium	• Monitor rental housing supply and vacancy • Implement rental support program for period of high rental housing demand
	Social Value: SV3 Community identity and spirit ***Impacts: Loss of 'Outback' identity***				
ID3A	Significant change in land use and industry development	Unlikely	Minor	Low	• Comply with Local Government Planning Scheme
ID3B	Perception of industry development heralding an era of 'industrialisation' of the landscape	Unlikely	Minor	Low	• Comply with Local Government Planning Scheme
	Social Value: SV3 Community identity and spirit ***Impacts: Decreased community engagement with local governance***				
ID3C	Perception that industry development approval is against majority community wishes	Likely	Moderate	Medium	• Implement regular community forums • Implement Grievance Management Program

	Potential threat	Pre-mitigated assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social Value: SV3 Community identity and spirit ***Impacts: Increased sense of cultural loss***				
ID3D	Concern with increased access to, and development risks on, traditional country	Unlikely	Negligible	Very Low	• Implement robust land access protocols • Monitor community and visitor sentiment • Implement regular community forums
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Decreased investment in pastoral and horticultural enterprises***				
ID4A	Concern that long-term access to quality groundwater may be restricted due to industry development	Possible	Moderate	Medium	• Provision of regular monitoring results to communities • Implementing regular community forums
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Decrease in tourism visitation***				
ID4B	Perception that 'outback' identity is compromised by 'major industrialisation' of the region	Unlikely	Minor	Low	• Monitoring of community and visitor sentiment • Implementing regular community forums
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Increased cost of labour for local businesses***				
ID4C	Higher gas industry wage rates available to local residents drives competition for employees	Likely	Moderate	Medium	• Implementing regular community forums • Implement Grievance Management Program
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Local business closures***				
ID4D	Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Possible	Moderate	Medium	• Implementing regular community forums • Development and implementation of Local Content Policies and programs • Implement Grievance Management Program

5.2. Rural communities

Rural communities include the 'affected communities' in the north, east and central areas of the Beetaloo sub-basin (see Appendix A), where there is a majority of Aboriginal residents in townships. This section presents a summary of indicative social values associated with these communities and an assessment of the significance of the threats to social values.

5.2.1. Social values

Table 5.3 summarises the social values identified for the rural communities in the three catchments.

Table 5.3 Rural communities' social values

Social value	Indicator	Social value baseline summary
SV1 Liveable community	Proximity and access to traditional country Degree of satisfaction with management of traditional country Respectful and harmonious relationships within and between communities (both Aboriginal and non-Aboriginal) Access to service delivery (in particular health and education) that acknowledges and respects culture Ability for extended family residence Respect for law by community members Adequate infrastructure that is well-maintained (roads, airport, power, water and sewerage, telephone, internet) Effective local governance Opportunity for recreational, cultural and sporting pursuits Safe social and physical environment	Rural communities comprise a predominantly Aboriginal population characterised by a young age profile (median age ranging from 21 to 26). The exceptions are Mataranka, the area surrounding Borroloola and the pastoral properties within the Beetaloo sub-basin area which have higher numbers of non-Aboriginal persons involved in tourism and pastoral enterprises. Communities are generally harmonious places, and have high levels of one-parent families. The activities of young persons in larger communities such as Ngukurr contribute to inter-family tension from time to time (through disregard for elders, substance abuse, general behaviours not consistent with traditional social norms etc). Community members are mostly close to traditional country, though often restricted in mobility which limits activity on country. A Territory-wide survey of community wellbeing in 2011 indicated that while a majority of individuals felt their life was improving, there was less support for the notion that communities were improving (or on the 'way up'). While services in health are generally adequate by rural standards, population health can be poor, characterised by low life expectancy for men, high child morbidity due to inadequate environmental health standards, and chronic circulatory and respiratory illnesses and diabetes in middle age. Despite this, people often self-report health as being good, due to a worldview that includes other factors such as being close to family. Road access is reasonable, but often subject to seasonal restrictions. The Roper Highway is gradually being upgraded with high-level crossings of the Roper and Wilton Rivers being installed. Most communities have an adequate level of community facilities. Local governance is functional,

Social value	Indicator	Social value baseline summary
		but often budget constrained due to the inability to raise rate income. The formation of larger Councils initially fostered a perception that there had been a diminution of local community control and local leadership.
SV2 Affordable lifestyle	Availability of adequate housing Income levels Cost of housing Cost of food, power and other essential items	The availability of housing continues to be a major problem in Aboriginal communities with shortage and overcrowding common (together with associated problems such as occupant tensions and accelerated deterioration). High population growth rates in Aboriginal communities indicate that this situation is unlikely to be resolved in the near to medium term. The adequacy of income levels are uncertain. Census data indicates that Aboriginal and Torres Strait Islander (ATSI) household median income ranges from 75% to 140% of the Roper Gulf Regional Council median household income, but is around 50% of the NT median household income. Some living expenses are low (e.g., housing rents), however food costs are in the order of 30 to 40% above costs in regional centres. While lifestyles may be affordable, there may be little room for external shocks (e.g., due to serious illness), and lifestyles are subject to low accommodation standards.
SV3 Community identity and spirit	Recognition and promotion of cultural heritage Perceptions of being able to influence community destiny Existence of viable enterprise activity Number and strength of Aboriginal organisations Status of reconciliation with non-Aboriginal community Level of volunteering and availability of assistance Local celebrations	Aboriginal people's residence in rural communities close to traditional country contributes markedly to community identity and spirit, particularly with smaller communities. Challenges are more significant in larger communities that contain residents from a diversity of clans. Consequently the protection of sites is a general concern of all community members. Voluntary work is noted as being higher in smaller communities. Art and Craft Centres and Aboriginal Ranger Groups are also evidence of a significant level of community spirit, in contrast to the often negative portrayal of community life in mainstream media. There are a number of festivals and other community events (such as rodeos and NAIDOC Week celebrations) and investment in local pastoral enterprises (such as at Minyerri) which contributes to pride in moving from welfare dependence. All communities express pride in the number of members who are able to secure jobs in the mainstream labour market, or establish a commercial enterprise as an alternative to dependence on welfare payments.
SV4 Capacity for sustainable economic activity	Availability of employment opportunities Aboriginal workforce participation and employment	Rural communities are characterised by an extremely limited range of economic activity and associated employment opportunities. Most formal employment is in the provision of government services (education,

Social value	Indicator	Social value baseline summary
	Aboriginal business start-ups and ownership Level of education achievement, including retention to Year 12 and post-school destinations	health and government administration) though continual effort is made to engage with private sector economic activity through seasonal pastoral and mining work where available, and through the pursuit of flexible labour hire initiatives that depend on worker mobility. The employment participation rate is low, and the numbers not in the labour force have been steadily increasing. This situation presents youth with little to no incentive to put effort into education which often means leaving the familiar surrounds of community and family.

5.2.2. Potential threats and their significance

Potential impacts to the identified social values are discussed in the following sections for each social value and threat (impact driver). The risk of the threats occurring and the associated consequences are assessed to provide an indication of the impacts that are likely to be significant should unconventional gas development proceed in a manner consistent with the conceptual development. The assessment is summarised in Table 5.5.

SV1 Liveable community

Impaired community amenity

ID1A Rapid workforce influx to urban areas

The conceptual development includes accommodation facilities near transport hubs where they are located within commuting distance to the gas fields or accommodation facilities located at the gas fields, with the workforce working rosters on a FIFO or DIDO basis. Small and Aboriginal communities do not have the capacity or infrastructure to accommodate gas field construction and operation workforces and are unlikely to be considered for accommodation. Consequently, the risks associated with this threat were not assessed for rural communities.

Reduced amenity, road accidents and increased vehicle maintenance costs

ID1B Increase in heavy vehicle traffic on local roads

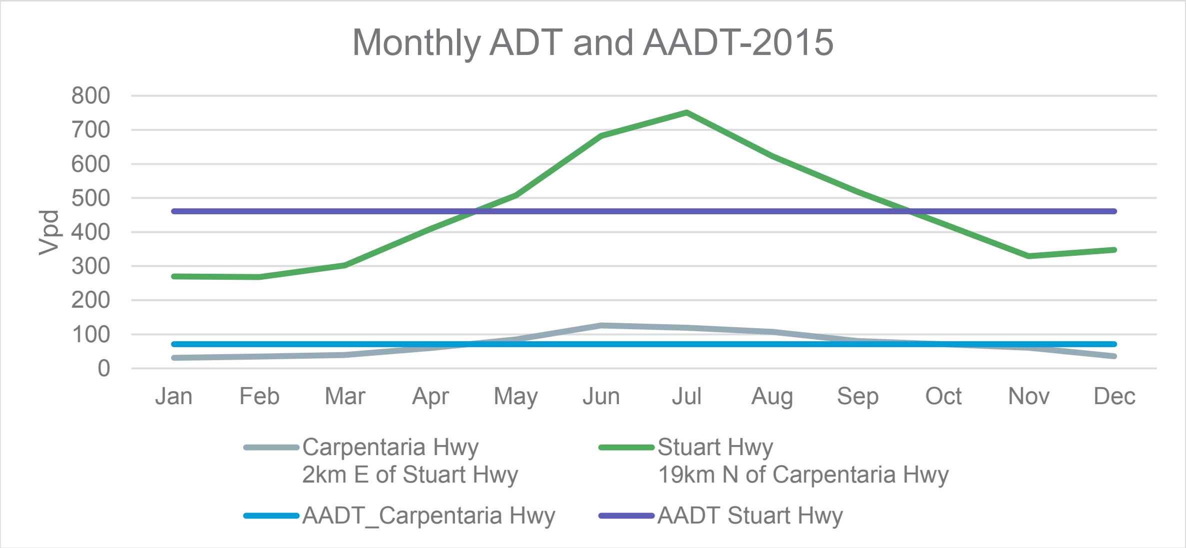
An increase in heavy vehicle traffic on highways is certain, particularly during the construction phase for a gas processing and compression facility or when pipe for a new pipeline is being delivered. The use of local roads, such as the Daly Waters to Cox River Road by heavy vehicles will be contingent on the location of major facilities. Light vehicle traffic associated with construction or operations will be present on highways as well as on local roads. The most important generators of traffic associated with a project will be workforce accommodation and construction hubs.

A summary of the Average Annual Daily Traffic Volumes (AADT) and the percentage of heavy vehicles in 2015 for the Stuart and Carpentaria highways are provided in Table 5.4. Figure 5.1 indicates the seasonal variability in traffic volumes on these highways.

Table 5.4 Traffic volumes from 2015 vehicle count

Highway	Description	AADT	% Heavy vehicles*
Carpentaria Highway	Tablelands Highway to Stuart Highway 2 km east of Stuart Highway	71	21.6% (~13% triple road trains)
Stuart Highway	Carpentaria Highway to Roper Highway 19 km north of Carpentaria Highway	461	22.2% (~12% triple road trains)
	Roper Highway to Victoria Highway 6 km south of Cutta Cutta Caves	890	14.5% (~7% triple road trains)

* AUSTROADS Class 6 to 12, Long, Medium and Large Combinations
Source: NT Government, Department of Transport, Annual Traffic Report, 2015



Source: NT Government, Department of Transport, Annual Traffic Report, 2015

Figure 5.1 Highway traffic variability - 2015

The consequences of any increase in traffic are expected to be minor. The capacity of both the Stuart and Carpentaria highways is such that increased traffic levels will be well below the levels requiring any road upgrade works. The capacity of the Carpentaria Highway is estimated at 9,000 vehicles per day between the Stuart Highway and the McArthur River Mine access road[3]. As background traffic volumes are very low (with a 3% growth rate, AADT in 2024 without the project is in the order of 95 vehicles per day (vpd)), traffic volumes are expected to remain significantly below the existing road capacity of 9,000 vpd requiring no upgrade works to accommodate future year traffic volumes on the Carpentaria Highway. The same situation is likely to prevail on the Stuart Highway.

Local residents have an existing awareness of the presence and effects of heavy vehicles on local roads, and it is assumed that maintenance will be delivered on time, and that Traffic Management Plans governing speed and use of approved routes only and driver behaviour are in place and enforced.

[3] McArthur River Mine Stage 3 EIS https://ntepa.nt.gov.au/__data/assets/pdf_file/0004/287788/Chapter-8-Traffic-and-Transport.pdf

Conflict between community members

ID1C Conflict between supporters and opponents of unconventional gas industry development

Development of an unconventional gas industry is a highly emotive issue in the Northern Territory, as evidenced by press reports of community concerns and positions expressed during stakeholder consultation. There appears to have been a significant level of anti-industry advocacy, and the likelihood of conflict is considered possible (as it has occurred in other jurisdictions) and the consequences could be moderate in smaller communities, leading to a weakening of social capital and negative perceptions of the community as being a supportive and welcoming environment for both new and existing residents.

ID1D Receipt of royalties by a sub-set of community members

Traditional owners (TOs) are entitled to and will receive royalties linked to gas production. These TOs will almost certainly live in small communities across and beyond the Beetaloo sub-basin, where the potential for strained relations with other community members not in receipt of royalties will be high. As well, the impacts of gas development are perceived to occur on a regional scale (e.g., ground and surface water effects), even though the actual areal footprint of development will be relatively limited (and hence, result in a limited or tightly targeted distribution of royalties). This may have major consequences for intra-community and TO inter-group relationships.

Anxiety about availability, access to and quality of water resources

ID1E-Concern over potential risk to groundwater quality

Regardless of the actual location of projects in the Beetaloo sub-basin, there is likely to be concern in regard to future groundwater quantity and quality in the event of industry development. Evidence through stakeholder engagement and submissions to the Inquiry indicates a likelihood of almost certain and a consequence of major based on anxiety about the perceived effects on human health and cultural integrity, indicating a very high risk rating.

SV2 Affordable lifestyle

Decreased housing availability and affordability

ID2A Housing supply unable to meet spike in demand

ID2B Increased short-term rental costs

The nature of development in the Beetaloo sub-basin (where workers are likely to be based on site in accommodation facilities due to remoteness) is not likely to affect housing in rural communities where there is a limited housing market, or where communities are located on Aboriginal land where there is a predominance of social housing allocated to Aboriginal people and not available for lease. It is possible that Mataranka could see some effect through a limited stimulation for increased supply. Hence the significance of the above threats are categorised as low and very low respectively.

SV3 Community identity and spirit

Loss of ‘outback’ identity

ID3A Significant change in land use and industry development

ID3B Perception of industry development heralding an era of ‘industrialisation’ of the landscape

Decreased community engagement with local governance

ID3C Perception that industry development approval is against majority community wishes

Increased sense of cultural loss

ID3D Concern with increased access to, and development risks on, traditional country

Two potential threats to this value (ID3A and ID3B) are assessed as possible, depending on the scale and location of development and its potential to generate significant visual effects that may influence perceptions. As development will coexist with pastoral operations and not involve highly visible large-scale infrastructure or landscape change (such as overburden dumps) the consequences are assessed as minor indicating low significance. Travellers or tourists who may seek out an ‘outback’ experience often expect to see resource development in remote areas (for example, in the Cooper Basin and in the Mount Isa area).

Threats ID3C and ID3D are assessed as likely with minor and moderate consequences for small communities in the absence of any concerted program of education and awareness in regard to the impacts and benefits of industry development based on realistic scenarios of industry/project development, together with proposed measures for the management of impacts. While threat ID3C is difficult to ameliorate (either the decision is against community wishes or it isn’t), threat ID3D consequences may diminish over time should participation in the identification and management of cultural heritage sites and impacts be demonstrated to be effective.

SV4 Capacity for sustainable economic activity

Decreased investment in pastoral and horticultural enterprises

ID4A Concern that long-term access to quality groundwater may be restricted due to industry development

Decrease in tourist visitation

ID4B Perception that ‘outback’ identity is compromised by ‘major industrialisation’ of the region

Increased cost of labour for local businesses

ID4C Higher gas industry wage rates available to local residents drives competition for employees

Local business closures

ID4D Industry demand attracts external specialist enterprises to establish and draw business from local businesses

Threat ID4A is currently felt strongly, prior to any detailed project proposal being advanced, and is likely to remain for the foreseeable future with the potential to restrict investment in pastoral or tourism enterprises, or impair their future sale value. The significance of the threat is assessed as high. The significance of the additional three threats are rated as low or very low for rural communities. Apart from small highway communities, it is not envisaged that development would occur in the immediate vicinity of communities which may induce perceptions of 'major industrialisation', and there is little to no evidence of this occurring in other gas development areas, such as the Surat Basin, where some communities have accommodated such development and built tourist attractions on its presence (e.g., Roma). The limited skills in small community populations, where labour markets are very thin, means that labour competition is a remote possibility.

Table 5.5 Rural communities' social value threat assessment

	Potential threat	Pre-mitigation assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social Value: SV1 Liveable community ***Impact: Impaired community amenity***				
ID1B	Increase in heavy vehicle traffic on local roads	Almost certain	Minor	Medium	• Project Traffic Management Plans • Community awareness campaigns, particularly for Aboriginal communities
	Social Value: SV1 Liveable community ***Impact: Impaired community amenity***				
ID1C	Conflict between supporters and opponents of unconventional gas industry development	Possible	Moderate	Medium	• Provide regular environmental and social monitoring results to communities • Implement regular community forums • Implement Grievance Management Program
	Social Value: SV1 Liveable community ***Impact: Impaired community amenity***				
ID1D	Receipt of royalties by a sub-set of community members	Almost certain	Major	Very High	• Provide financial management and investment support
	Social Value: SV1 Liveable community ***Impact: Impaired community amenity***				
ID1E	Concern over potential risk to groundwater quality	Almost certain	Major	Very High	• Provide regular environmental and social monitoring results to communities • Implement regular community forums • Implement Grievance Management Program

	Potential threat	Pre-mitigation assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social Value: SV2 Affordable lifestyle ***Impact: Decreased housing affordability***				
ID2A	Housing supply unable to meet spike in demand	Unlikely	Minor	Low	• Regular monitoring of housing affordability
ID2B	Increased short-term rental costs	Remote	Minor	Very Low	• Regular monitoring of housing affordability
	Social Value: SV3 Community identity and spirit ***Impacts: Loss of 'Outback' identity, Decreased community engagement with local governance, Increased sense of cultural loss***				
ID3A	Significant change in land use and industry development	Possible	Minor	Low	• Monitor community and visitor sentiment in rural communities
	Social Value: SV3 Community identity and spirit ***Impacts: Loss of 'Outback' identity, Decreased community engagement with local governance, Increased sense of cultural loss***				
ID3B	Perception of industry development heralding an era of 'industrialisation' of the landscape	Possible	Minor	Low	• Monitor community and visitor sentiment in rural communities
	Social Value: SV3 Community identity and spirit ***Impacts: Loss of 'Outback' identity, Decreased community engagement with local governance, Increased sense of cultural loss***				
ID3C	Perception that industry development approval is against majority community wishes	Likely	Moderate	Medium	• Implement regular community forums • Implement Grievance Management Program
	Social Value: SV3 Community identity and spirit ***Impacts: Loss of 'Outback' identity, Decreased community engagement with local governance, Increased sense of cultural loss***				
ID3D	Concern with increased access to, and development risks on, traditional country	Likely	Moderate	Medium	• Regular visitation and feedback to TOs on effectiveness of management measures • Implement robust land access protocols

	Potential threat	Pre-mitigation assessment			Mitigation
		Likelihood	Consequence	Assessed risk	
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Decreased investment in pastoral and horticultural enterprises***				
ID4A	Concern that long-term access to quality groundwater may be restricted due to industry development	Likely	Major	High	• Provide regular environmental and social monitoring results to communities • Implement regular community forums • Implement Grievance Management Program
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Decrease in tourism visitation***				
ID4B	Perception that 'outback' identity is compromised by 'major industrialisation' of the region	Possible	Minor	Low	• Monitor community and visitor sentiment in rural communities
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Increased cost of labour for local businesses***				
ID4C	Higher gas industry wage rates available to local residents drives competition for employees	Remote	Negligible	Very Low	• Implement regular community forums • Implement Grievance Management Program
	Social Value: SV4 Capacity for sustainable economic activity ***Impacts: Local business closures***				
ID4D	Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Remote	Negligible	Very Low	• Implement regular community forums • Implement Grievance Management Program

5.3. Impact summary and mitigation strategies

Table 5.6 and Table 5.7 list the threats for urban and rural communities respectively where the assessed risk of the threat occurring is medium or higher.

For urban communities, there is a medium level of threat to social values SV1, SV2 and SV4, primarily due to the potential for population increase and the concern for groundwater sustainability. The potential for community discord due to divergent attitudes to risk held by supporters and opponents of unconventional gas development is considered material, particularly as the townships have relatively low populations.

For rural Aboriginal communities, including pastoral properties in the Beetaloo sub-basin area, the key threats are to social values SV1 and SV4, primarily due to the perceived environmental risk to both quantity and quality of groundwater due to hydraulic fracturing required to extract gas from the shale. Receipt of royalties in remote Aboriginal communities also has the potential to induce income disparity that may negatively affect relations between different TO groups.

Table 5.6 Summary of medium and higher threat significance for urban communities

	Potential threat	Likelihood	Consequence	Assessed risk
ID1A	Rapid workforce influx to urban areas	Possible	Moderate	Medium
ID1B	Increase in heavy vehicle traffic on local roads	Likely	Minor	Medium
ID1C	Conflict between supporters and opponents of unconventional gas industry development	Possible	Moderate	Medium
ID1E	Concern over potential risk to groundwater quality	Almost certain	Moderate	High
ID2A	Housing supply unable to meet spike in demand	Possible	Moderate	Medium
ID2B	Increased short-term rental costs	Possible	Moderate	Medium
ID3C	Perception that industry development approval is against majority community wishes	Likely	Moderate	Medium
ID4A	Concern that long-term access to quality groundwater may be restricted due to industry development	Possible	Moderate	Medium
ID4C	Higher gas industry wage rates available to local residents drives competition for employees	Likely	Moderate	Medium
ID4D	Industry demand attracts external specialist enterprises to establish and draw business from local businesses	Possible	Moderate	Medium

Table 5.7 Summary of medium and higher threat significance for rural communities

	Potential Threat (Rural)	Likelihood	Consequence	Assessed risk
ID1B	Increase in heavy vehicle traffic on local roads	Certain	Minor	Medium
ID1C	Conflict between supporters and opponents of unconventional gas industry development	Possible	Moderate	Medium

	Potential Threat (Rural)	Likelihood	Consequence	Assessed risk
ID1D	Receipt of royalties by a sub-set of community members	Almost certain	Major	Very High
ID1E	Concern over potential risk to groundwater quality	Almost certain	Major	Very High
ID3C	Perception that industry development approval is against majority community wishes	Likely	Moderate	Medium
ID3D	Concern with increased access to, and development risks on, traditional country	Likely	Moderate	Medium
ID4A	Concern that long-term access to quality groundwater may be restricted due to industry development	Likely	Major	High

Particular challenges when undertaking both strategic and project-level SIA in the Beetaloo sub-basin include the remoteness of communities (influencing the time available to consult effectively), and the cultural diversity and differing world views of the major stakeholder groups – Aboriginal communities and pastoral leaseholders. The significance of these challenges is amplified due to the limited understanding of the nature of the unconventional gas industry, and of the technologies that would be deployed to extract gas and manage potential environmental and social impacts, as well as the distrust of governments and their capacity to regulate the industry effectively on behalf of all community members.

Despite these challenges, none of the identified threats are considered to be incapable of being mitigated and managed, as they are being managed in other onshore gas development areas currently. Effective management would require close collaboration between various industry groups and project proponents, government and the community to ensure that responsibility for management and reporting on sub-basin level impacts is clear, and that mechanisms for community feedback and response are widely-known and effective.

Indicative components of a social impact management program, based on the level of impact definition available from the high-level assessment, are outlined below. Additional activities would likely be identified when a more detailed project description is subject to a comprehensive project-level SIA.

5.3.1. Community

Ongoing effective community and stakeholder engagement is fundamental to the effective management of impacts and the maintenance of a ‘social licence to operate’. Key factors to consider in the development of a community engagement strategy include:

- The need for community industry awareness campaigns, particularly for Aboriginal communities. This needs to be an ongoing process, as the development and deployment of improved technology is proceeding at a rapid rate.
- The requirement for implementation of robust land access protocols.
- The need to provide regular environmental monitoring results to communities in a transparent manner that builds community confidence and trust in the monitoring process.

- Participation in regular community forums with government and other industry participants to discuss industry issues. Responsibility for the design and leadership of these forums may rest with government and peak bodies, however to be successful they will require the participation of industry at a senior level.
- The implementation of a Grievance Management Program, including community access to an independent advocate if necessary.
- The need for monitoring of community and visitor sentiment on a structured basis to ensure that the views of all sectors are heard and considered.
- The development and implementation of a workforce cultural awareness program and a workforce code of conduct to contribute to ongoing positive and supportive community relations.
- The development and implementation, in consultation with government, of local content policies and programs to maximise opportunity for Northern Territory business input and development.

5.3.2. Workforce and housing

The management of potential housing issues needs considerable care to ensure that housing market distortions are avoided. While communities generally do not favour FIFO practices, due consideration needs to be given to planning factors such as local availability of skills, and the sometimes limited period of time for which particular employment levels are required, such as the construction phase for a gas processing and compression plant where a high level of employment may only last around 18 months. Local planning needs to be based on realistic long-term employment levels. Factors to consider when developing local workforce recruitment and housing strategies include:

- The need to develop and implement a Workforce Accommodation Strategy with Local Government, with a view to integration with local procurement and logistics support strategies.
- The need for compliance with the Local Government planning scheme if considering the development of accommodation initiatives in urban areas.
- The need for ongoing monitoring of rental housing supply and vacancy levels to identify project-induced demand.
- The merits of implementing a rental support program for periods of high rental housing demand to ensure that low-income people are not priced out of the rental market.

5.3.3. Traffic

Project traffic management plans are generally effective in managing risks involved in the transport of personnel and materials required to develop projects provided that they:

- Identify risks to be managed on low-traffic local roads utilised by local community members.
- Ensure that there is a high level of traffic awareness and safe driver-behaviour requirements imparted to local community members.
- Provide for the training of project drivers and the monitoring and policing of driver behaviour.

5.4. Potential opportunities for enhancement of social values

While the development of unconventional gas extraction in the Beetaloo sub-basin is expected to be gradual under the conceptual development scenario and not schedule-driven as witnessed with coal seam gas development in the Surat Basin, there are likely to be a number of opportunities for the enhancement of social values, both in urban as well as rural communities. These could include:

- The development of an increased capacity in logistics operations, and the establishment of an unconventional gas industry support base, initially in Katherine but potentially in other towns such as Tennant Creek if favourable conditions eventuate. This would lead to increased employment, training and a broadening of the skills base of the local workforce, and potentially a modest population increase should workers see Katherine or Tennant Creek, as a desirable places to live.
- An opportunity, through local procurement of inputs for gas field development, to diversify the economic base of regional support towns through the attraction of new business ventures and the expansion of existing business ventures in construction, mechanical maintenance and industrial supplies.
- Collaboration between industry proponents may also provide an opportunity to establish regional support facilities, such as a worker accommodation village or an upgraded airstrip to handle FIFO transport, in proximity to a rural location (such as Daly Waters) where the opportunity for multi-use of the facility (such as for tourist accommodation) may expand and strengthen the economic base of the town.
- An opportunity, through gas industry supported activity, to deliver training and employment opportunity to residents of Aboriginal communities in the areas surrounding the Beetaloo sub-basin, building on employment and training activity that has been implemented as part of exploration work (undertaken by Pangaea and Origin Energy). This opportunity need not rely solely on the existence of Aboriginal Land Use Agreements (ILUAs) with TO groups, but be a product of a direct government policy to deliver benefits to rural communities. It must also be recognised that the poor housing conditions, in particular over-crowding, in remote communities is a particular barrier to employment retention and the ability to be fit-for-work at the commencement of a roster for community-based employees.
- Community input to gas field development plans provide an opportunity to plan infrastructure development such that communities may benefit (e.g., through improved access to particular sites of importance), as landholders could use gas field infrastructure to benefit property operations.
- Community involvement in regional environmental monitoring associated with industry development, through participation by natural resource management groups and Aboriginal ranger groups who already have demonstrated capacity. As well as providing employment opportunities, this could also act to increase community confidence in the transparency of company environmental management and monitoring programs.

The ability to capture these opportunities will require a collaborative approach to industry development by the Northern Territory Government, project proponents and representatives of the community, which aligns with the industry development approach outlined in the Northern Territory Government's Economic Development Framework[4] released on 20 June 2017. It would also be expected that initiatives aimed at enhancing community capacity to take advantage of opportunities

[4] See https://edf.nt.gov.au/growth-sectors/energy-and-minerals

that may be available through industry development would be developed and implemented during the strategic assessment phase, as recommended in the SIA Framework report (CSRM, 2017).

6. Issues to be considered in implementing the SIA Framework

CSRM (2017) identified leading practice SIA as comprising:

- Strategic, adaptive approach throughout lifecycle of development that addresses cumulative impacts.
- Communication, coordination and collaboration between industry participants.
- Independently-led, participatory social baseline assessment.
- Independently-led community engagement.
- Participatory, ongoing monitoring of social indicators and transparent reporting of results.

The SIA case study found that Aboriginal and other community members are highly sensitised to the potential impacts of an unconventional gas industry, particularly bio-physical impacts on surface water and groundwater, and impacts on their communities and values. Their concerns arise, in part, from a lack of detailed information about the potential unconventional gas industry and actual project proposals.

The Panel noted in its Interim Report (Inquiry, 2017b) that '*current knowledge by the Aboriginal community is inadequate, and as a consequence, this points to an emerging social risk with Aboriginal people becoming enmeshed in conflict between pro and anti-fracking groups'*.

This was evident in the consultation undertaken for the SIA case study.

The Panel also noted that '*it is imperative that accurate information is provided to the Aboriginal groups likely to be directly affected by hydraulic fracturing as soon as practicable, and that the peak bodies with responsibility for carrying out this work give the highest priority to ensuring this occurs well in advance of requirements for decision-making'*.

Information about unconventional shale gas development and hydraulic fracturing was provided to the Aboriginal and urban communities in the second consultation round and was generally well received, indicating that with appropriate planning and care, the knowledge base of Aboriginal communities can be raised sufficiently to enable them to make informed decisions and provide informed comment and input on potential impacts of unconventional gas development and their management.

Engagement with Aboriginal communities must adopt a structured approach that incorporates the following activities:

- **Preparatory meeting(s)** (as done in the second consultation round) that identifies the community members who should be consulted, their needs to participate in the consultation, the issues to be discussed, and appropriate dates and times for the meeting(s).
- **Social values meetings** during which the communities' social values are identified and documented. Sufficient time must be allowed for the complex issues relating to Aboriginal communities to be explored and understood.

- **Awareness meeting(s)** in which the communities are provided with information about unconventional gas development in sufficient detail to enable them to understand how development activities relate to, and might impact on their communities and their values. This engagement should include discussion of what is, and is not negotiable with respect to engineering and technical aspects of unconventional gas development.
- **Project-specific meetings** in which Aboriginal and other communities are presented with a development proposal and detailed information about its environmental and social impacts. This engagement should allow sufficient opportunity and time for community members to have input to the development concept and management of its impacts.
- **Implementation meetings** in which Aboriginal and other communities are invited to participate in environmental review or other similar committees that provide ongoing forums for managing project-community relations, monitoring of environmental and social impacts, and implementation of environmental and social programs.

Project proponents must have a relationship with the communities in which they operate or who they affect. The relationship will be most successful where it is developed over time through the staged approach outlined above. The conduct of community engagement must therefore balance the need for independently-led consultation (to build confidence in the process and veracity of data) with company ownership of the relationship (to build credibility, a working relationship and ensure accountability).

Project proponents are the most qualified to talk about their projects and the engineering and technical aspects of their proposed development, including how impacts will be managed. Technical experts are most qualified to talk about potential impacts and the effectiveness of proposed management measures. Community engagement must incorporate the following participants throughout the lifecycle of the project:

- Project proponent.
- Engineering and technical experts.
- Community members and their representative bodies.
- Independent stakeholder engagement consultants.

7. Conclusion

The Beetaloo sub-basin SIA case study assessed the impacts of a conceptual shale gas development on communities in and around the Beetaloo sub-basin. The affected communities were grouped into social catchments due to their relationship to the regional service centres of Katherine and Tennant Creek and the major roads that connected these centres and the communities.

Indicative social values incorporating the community capitals and IAIA values were identified based on experience in Northern Territory Aboriginal communities and with unconventional gas development in other jurisdictions. The values informed community consultation on the social impacts of unconventional gas development, which was conducted in two stages.

Detailed discussion to confirm the social values, understand community concerns and inform the social baseline was compromised by the short duration of the case study (in contrast to the long-term strategic approach proposed by CSRM (2017)), community opposition to an unconventional gas industry, and lack of a real project with clearly defined activities and impacts.

Despite heightened sensitivity to the impacts of unconventional gas development due to a concerted campaign by opponents of industry development, some communities were appreciative of the information provided in the second round of consultation, confirming that awareness and education are key factors in working towards a ‘social licence to operate’.

The study found significant disparity between the regional service centres and remote Aboriginal communities due to their remoteness affecting access to services, their poor state of housing, limited access to a functioning labour market, and differences in health and education status. With development expected to be distant from these communities, the more pressing issue will be how they realise opportunities from unconventional gas development.

A range of threats and impacts, typical of unconventional gas development were identified. The key concerns for communities are impacts on surface water and groundwater resources, likely heightened by the PFAS contamination in and around RAAF Base Tindal near Katherine and incorrect assumptions about water management based on coal seam gas development in Queensland. The other key concerns relate to the manner in which Aboriginal communities will benefit from unconventional gas development, with the equitable distribution of benefits a major concern.

The study found that the identified threats and impacts can be managed using proven methods and strategies from unconventional gas development in other jurisdictions. Lessons learned in other jurisdictions will enable these approaches to be refined for the Northern Territory context and improved to avoid the suboptimal outcomes achieved in some instances.

The SIA Framework and CSIRO’s guidelines for achieving a ‘social licence to operate’ will assist in overcoming community perceptions that an unconventional shale gas industry is:

- Short-term and cyclical in nature.
- Similar to the coal seam gas industry in Queensland, with similar impacts.
- Aloof to community concerns and has disregard for the social outcomes of development.

The strategic approach to compiling a social baseline proposed by CSRM (2017) will assist in identifying and managing cumulative impacts on the geographically dispersed and diverse communities.

8. References

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Appendix A - Affected community profiles

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Tables

Figures

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1. Introduction

The approach to identifying and grouping affected communities into social catchments and compiling baseline profiles of the communities is presented in this appendix along with a regional overview and baseline information for affected communities in each social catchment.

2. Affected communities and social catchments

The Inquiry Terms of Reference defined 'affected communities' as:

> *the people or groups of people that are most likely to be impacted by the development of unconventional gas resources in and around the Beetaloo sub-basin… which may include, without limitation, community members, pastoralists, Aboriginal organisations and local businesses.*

By this definition, communities in and adjacent to the Beetaloo sub-basin are affected communities, particularly those in proximity to areas explored for unconventional gas reserves and those on or serviced by major transport routes, as these routes provide access to goods and services, labour markets and business opportunities. The affected communities, their relationship to the Beetaloo sub-basin and related transport routes are listed in Table A2.1.

Table A2.1 Affected communities and their relationship to the Beetaloo sub-basin

Affected community	Major transport route	Relationship to Beetaloo sub-basin
Katherine (town)	Stuart Highway	Outside; northwest of sub-basin
Barunga	Central Arnhem Road	Outside; northeast of sub-basin
Beswick	Central Arnhem Road	Outside; northeast of sub-basin
Mataranka	Stuart Highway	Outside; north of sub-basin
Jilkminggan	Roper Highway	Outside; northeast of sub-basin
Minyerri	Roper Highway	Outside; northeast of sub-basin
Ngukkurr	Roper Highway	Outside; northeast of sub-basin
Borroloola	Carpentaria Highway	Outside; east of sub-basin
Robinson River	Carpentaria Highway	Outside; east of sub-basin
Larrimah	Stuart Highway	Inside northern part of sub-basin
Daly Waters	Stuart Highway	Inside northern part of sub-basin
Dunmarra	Stuart Highway	Inside southern part of sub-basin
Newcastle Waters	Stuart Highway	Outside; south of sub-basin
Elliott	Stuart Highway	Outside; south of sub-basin
Tennant Creek	Stuart Highway	Outside; south of sub-basin

To facilitate assessment, the affected communities were grouped into social catchments. The factors influencing the clustering of the communities are:

- **Location and community links**: Centres with a population level that may indicate some potential for providing 'local employment' should sub-basin development proceed. Generally these communities are located outside of, but in proximity to, the Beetaloo sub-basin. Consideration of potential physical and cultural links are also important factors influencing grouping and the potential to experience shared perceptions of impact.
- **Logistics or support industry potential**: It is assumed that the development of an unconventional gas industry would require at least a moderate level of logistical and maintenance support. This could be a purpose-built area within gas field or a facility located in the existing large towns north and south of the sub-basin that currently support industrial activity, for example Katherine, which currently provides support to the mining industry and RAAF Base Tindal and/or Tennant Creek, which provides support to the mining industry.
- **Dominant economic activity**: Pastoral operations constitute the principal economic activity within the Beetaloo sub-basin, with the Stuart Highway and to a lesser extent the Carpentaria Highway facilitating economic activity associated with tourism.

These factors resulted in the affected communities being grouped according to the major transport route they used or were serviced by, and their relationship to Katherine and Tennant Creek, the regional towns north and south of the sub-basin respectively. Katherine and Tennant Creek were grouped together as they are the only urban centres in vicinity of the sub-basin. An overview of the social catchments and their affected communities is provided below.

2.1. Affected communities (urban)

This social catchment comprises the towns of Katherine and Tennant Creek, with populations of 9,800 and 3,000 respectively. Located on the Stuart Highway, these towns are service centres for their hinterland areas and have a higher population and broader array of services compared to the predominantly Aboriginal communities in the hinterland region. They have active community and business representative groups who plan and engage with government in order to draw public investment for development purposes in their area.

2.2. Affected communities (north)

The communities within this area to the east of Katherine include Barunga, Beswick, Mataranka, Jilkminggan, Minyerri, and Ngukurr. They have a combined population of approximately 3,300 of predominantly Aboriginal persons with the exception of Mataranka. These communities are within relatively easy reach of services available in Katherine. The furthest, Ngukurr, is located approximately 320 km east along the Roper Highway. Residents are likely to have traditional landownership interests in the northern part of the Beetaloo sub-basin and form a community of interest supported by access provided by the Roper Highway.

2.3. Affected communities (central)

The main communities in this area include Larrimah, Daly Waters, Dunmarra, Newcastle Waters and Elliott. They have a combined population of 460, which excludes residents on pastoral stations (of which there are 24 with land within the Beetaloo sub-basin). Common interests centre on pastoral operations, as well as servicing vehicle traffic (including the tourist trade) on the Stuart Highway.

While there may be limits on the ability to source a labour force from within this area, it could be expected that residents would seek opportunities for work and supplementary income, particularly if facilities and infrastructure were located on their properties.

2.4. Affected communities (east)

The main community in this area is Borroloola which has a population of approximately 700. Residents commonly access services in Katherine via the Carpentaria Highway through the Beetaloo sub-basin, but also in Tennant Creek accessed via the Tablelands and Barkly highways. Relationships extend north toward the Roper River and southeast toward the Queensland Gulf country and Mount Isa. As the nearest residential location to the McArthur River Mine, there are likely to be a number of residents with skills and work experience that are compatible with workforce requirements for a gas project, particularly during the construction phase where facilities and support infrastructure is being established.

The affected communities and social catchment they have been assigned are listed in Table A2.2.

Table A2.2 Social catchments and affected communities

Social catchment	Affected communities
Affected communities (urban)	Katherine (town) Tennant Creek
Affected communities (north)	Barunga Beswick Mataranka Jilkminggan Minyerri Ngukurr
Affected communities (central)	Larrimah Daly Waters Dunmarra Newcastle Waters Elliott
Affected communities (east)	Borroloola Robinson River

3. Baseline characterisation method

The term 'baseline' refers to the socioeconomic characteristics of affected communities. Data to support the characterisation of the socioeconomic baseline of affected communities is described in this section.

3.1. Data collection

The SIA case study reports secondary data collection. The primary data source was the Australian Bureau of Statistics (ABS). Table A3.1 presents the ABS statistical areas used in this report.

Additional information was sourced from the Northern Territory Government Treasury, as well as regional and local planning documentation developed by government and industry bodies.

Where possible, the latest census data (2016) was used. However, some data from the 2016 census was not available to the public at time of writing, and where this was the case 2011 census data was used.

Table A3.1 ABS statistical areas used in the SIA case study

Level	Statistical area level
Territory	
Northern Territory	SA4
Regional	
Katherine region	SA3-70205
Victoria River	SA2-702051068
Katherine Town	SA2-702051067
Elsey	SA2-702051065
Gulf	SA2-702051066
Social catchment	
Affected communities (urban)	
Katherine (town)	SA2-702051067
Tennant Creek	SA2-702021056
Affected communities (north)	
Roper Gulf RC	LGA-73600
Elsey	SA2-702051065
Barunga	SA1-7106501
Beswick	SA1-7106502
Mataranka	SA1-7106506
Jilkminggun	SA1-7106507
Minyerri	SA1-7106606
Ngukurr	SA1-7106608
Affected communities (central)	
Roper Gulf RC	LGA-73600
Elsey	SA2-702051065
Central Beetaloo	SA1-7106508
Elliott	SA1-7105510
Affected communities (east)	
Roper Gulf RC	LGA-73600

Level	Statistical area level
Borroloola	SA1-7106601
Borroloola surrounding area	SA1-7106602
Garawa	SA1-7106614
Mara	SA1-7106613
Yanula	SA1-7106612

3.2. Data analysis

In conjunction with community and stakeholder consultation, the data presented herein contributed to the derivation and substantiation of social values. A social value is defined in the SIA case study, as a quality of the area potentially subject to project effects for which community stakeholders have high regard, and that is conducive to individual or community well-being into the future.

The potential for a project to impair or enhance existing social values is central to assessing how communities may be affected if the unconventional gas industry were to be developed within the Beetaloo sub-basin.

The data informing the socioeconomic baseline is framed according to the social values, as defined in the SIA case study (which were in turn influenced by the data presented herein).

Four indicative social values were identified as being of importance to affected communities:

- SV1 Liveable community.
- SV2 Affordable lifestyle.
- SV3 Community identity and spirit.
- SV4 Capacity for sustainable economic activity.

The key indicators of these values differ depending on whether the community was rural or urban, as presented in Table A3.2 and Table A3.3. These indicators are intended to be illustrative rather than exhaustive.

Table A3.2 Social values and indicators for urban communities

Social value	Indicators (urban)
SV1 Liveable community	• Access to, and proximity of, quality services (health, education, aged care, childcare, retail etc) • Balanced demographic profile • Harmonious relationships, lack of conflict • Respect for law by community members • Adequate infrastructure that is well-maintained (housing, roads, airport, power, water and sewerage, telephone, internet) • Effective local governance • Opportunity for recreational, cultural and sporting pursuits • Safe social and physical environment
SV2 Affordable lifestyle	• Cost of land and housing • Local Government charges

Social value	Indicators (urban)
	• Income levels • Cost of food, power and other essential items
SV3 Community identity and spirit	• Level of volunteering and availability of assistance • Local celebrations • Recognition, preservation and promotion of heritage • Capacity to accommodate visitors • Perceptions of being able to influence community destiny • Employment share by industry
SV4 Capacity for sustainable economic activity	• Viability, vitality and diversity of local industry • Workforce participation and employment • Job creation and retention of young people • Supportive business environment (e.g. availability of serviced industrial land, adequate zoning, provision of information on opportunities) • On-going environmental integrity (e.g. surface and groundwater, land degradation) • Willingness of business to invest

Table A3.3 Social values and indicators for rural communities

Social value	Indicators (rural)
SV1 Liveable community	• Proximity and access to traditional country • Degree of satisfaction with management of traditional country • Respectful and harmonious relationships within and between communities (both Aboriginal and non-Aboriginal) • Access to service delivery (in particular health and education) that acknowledges and respects culture • Ability for extended family residence • Respect for law by community members • Adequate infrastructure that is well-maintained (roads, airport, power, water and sewerage, telephone, internet) • Effective local governance • Opportunity for recreational, cultural and sporting pursuits • Safe social and physical environment
SV2 Affordable lifestyle	• Availability of adequate housing • Income levels • Cost of housing • Cost of food, power and other essential items
SV3 Community identity and spirit	• Recognition and promotion of cultural heritage • Perceptions of being able to influence community destiny • Existence of viable enterprise activity • Number and strength of Aboriginal organisations • Status of reconciliation with non-Aboriginal community • Level of volunteering and availability of assistance • Local celebrations
SV4 Capacity for sustainable economic activity	• Availability of employment opportunities • Aboriginal workforce participation and employment • Aboriginal business start-ups and ownership • Level of education achievement, including retention to Year 12 and post-school destinations

4. Katherine regional context

A regional summary is provided as context for the affected communities' baseline profiles. The relevant region is the Katherine region, also known as the 'Big Rivers Region'. This summary is not intended to be a comprehensive characterisation of the region – it is intended as a high-level overview of key social characteristics.

The Katherine region extends from the border of Western Australia to the border of Queensland, and to the Gulf of Carpentaria in the north. It covers an area of 326,250 square kilometres and is represented by four SA2-level statistical areas: Victoria River, Katherine Town, Elsey and Gulf. The region recorded a population of 18,710 at the 2016 census, equating to 8.1% of the Northern Territory population. Katherine Town, the fourth largest town in the Northern Territory, is the regional centre for the provision of government and private sector services.

Summary regional statistics are shown in Table A4.1. These data show that Katherine Town dominates statistics for the Katherine region, comprising over half of the regional population. People identifying as Aboriginal or Torres Strait Islander (ATSI) comprise approximately 49% of the regional population, and between 70% and 85% in areas outside of Katherine Town. Outside of Katherine Town, English is a minority language.

This suggests that social analysis must be conducted at a community scale rather than a regional scale, because broad-scale analyses would not capture significant variations within the region. Studies and/or communications should be multi-lingual to reflect a variety of primary languages.

Table A4.1 Summary statistics for Katherine region (ABS Census, 2016)

	Northern Territory	Katherine region	Victoria River	Katherine Town	Elsey	Gulf
Population	228,836	18,716	2,487	9,777	2,301	4,151
% Territory	100%	8%	1%	4%	1%	2%
% Region	-	100%	13%	52%	12%	22%
ATSI People	58,248	9,162	1,829	2,179	1,635	3,519
%	25.5%	48.9%	73.5%	22.3%	71.1%	84.8%
Median age	32	29	25	33	29	25
ATSI median age	25	23	22	25	25	22
Top 3 languages spoken at home	English (58.0%)	English (46.3%)	English (21.7%)	English (65.0%)	Kriol (61.5%)	Kriol (41.8%)
	Kriol (1.9%)	Kriol (19.9%)	Warlpiri (19.1%)	Kriol (4.6%)	English (21.1%)	English (31.2%)
	Djambarrpuyngu (1.9%)	Warlpiri (2.8%)	Gurindji (13.6%)	Tagalog (1.2%)	Rembarrnga (0.4%)	Nunggubuyu (5.8%)

Notwithstanding intra-regional variations, broad characteristics of Katherine region can be set out. This section discusses population and demographics, the region's economic profile, and the degree of community services available.

4.1. Population and demographics

As shown in Table A4.1, the population of Katherine region was 18,710 persons in 2016. Population trends in the past and projected into the future are shown in Table A4.2. This projection suggests that the rate of Aboriginal population growth is projected to be more than twice the growth rate of the non-Aboriginal population in the 2021–2026 period.

In future, there is likely to be a larger Aboriginal population, both numerically and as a proportion of the total population. The growth rate of the non-Aboriginal population is projected to slow, which may accentuate the proportional difference between Aboriginal and non-Aboriginal populations.

Table A4.2 Population growth rates (past, current and projected) for Katherine region

	2011–2016	2016–2021	2021–2026
Katherine region Aboriginal population	1.1%	1.1%	1.2%
Katherine region non-Aboriginal population	0.7%	0.7%	0.5%

Source: Northern Territory Department of Treasury and Finance, Northern Territory Population Projections Main Update (2014 Release)

Population growth is not expected to be uniform across the region, as Table A4.3 shows. Growth rates ranged from 2.3% annually in Elsey, compared to a 0.2% decline in Victoria River. There does not appear to be any correlation between growth rates and the proportion of Aboriginal persons.

Table A4.3 Population growth within Katherine region (2011–2016)

SA2-level statistical area	2011 population	2016 population	Annual growth rate	% ATSI in 2016
Katherine (town)	9,209	9,777	1.2%	22%
Gulf	4,044	4,151	0.5%	85%
Victoria River	2,515	2,487	-0.2%	74%
Elsey	2,054	2,301	2.3%	71%

The proportion of ATSI persons varies significantly across the region (Table A4.1Table A4.1 and Table A4.3). Aggregated as a region, the ratio of Aboriginal to non-Aboriginal persons within the Katherine region was 49% in 2016, representing a slight decline from previous years (Figure A4.1).

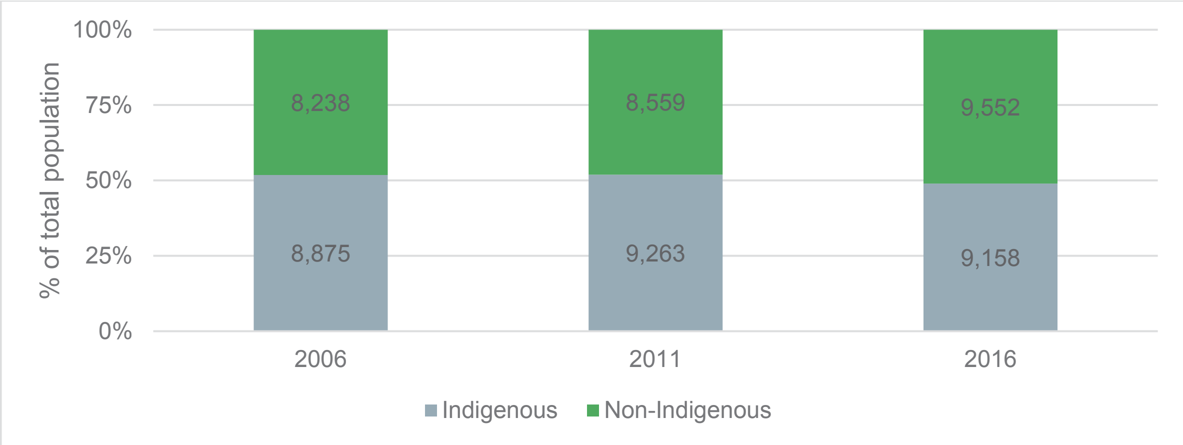


Figure A4.1 Aboriginal and non-Aboriginal populations in Katherine region (2006–2016)

4.2. Major industries

Katherine region had a gross regional product of $1,338 million in 2011–2012 (Regional Development, 2014), equating to 7.4% of the Northern Territory's gross state product. The major industries in the region are defence, mining, tourism, public administration, agriculture, forestry and fishing.

Defence

The defence sector contributes approximately $42 million annually to the gross regional product, and 46% of businesses service the sector in some form (Regional Economic Development Committee, 2014). Two military facilities are located within the region: the RAAF Base Tindal, and the Australian Army's Bradshaw Field Training Area. The Northern Territory Government notes that the Department of Defence has a significant infrastructure program proposed for the Northern Territory over the next decade (Defence Strategy Northern Territory, 2016).

Mining

The mining industry is the highest contributing industry to the Katherine regional economy, making up $293 million in gross regional product in 2011-2012 and employing 265 people (Regional Economic Development Committee, 2014). Major mining operations include McArthur River Mine, Redbank Mine and Mataranka Limestone. There are also a number of quarries and extractive operations (sand, soil, rock, gravel). The McArthur River Mine is situated near Borroloola, and is a large-scale zinc-lead mine. The mine has been operating since 1995 and is the world's second largest zinc resource. The mine operates 24/7 on a fly-in fly-out basis. In 2013, regulatory approval was given to increase production to 5 million tonnes per annum and extend the mine life to 2037. Since 2007, the mine has invested more than $12.3 million into the Roper Gulf Region through the MRM Community Benefits Trust and other community service initiatives and employed 762 people (McArthur River Mine, 2017).

Tourism

Tourism is a major industry in the Katherine Region. Key tourist attractions include Nitmiluk National Park, Edith Falls, Daly Waters Pub, and Mataranka Hot Springs, as well as other cultural tourism and fishing opportunities. Tourism in the Katherine Region is highly seasonal with peak activity during the dry season, between May and August. In the previous year (ending March 2017), the Katherine Daly tourism region recorded 317,000 visitors, slightly lower than the three-year average of 339,000 visitors from 2015–2017 (Northern Territory Tourism, 2017). Of all visitors, 54% of overnight visitors are from elsewhere within the Northern Territory, 36% are interstate, and 10% international (ibid).

Agriculture, forestry and fisheries

Agriculture, forestry and fisheries contributed $144 million to the gross regional product in 2011-2012, and employed over 700 people (Regional Economic Development Committee, 2014). Of all field and horticultural crops produced in the Northern Territory, over 40% are supplied from the Katherine region (Northern Territory Farmers, 2015). Key crops include mangos, melons, hay/fodder, citrus and nursery/turf products. Similarly, nearly 40% of all cattle in the Northern Territory are raised in the Katherine region (Regional Economic Development Committee, 2014), which are generally exported through the Port of Darwin. This industry more than doubled in its gross regional product contribution in the decade between 2002 and 2012.

Public administration and safety

The public administration and safety industry contributed $139 million to the gross regional product in 2011-2012, employing 1,922 persons, more than any other sector (Regional Economic Development Committee, 2014). However, there was a slight decline of about 3% over the preceding decade, indicating that this industry is steady but slightly receding.

4.3. Workforce participation

ABS data for the Katherine region indicates that approximately 40% of people of working age (15 years or older) are not employed. Figure A4.2 indicates that this pattern was steady between 2001 and 2011. Figure A4.3 shows that Aboriginal persons tend to be disproportionately unemployed within the Katherine region.

Figure A4.2 Workforce engagement in the Katherine region (2001–2011)

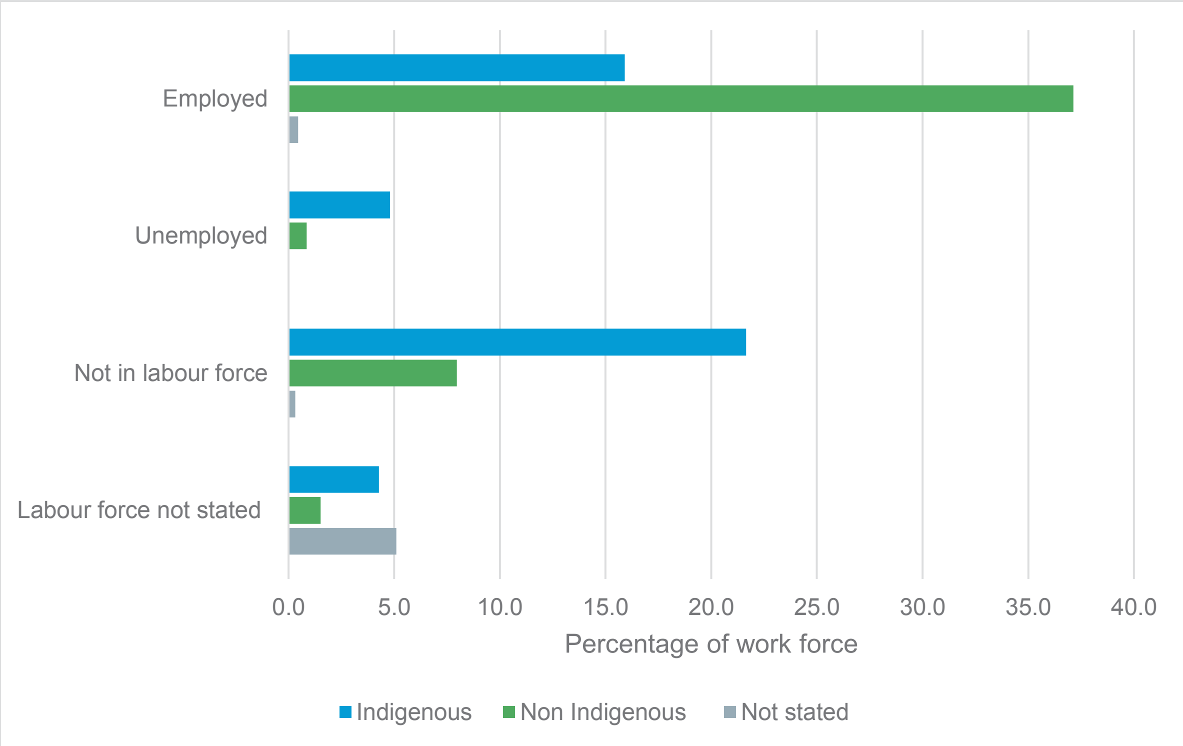
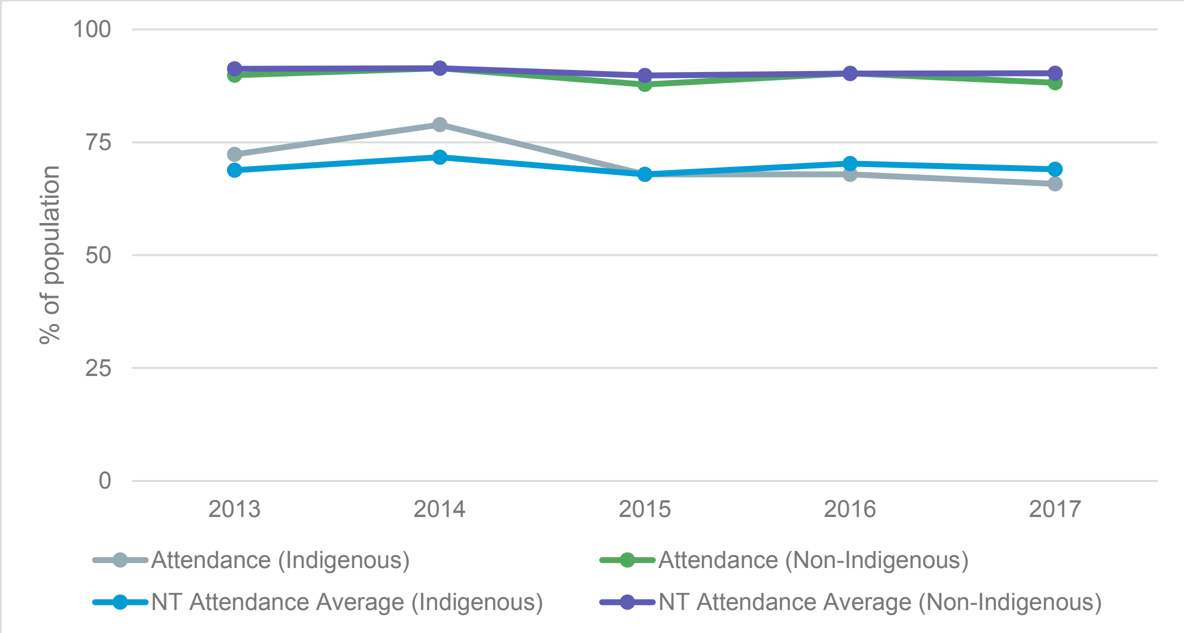


Figure A4.3 **Aboriginal and non-Aboriginal engagement in the work force in the Katherine region**

4.4. Education

Access to educational facilities varies across the region. In Katherine (town), there are eight schools which collectively cater for high school, primary school and special needs. Across the region, students usually have access to the one school in the town or community which caters for all students from kinder to Year 10 or 12 (NT Government, 2017).

School attendance rates in the Katherine region are presented in Figure A4.4. Aboriginal attendance is consistently lower than non-Aboriginal attendance, by over 20% in some years, which is also the case for the Northern Territory as a whole.



Source: NT Department of Education, 2017

Figure A4.4 School attendance in the Katherine region compared to Northern Territory average

4.5. Health services

The region's major hospital (Katherine Hospital) is located in Katherine town and has 60 beds. Specialist or acute health conditions which cannot be treated in Katherine are most often transferred to Darwin or Adelaide hospitals. There are a number of community General Practitioners and Aboriginal health organisations in the region.

Katherine West Health Board (KWHB) and Sunrise Health Service Aboriginal Corporation are the two major Aboriginal and remote health providers for the region. KWHB health board provides health services to remote aboriginal communities to the West of Katherine. The Sunrise Health Service Aboriginal Corporation works with communities to the east of Katherine (Sunrise Health Services Aboriginal Corporation, 2016).

4.6. Cost of living

The cost of housing within Katherine region (2011 compared to 2016) is presented in Table A4.4. The median rent rose approximately 5.3% per year. In both years, a minority of households paid rent equivalent to more than 30% of the household's income – but, as a percentage of all households, this proportion more than doubled between 2011 and 2016. This may indicate a rising trend of affordability stress for renters, though more research would be required to determine underlying reasons. For example, the possibility of rental increases in Aboriginal communities following the Commonwealth and NT Government Strategic Indigenous Housing and Infrastructure Program.

Homeowners within the Katherine region did not exhibit similar levels of stress. Monthly mortgage payments increased less than 2% between 2011 and 2016. The proportion of households spending more than 30% of the household's income nearly halved over the same period, suggesting that homeownership had become more affordable relative to income levels over the 5-year period.

The cost of goods (as given in Table A4.5) rose on average 2.4% per year.

Table A4.4 Katherine regional rental and mortgage breakdown

Category	2011	2016	2011	2016	2011	2016
	Katherine region		Northern Territory		Australia	
Median rent	$100	$130	$225	$315	$285	$335
Households where rent payments are 30%, or greater, of household income (%)	3.4%	7.6%	9.0%	9.1%	10.4%	11.5%
Mortgage monthly repayments ($)	$1,700	$1,733	$2,054	$2,167	$1,800	$1,755
Households where mortgage payments are 30%, or greater, of household income (%)	4.8%	2.5%	7.7%	5.5%	9.9%	7.2%

Source: ABS Census, 2011 and 2016

Table A4.5 Katherine regional cost of food basket survey

Area	2010	2011	2012	2014	2015
Katherine district average	$724	$797	$796	$801	$814
Katherine supermarket	$508	$565	$542	$571	$559
Katherine corner stores	$656	$720	$628	$746	$800

Source: NT Department of Health, 2012, 2014, 2015

5. Baseline profiles for affected communities

This section presents social baseline information for the four social catchments, within which affected communities have been grouped. The baseline information is sorted according to the social values identified. As discussed in the introduction to this appendix, the purpose of this information is to provide an evidence base for the SIA. As a high-level SIA case study, the evidence collected was not intended to be comprehensive, but to provide an indicative baseline for each social value.

5.1. Affected communities (urban)

This social catchment comprises Katherine town and Tennant Creek. Katherine is the fourth largest town, with 4% of the Northern Territory's population, about a quarter of which is Aboriginal. It is located 312 km southeast of Darwin on the Katherine River. The Katherine Local Government area covers 7,417 square kilometres. The Stuart Highway runs through Katherine, linking the town to Darwin in the north and other urban centres to the south.

The Aboriginal people of Katherine live in different communities located in and around Katherine. The largest of these are Mialli Brumby (also known as Kalano), which is located along the northern side of the Katherine River, and Rockhole, which is 15 km from the town centre. The other living areas are Binjari, Walpiri, and Gorge Camp (Jodetluk). Many Aboriginal people also live within the Katherine town itself.

Tennant Creek is the Northern Territory's fifth largest town, with 2% of the Northern Territory's population, about a half of which is Aboriginal. It is located on the Stuart Highway, approximately 989 km south-southeast of Darwin. The Traditional Owners of the area surrounding Tennant Creek are the Warumungu people. The two main Aboriginal languages spoken are Warumungu and Walpiri. The other main languages in the region are Walmanpa, Alyawarra, Kaytete, Wambaya and Jingili (Northern Institute, 2013).

Tennant Creek is located in the Barkly Region and serves as the region's key service centre. In addition to the major towns and major populations, the Barkly Region includes eight minor communities, 70 family outstations, 49 pastoral stations, mining operations and commercial properties (Jemena, 2016).

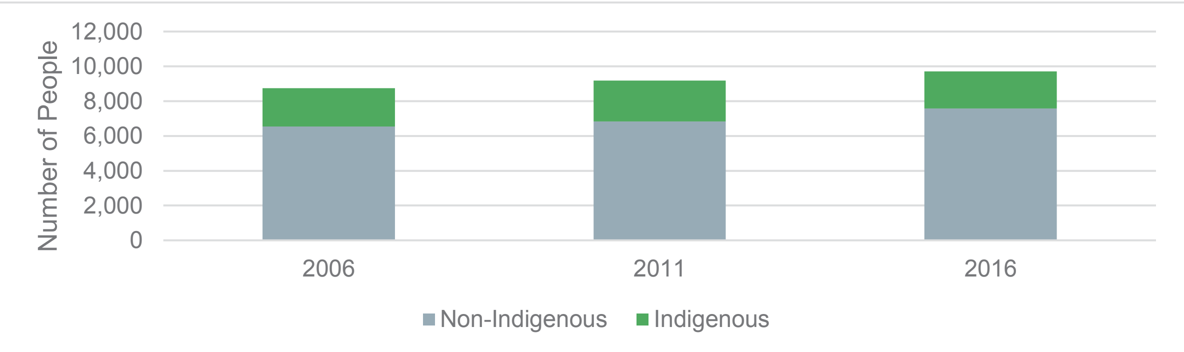
Katherine and Tennant Creek are grouped in the same social catchment because they share characteristics as urban communities. Because they are not located proximately to each other (being separated by over 600 km), baseline information for each will be presented separately.

5.1.1. Baseline information for Katherine town

SV1 Liveable community

Population and demographics

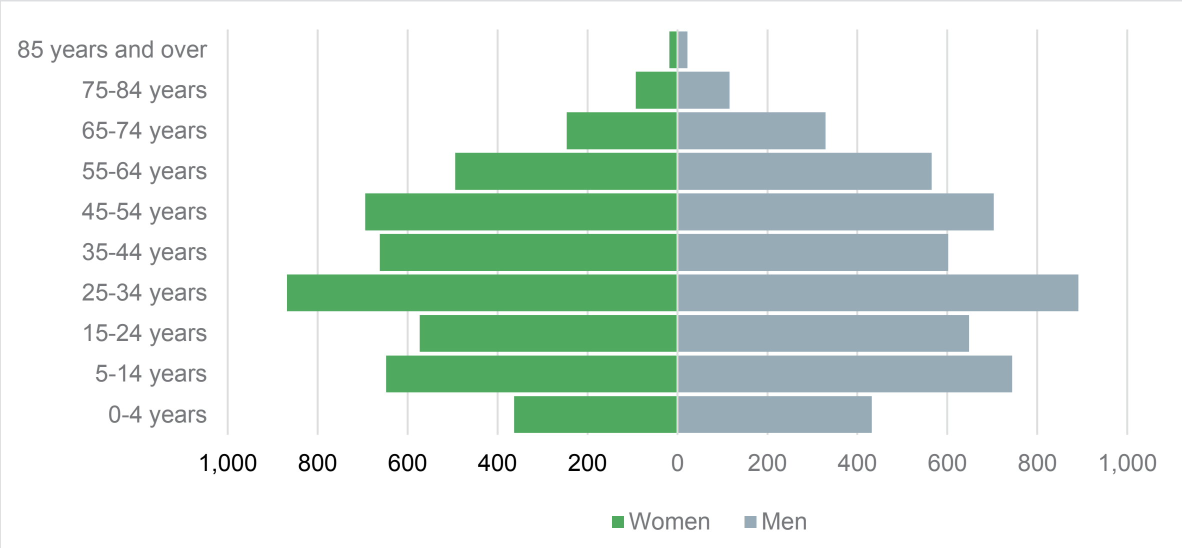
According to the 2016 census, Katherine town has a population of 9,717 persons with a median age of 33 – older than the other areas of Katherine region and likely due to its relatively lower proportion of ATSI people (22% compared with 49% for the region), who tend to have a lower median age (see Table A4.1). The total population has exhibited steady growth over the last decade (Figure A5.1).



Source: ABS Census, 2016

Figure A5.1 Katherine town population growth (2006–2016)

The average household size has been 2.8 persons per household since the 2006 census, with an average of 1 person per bedroom (Table A5.1). This may be due to Katherine being made up largely of working-age non-Aboriginal residents, and school-age and older working-age Aboriginal residents (Northern Institute, 2014). Figure A5.2 presents an age-sex pyramid for Katherine for 2016, showing that the town's population tends to be 25 to 54 years of age, with relatively fewer children and young adults.



Source: ABS Census, 2016

Figure A5.2 Age-sex pyramid of Katherine town

The population turnover (the sum of intra-Territory, interstate and overseas migration as a percentage of the resident population) is high, reaching 63% in 2011 (ibid). This suggests a certain level of demographic instability, possibly leading to fluctuating needs of Katherine town over time. Non-Aboriginal migrants tended to migrate to and from other Australian states, while Aboriginal migrants tended to be intra-Territory migrants moving to and from Roper Gulf, Victoria River, Daly, and Darwin.

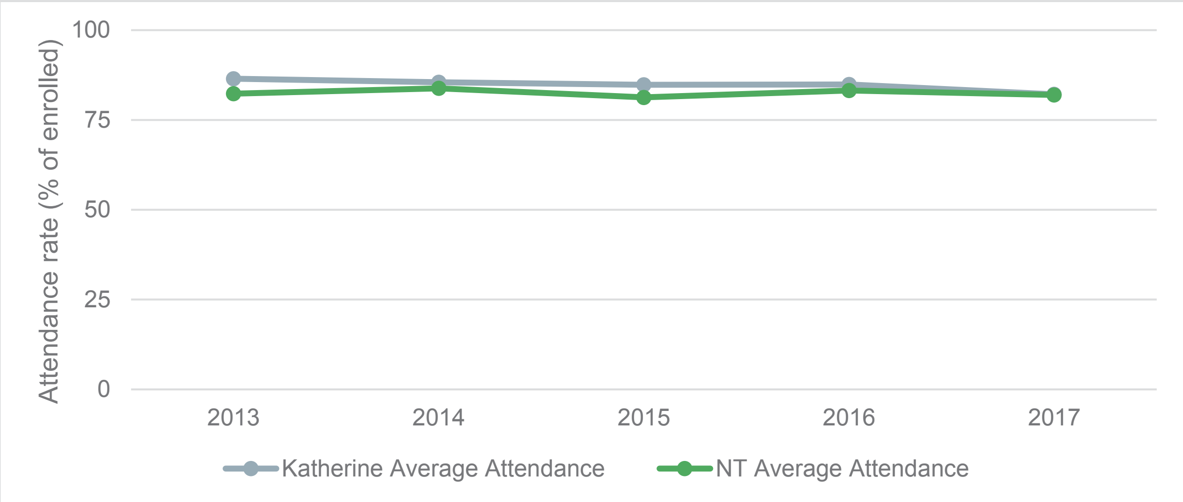
Table A5.1 Median age and household demographics for Katherine town

Category	2006	2011	2016
Median age	31	31	33
Average household size	2.8	2.8	2.8
Average number of people per bedroom	1	1	1

Education

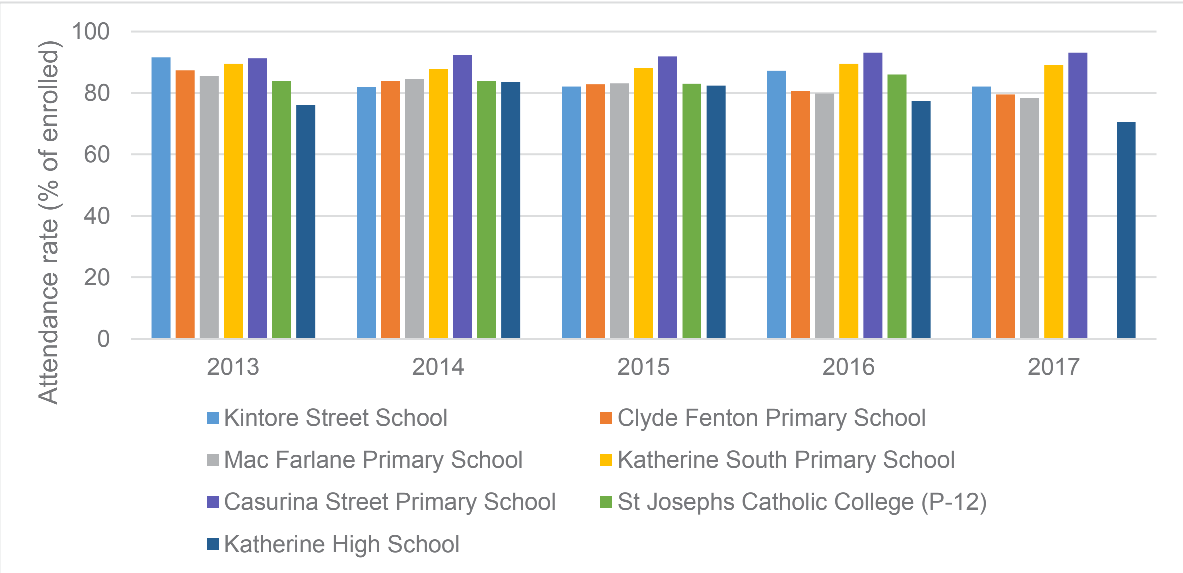
Katherine has a number of public and private primary and high schools. These include St Joseph's Catholic College, Kintore Street School, Clyde Fenton Primary School, Katherine High School, Mac Farlane Primary School, Katherine South Primary School and Casuarina Street Primary School. The Kintore School caters for students with physical and intellectual impairments from pre-school to Year 12. Charles Darwin University also has a campus located on the outskirts of Katherine which offers agriculture, rural operations, conservation and land management and automotive courses.

The attendance rates for the Katherine schools have been declining over the last five years, but until 2017 have historically been higher than the Northern Territory average (Figure A5.3). When disaggregated by school (Figure A5.4), it can be seen that primary school attendance has declined over the last five years but remained above 78%, while attendance at Katherine High School has dropped below 71% in 2017.



Source: NT Department of Education, 2017

Figure A5.3 Katherine school attendance rates compared to the Northern Territory average



Source: NT Department of Education, 2017

Figure A5.4 Katherine town attendance - by school

Crime

Katherine has seen an increase in crime against people and property over the last two years. Crimes against the person were committed at a rate of 5,290 per 100,000 population in 2016–2017, a 16% increase from the previous year. Crimes against property were committed at a rate of 9,128 per 100,000 population in 2016–2017, a 23% increase (Northern Territory Police, 2017).

The rate of crime against the person in Katherine is close to double the rate of Darwin and is slightly less than Alice Springs. The rate of crime against property is less than Darwin and significantly less than Alice Springs. The Northern Territory has the highest offender rate in Australia.

In 2016, the highest offending group in the Northern Territory was 20 to 24 year olds (ABS Census, 2016). The Northern Territory Government is spending $18.2 million on youth crime prevention and allocating funding for new youth workers for Katherine as part of a youth justice system overhaul (Jones, 2017).

Community services

As Katherine is the largest town in the region it acts as a community services hub. Commonwealth and Territory Governments have offices and staff based in the town which service the wider region. The Northern Territory Police have a large station in Katherine. Many other non-government organisations and community groups are clustered in Katherine. Some of these include Anglicare, Red Cross, Beyond Blue, Cares NT, Cancer Council, Head Space, Lion’s Club, Salvation Army, Apprenticeships NT, Women’s Crisis Centre and RESPECT – Relationships Australia.

There are a large number of community and social groups in the town. These include Big River BMX Club, Katherine Air Force Cadets, Katherine Archery Club, Katherine Bowls Club, Roller Derby, Community Radio Station, Girl Guides, Krocs Social Rugby Club, Senior Citizen Association, QLife (for lesbian, gay, bisexual, transgender and intersex) and Landcare groups.

Katherine has a number of facilities and programs for young people. There are four sports ovals (two with lights for night use), a BMX track, a skate park, children's adventure playground, aquatic centre and a number of park and recreational areas.

The Katherine YMCA provides an Aboriginal youth program which is targeted at assisting students at risk of disengaging from education. In July 2017, the Commonwealth Government committed $200,000 to support the program (Aboriginal Affairs Media Hub, 2017). The YMCA also provides youth diversion programs for at risk youth and boys and girls groups which provide activities and social networks. The YMCA Community Youth Development provides constructive and engaging youth activities, events and programs and schools holiday programs.

The lists of community services is much greater than other towns and communities within the region. Katherine’s population has far greater access to community and government support services than any other town in the Katherine Region.

Health

As Katherine is a regional hub there are a number of large health services based in the town, including Katherine Hospital. The Katherine Hospital is a non-specialist public hospital that services Katherine and the surrounding region and remote areas. It has 60 beds and a 24-hour emergency department.

Katherine also has general practitioner community practices, Aboriginal health clinics and mental health services. The Wurli Wurlinjang Health Service provides services to Aboriginal people in Katherine. Significant health issues impact Aboriginal populations in Katherine. There is a high level of endemic diseases such as diabetes, rheumatic heart disease, and chronic heart and kidney disease (Roper Gulf Regional Council, 2017). These endemic diseases are linked to the relative poverty of the region and lifestyle issues such as high alcohol consumption, high smoking rates, overcrowded social housing and poor nutrition (ibid). There is a significant health gap between Aboriginal and non-Aboriginal Australians which is apparent within the Katherine population (ibid).

Access to health services is significantly better for the Katherine population than the wider Katherine Region.

Infrastructure

Katherine is a regional hub and the largest town in the region, with correspondingly sophisticated infrastructure relative to the rest of the region. Katherine has a small shopping mall with retail outlets, a Woolworths supermarket, chemists, bakeries and bottle shops. There are a number of other retail outlets, cafes, fast food restaurants, pubs, petrol stations, and shopfronts around Katherine.

There is also a number of government buildings including a courthouse and tourist information centre. The aquatic centre, sports grounds and showgrounds are all managed by the Katherine Town Council (Katherine Town Council, 2009). There is also a speedway where racing events are held. The roads in Katherine are all sealed and access to Katherine is open all year, other than in major flood events.

Katherine has a number of tourism facilities and accommodation. There are two small museums, art centres and a visitor’s centre. There are a number of hotel and motel accommodation businesses in Katherine which support the seasonal tourism business.

Most of the major banks have offices in Katherine including the Commonwealth Bank, ANZ Bank, Westpac Bank, Bendigo Bank and the Territory Insurance Office.

Katherine has a domestic airport and RAAF Base Tindal. There is a large amount of infrastructure on the base to support the Defence population.

Katherine is currently experiencing ground and drinking water contamination from PFAS chemicals. The contamination has been linked to the use of firefighting foams on the RAAF Base Tindal and treatment options are currently being explored. This contamination has heightened the towns concerns around risks posed to water from other technologies, such as hydraulic fracturing.

SV2 Affordable lifestyle

The cost of housing and rental costs have remained proportional over the last five years, although rental costs increased at a slightly faster rate (Table A5.2). The median personal income between 2011 and 2016 increased 22%, while rental costs increased 25%. There was a 40% increase in the proportion of households who devoted more than 30% of their household income to rent. This increase was less than the region as a whole, which more than doubled over the same period. Home ownership appeared to have become relatively cheaper compared to income.

Table A5.2 Income and housing statistics for Katherine town

Category	2011	2016
Median total personal income ($/weekly)	$758	$922
Median total family income ($/weekly)	$1,766	$2,081
Median total household income ($/weekly)	$1,429	$1,690
Median rent	$200	$249
Households where rent payments are less than 30% of household income (%)	93.8%	91.4%

Category	2011	2016
Households where rent payments are 30%, or greater, of household income (%)	6.2%	8.6%
Mortgage monthly repayments ($)	$1,733	$1,733
Households where mortgage payments are less than 30% of household income (%)	94.9%	96%
Households where mortgage payments are 30%, or greater, of household income (%)	5.1%	4%

SV3 Community identity and spirit

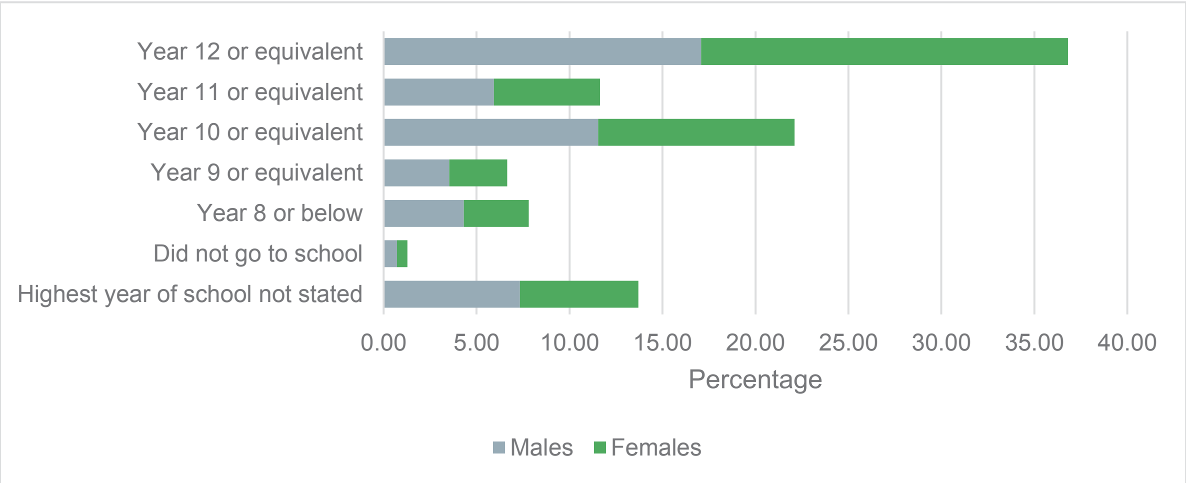
Being the major town within Katherine region, Katherine provides community services and functions which engage people from across the region. Katherine is a large multicultural town, with a strong Aboriginal and agricultural history and identity. It attracts tourists each year from across Australia and from overseas. Being the largest town in the region, Katherine has a wide range of community events, social activities and shows which draw people from across the region.

Katherine has a number of community forums including the Katherine Times newspaper, the local 8KTR Community Radio Station, the Katherine Community Markets held each Sunday morning and a number of community social and interest groups. One of the largest annual events is the Katherine Agricultural Show, which people from across the region travel to attend and compete in various events.

The Department of Defence has a number of initiatives to help promote community and inclusion in Katherine and on the Defence RAAF Base Tindal (Defence Community Hub, 2017). These include a community-based newsletter, swimming sessions, choir and a special needs support group.

SV4 Capacity for sustainable economic activity

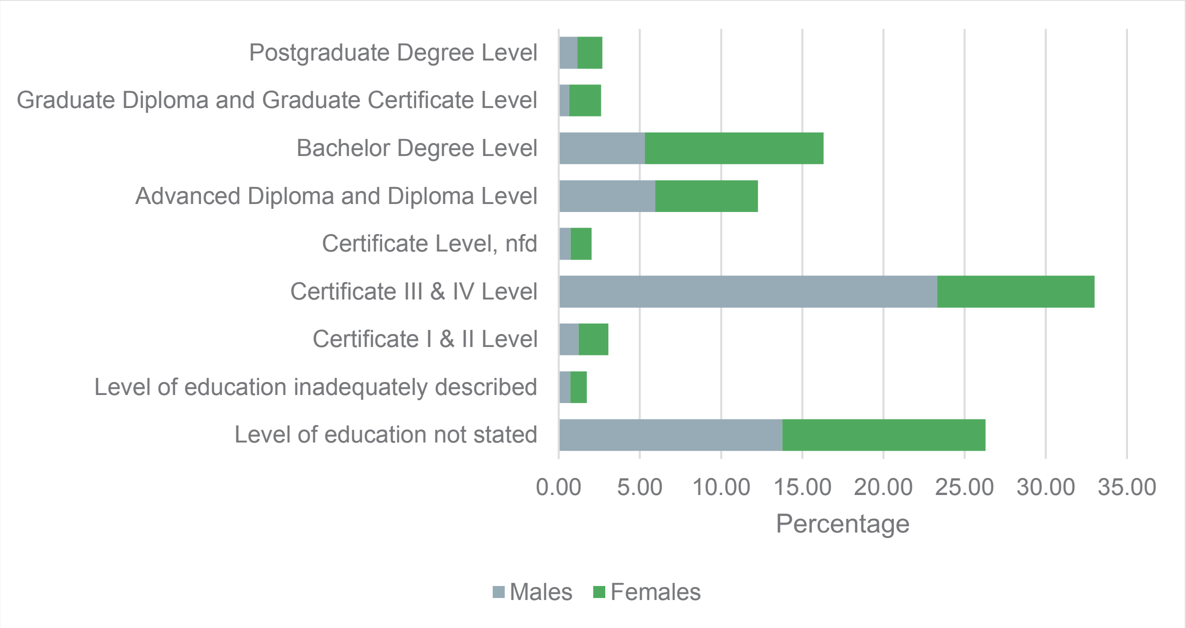
The most common level of education achieved in Katherine is Year 12, as shown in Figure A5.5. This is significantly different to the Roper Gulf and surrounding communities, where Year 10 and below where the most commonly achieved. Katherine is comparable to Darwin, which also has Year 12 as the highest level of education achieved.



Source: ABS Census, 2011

Figure A5.5 Katherine highest level of education achieved

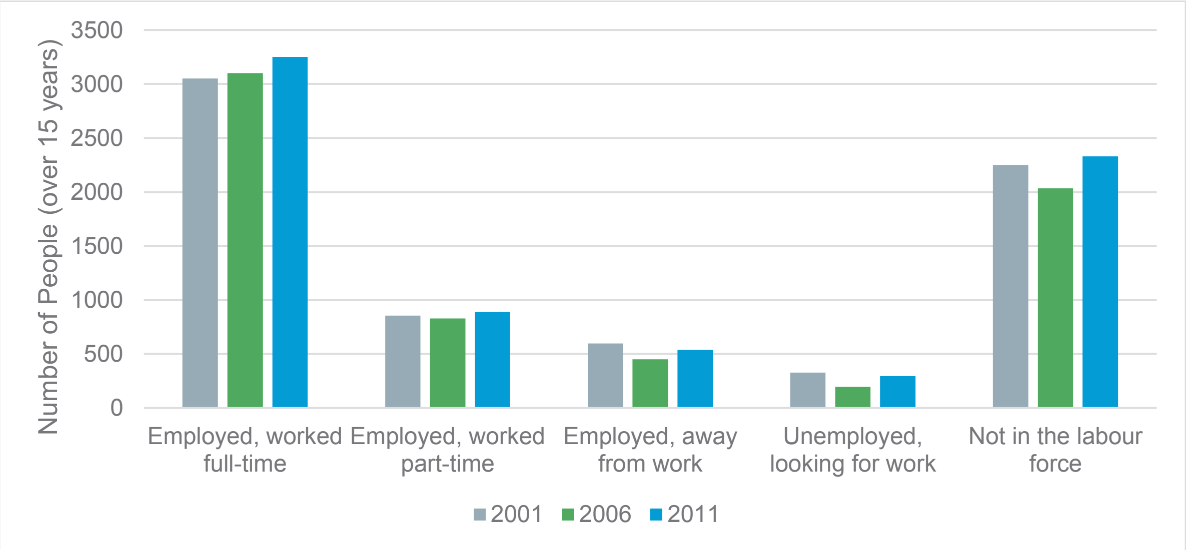
The most commonly achieved post-school qualification is a Certificate III and IV (Figure A5.6), comparable to patterns in the Roper Gulf. Higher levels of education, including advanced diplomas and bachelor degrees are commonly achieved in Katherine than the wider region. This is likely due to the high level of government, health and social services based in Katherine. The access to Charles Darwin University Campus would also influence the population's tertiary education levels.



Source: ABS Census, 2011

Figure A5.6 Katherine non-school qualifications

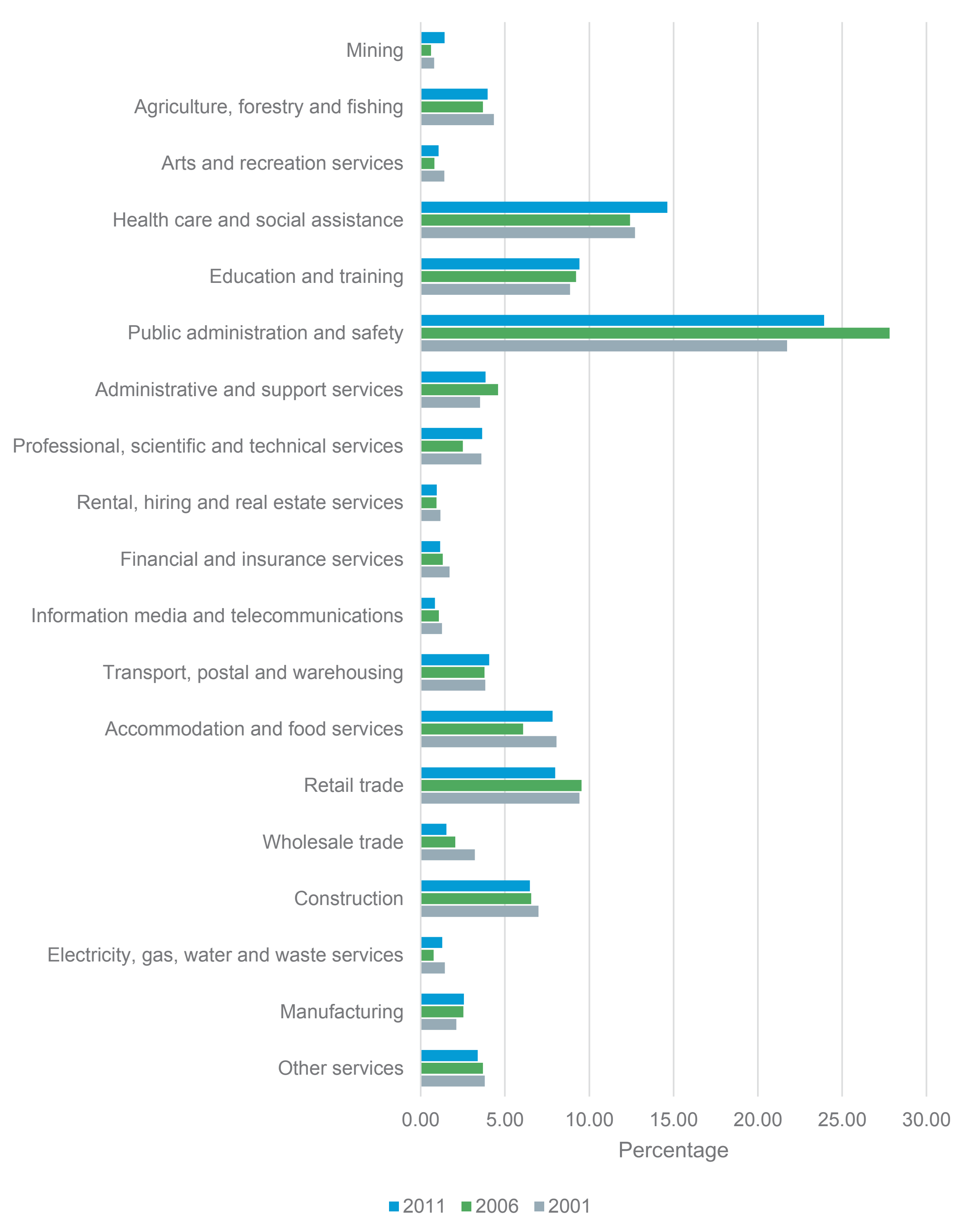
The majority of the Katherine population was employed full-time between 2001 and 2011, indicating a highly engaged workforce. Census data is shown in Figure A5.7.



Source: ABS Census, 2011

Figure A5.7 Workforce participation in Katherine

The key employment sectors in Katherine town are public administration and safety, health care and social assistance, and education and training (Figure A5.8). Katherine town also operates as a supply hub for regional businesses, as discussed above.



Source: ABS Census, 2011

Figure A5.8 Employment by sector in Katherine town

5.1.2. Baseline information for Tennant Creek

SV1 Liveable community

Population and demographics

Tennant Creek is the Northern Territory's fifth largest town, with 2% of the Northern Territory's population. It is located on the Stuart Highway. The Traditional Owners of the area surrounding Tennant Creek are the Warumungu people. The two main Aboriginal languages spoken are Warumungu and Walpiri. The other main languages in the region are Walmanpa, Alyawarra, Kaytete, Wambaya and Jingili (Northern Institute, 2013a).

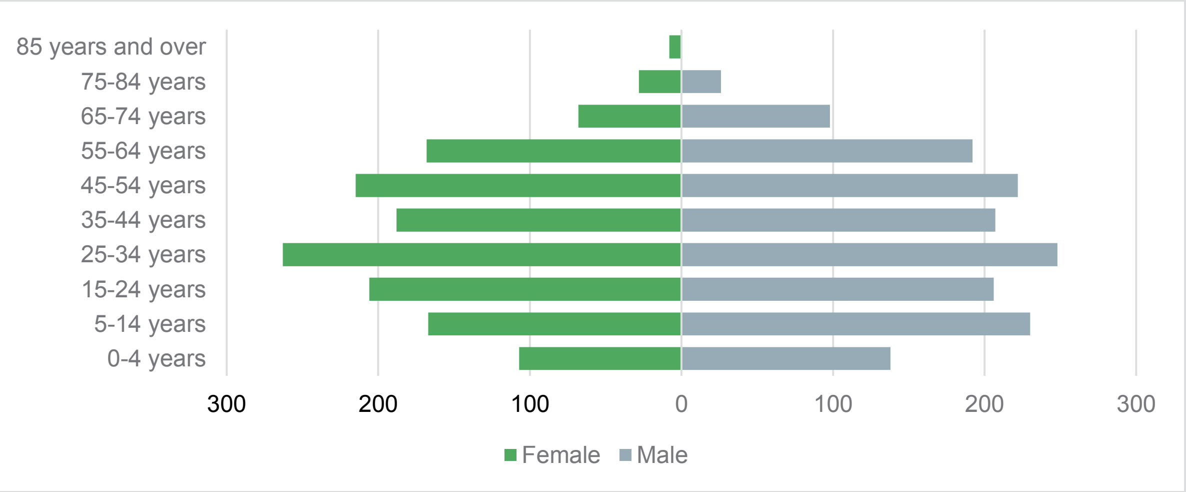
Tennant Creek is located in the Barkly Region and serves as the region's key service centre. In addition to the major towns and major populations, the Barkly Region includes 8 minor communities, 70 family outstations, 49 pastoral stations, mining operations and commercial properties (Barkly Regional Council, 2011).

Tennant Creek has a population on 2,991 and has seen a 2% decrease in population of since 2011 (Table A5.3). The median age in Tennant Creek in 33, which is slightly higher than the Northern Territory average, and the age bracket 25 to 34 years of age is the largest (Figure A5.9; also Northern Institute, 2013a). While non-Aboriginal residents tend to migrate to and from the town to interstate, Aboriginal residents migrate in from the surrounding region and out to Darwin and interstate (ibid).

Table A5.3 Key demographic data for Tennant Creek

Category	2006	2011	2016
Median age	31	32	33
Average household size	2.9	2.9	2.7
Average number of people per bedroom	1	1	1

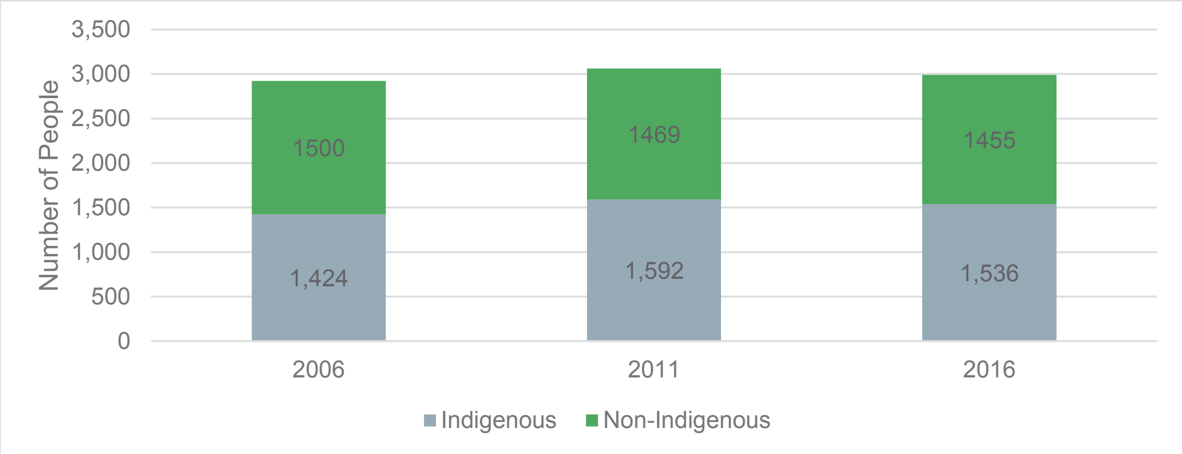
Source: ABS Census, 2006, 2011 and 2016



Source: ABS Census, 2016

Figure A5.9 Age-sex pyramid for Tennant Creek

Tennant Creek makes up close to half of the Barkly Region's population of 6,893, which is estimated to increase by 8.9% by 2021–2026 (ABS Population Projections, 2008). As can be seen in Figure A5.10, Aboriginal residents make up approximately 50% of the population.



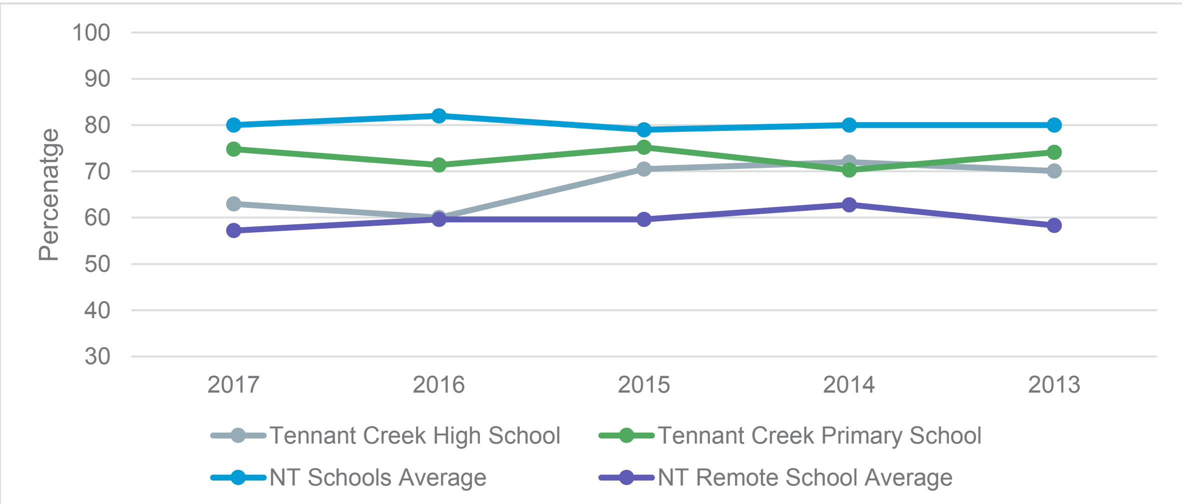
Source: ABS Census, 2016

Figure A5.10 Tennant Creek population breakdown – Aboriginal and non-Aboriginal

Education and community services

As Tennant Creek is a region hub for the Barkly Region, it has a number of community services. These include childcare services, school nutrition programs, aged cared and disability services, safe houses, night patrol, community arts center, Australian Post and Centrelink. A number of government departments, legal services and commercial business located in Tennant Creek.

One primary school and one secondary school are located in Tennant Creek. School attendance averages in the town fluctuate below the Northern Territory average but sit above the average attendance rates for remote schools (Figure A5.11) (NT Department of Education, 2015).



Source: NT Department of Education, 2015

Figure A5.11 Tennant Creek school attendance compared to Northern Territory averages

Crime

Tennant Creek recorded 10,647 crimes per 100,000 against the person and 17,208 per 100,000 against property between July 2016 and June 2017 (Northern Territory Police, 2017). During this time there was a 19.9% increase in crimes against the person and a 7% increase in crimes against property. Crimes against the person in Tenant Creek are approximately 26% higher per 100,000 than across the Northern Territory. Crime against property in Tennant Creek is approximately 17% less per 100,000 than across the Northern Territory (ibid).

Health

While health data specific to Tennant Creek was not available, the Northern Territory Medicare Local Health Atlas of 2014 (Medicare Local Northern Territory, 2014) indicated that the Barkly Region has a low Index of Relative Social Disadvantage (IRSD). The Barkly Region fell within the lowest decile of IRSD ranking within Australia. The IRSD is a general socioeconomic index that summarises a range of information about the economic and social conditions of people and households within an area. The mortality ratio for the Barkly region (the number of deaths per 1,000 people over a given period) is approximately 13.3, which is higher than the Northern Territory ratio of 7.6. According to the Northern Territory Medicare Local Health Atlas of 2014 the Barkly Region is of particular concern for low birth weights, with almost a quarter (24.7%) of the babies having a low birth weight (ibid).

Tenant Creek has a 20-bed hospital which provides accident and emergency and outpatient facilities. The hospital also provides allied health services, aged care and visiting specialists' services. St John Ambulance is located at the hospital and services a 150 km radius around Tennant Creek.

Anyinginyi Health Aboriginal Corporation provides primary health care and dental services to Aboriginal people in Tennant Creek and the surrounding region in addition to services such as community development, sport, and alcohol after care and education. More than 2,500 people access Anyinginyi's health clinic each year, with 90% of services and 80% of patients being Aboriginal (Jemena, 2016).

SV3 Affordable lifestyle

Housing and income data for Tennant Creek is provided in Table A5.4. Rental costs have risen 14% in the last five years, while personal income has risen only 3%. The average personal income is $650 per week, which is approximately a quarter less than the Northern Territory average and nearly a third less than Katherine.

Table A5.4 Housing affordability in Tennant Creek

Category	2011	2016
Median total personal income ($/weekly)	$631	$650
Median total family income ($/weekly)	$1,401	$1,592
Median total household income ($/weekly)	$1,373	$1,551
Median Rent	$125	$175
Mortgage monthly repayments ($)	$969	$1,216

Source: ABS Census, 2016

SV4 Community identity and spirit

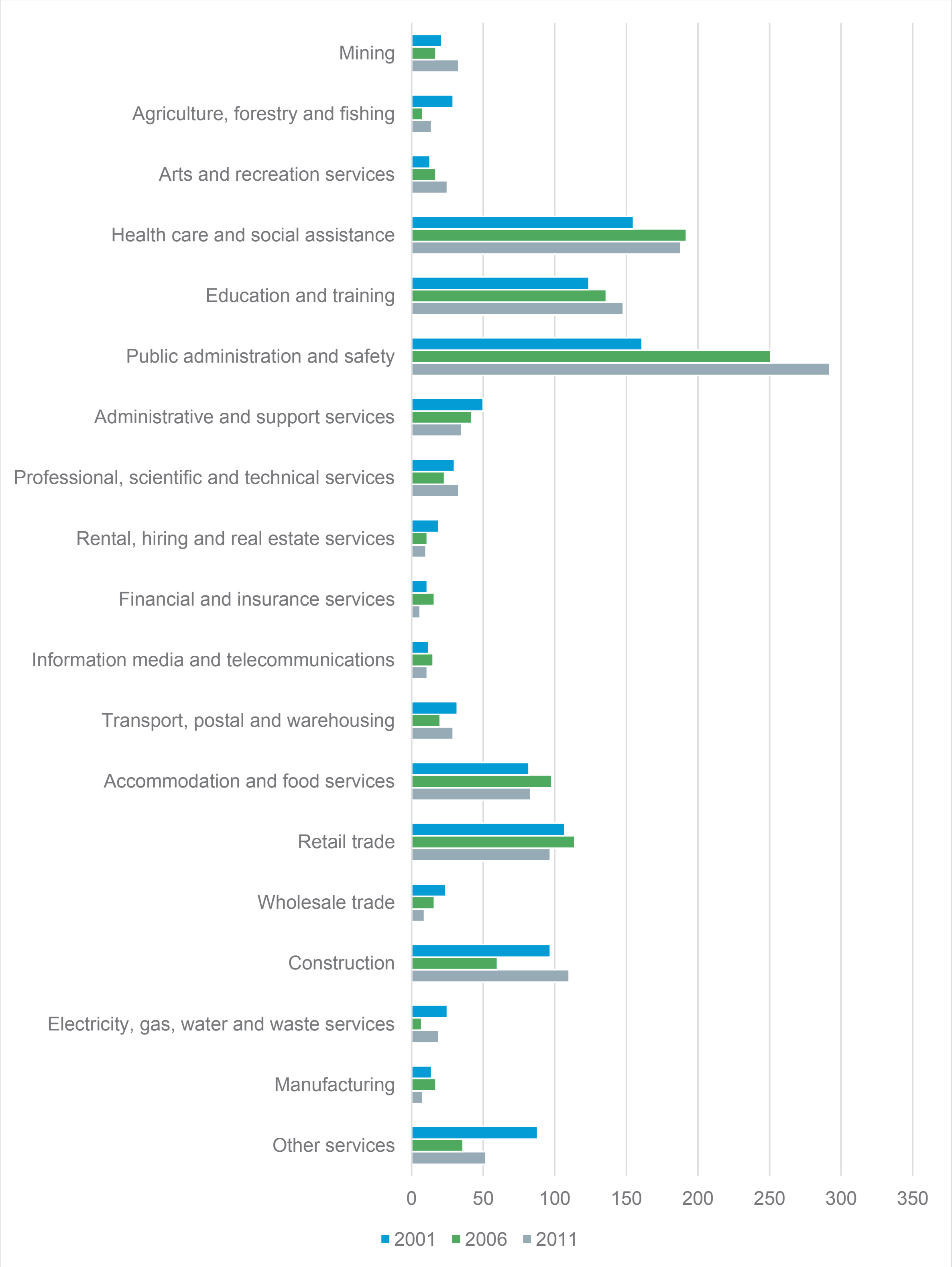
Tennant Creek is a multicultural society, with half of the population identifying as Aboriginal. There are residents from a range of nations including England, India, Germany, Greece, Philippines, Nepal and New Zealand (ABS Census, 2016). The region has a strong and proud Aboriginal history which is celebrated in the Nyinkka Nyunyu Art and Culture Centre, which has a number of fixed exhibitions which tell the local history from an Aboriginal point of view (Nyinkka Nyunyu Art and Culture Centre, 2004). It is also a space where local community performances are held, including traditional and contemporary dance, music, theatre and visual arts. Interstate and Northern Territory artists also hold performances and community events at the centre (Nyinkka Nyunyu Art and Culture Centre, 2004).

Tennant Creek is an important social and cultural hub for the Barkly Region. The town holds a number of large regional events which bring together people from across the region and Australia. A major community event is the annual Dessert Harmony Festival. The festival is the region's platform for the culturally diverse population to present, engage, participate and access the arts. The festival attracts artists from across Australia and allows the region to celebrate creativity and cultures (Desert Harmony Festival, 2017).

Tennant Creek also holds the Barkly Campdraft and Rodeo, which brings together a large number of people from pastoral stations across the region. The historic significance of this event represents the tradition of practicing, and competing in, the pastoral skills that provided the backbone of establishing the cattle industry and the pastoral stations that are one of the major economic factors in the region (Do the NT, 2017). Several horse racing events throughout the year also draw people to the town from across the Northern Territory.

SV4 Capacity for sustainable economic development

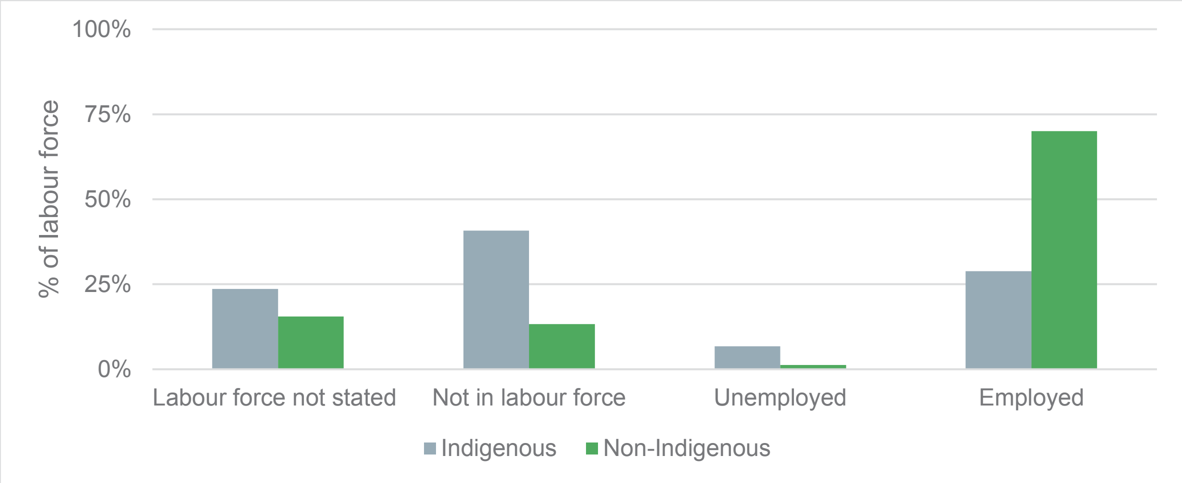
The key industries in and around Tennant Creek are mining, cattle and tourism. Public administration, health/social assistance and education/training are the highest areas of employment in Tennant Creek (Figure A5.12). Accommodation/food services and retail trade are also high areas of employment, due to their connection with the tourism industry.



Source: ABS Census, 2011

Figure A5.12 Employment by Industry in Tennant Creek

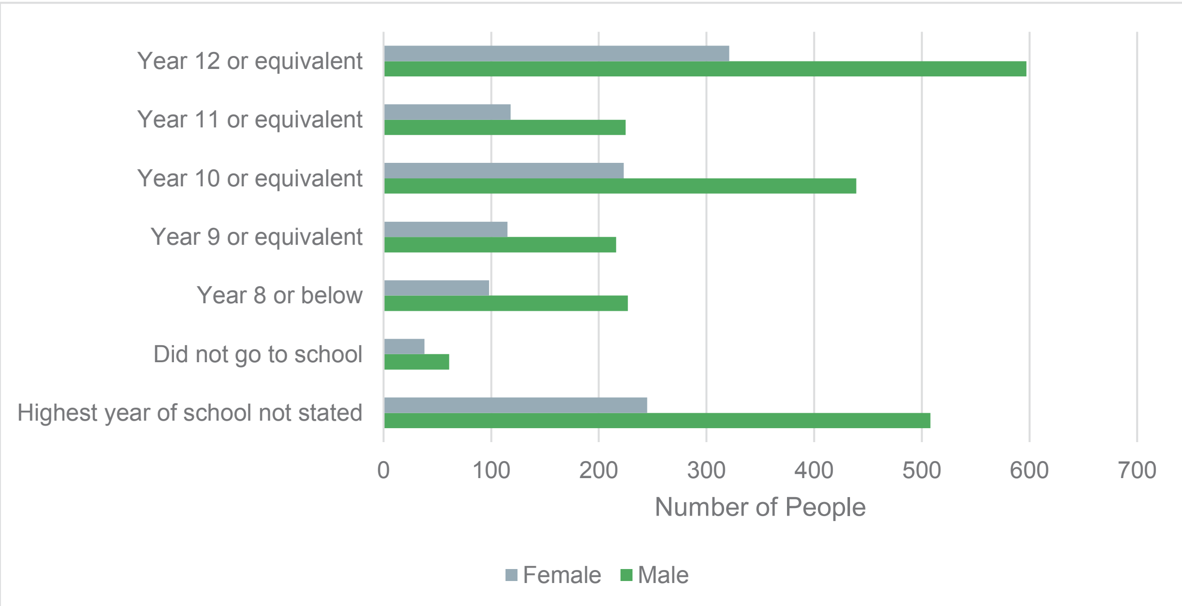
Unemployment in the Barkly Region is a significant issue. The overall unemployment rate of 8.9% for Tennant Creek was the highest in the Northern Territory in 2015, although it was down from 9.6% in 2014 (Jemena, 2016). The unemployment rate for Aboriginal people is 23.1% in the Barkly region. This is almost four times the Northern Territory unemployment rate (Jemena, 2016). Similarly, Figure A5.13 shows that unemployment among Aboriginal people is significantly higher than among non-Aboriginal people.



Source: ABS Census, 2011

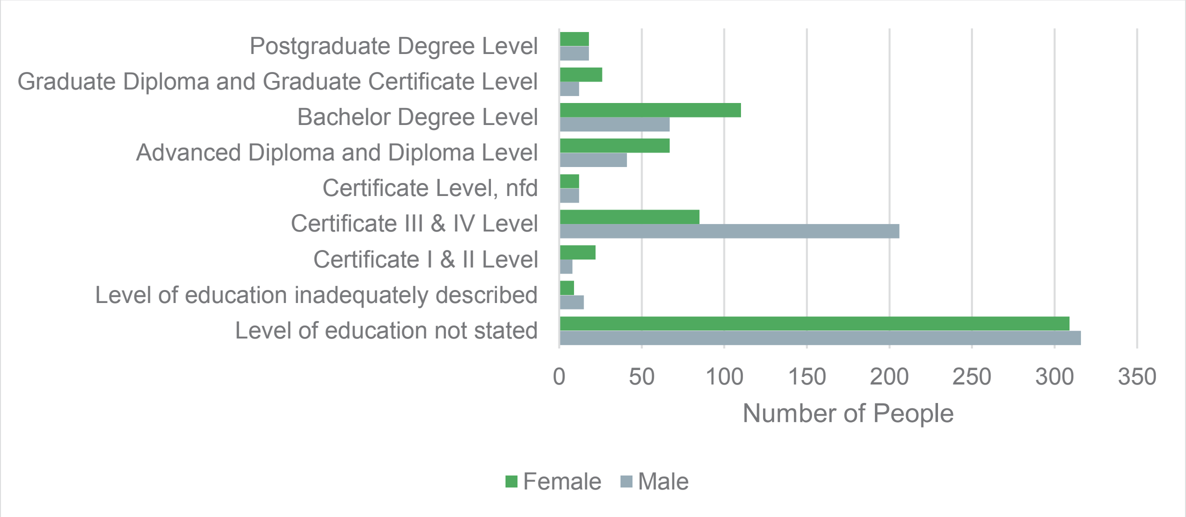
Figure A5.13 Workforce participation in Tennant Creek

Figure A5.14 and Figure A5.15 provide an indication of the educational attainment in Tennant Creek. Overall, 27% completed Year 12, while 41% did not progress beyond Year 10. Certificate III and IV qualifications was the most commonly completed non-school training.



Source: ABS Census, 2011

Figure A5.14 Highest level of schooling attained in Tennant Creek



Source: ABS Census, 2011

Figure A5.15 Non-school qualifications in Tennant Creek

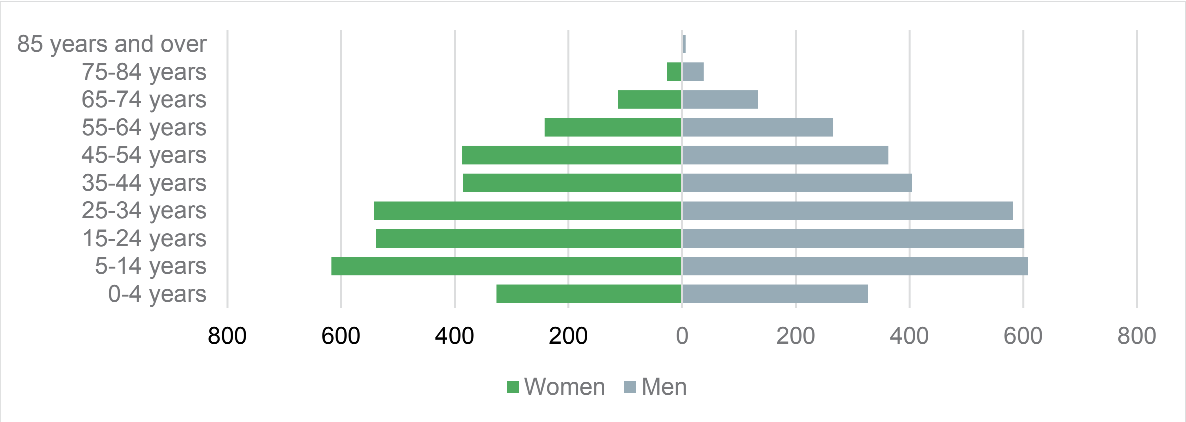
5.2. Affected communities (north)

There are six communities in this social catchment: Mataranka, Barunga, Beswick, Jilkminggan, Minyerri and Ngukurr. These communities are all serviced by the Roper Gulf Regional Council. This region is largely rural and has a number of small towns and Aboriginal communities and outstations. The Roper Gulf Regional Council area encompasses a total land area of nearly 186,000 square kilometers, with roughly one person for every 26 square kilometers.

5.2.1. SV1 Liveable community

Population and demographics

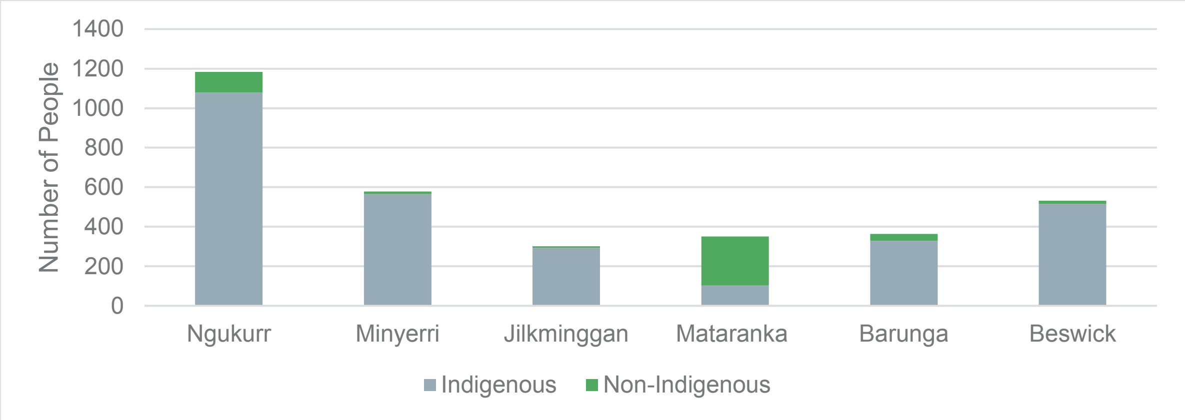
The Roper Gulf Region in 2016 had a population of 6,505. The region is demographically young with a median age of 26 years. The population has grown at approximately 1.3% each year since 2006. Figure A5.16 shows a generally balanced population, with the exception of low numbers of children 4 years old and younger. It is unclear why this pattern was recorded.



Source: ABS Census, 2016

Figure A5.16 Age-sex pyramid of Roper Gulf region

The population is predominantly Aboriginal across all communities within this social catchment, as shown in Figure A5.17. The only exception is Mataranka, which is 71% non-Aboriginal.

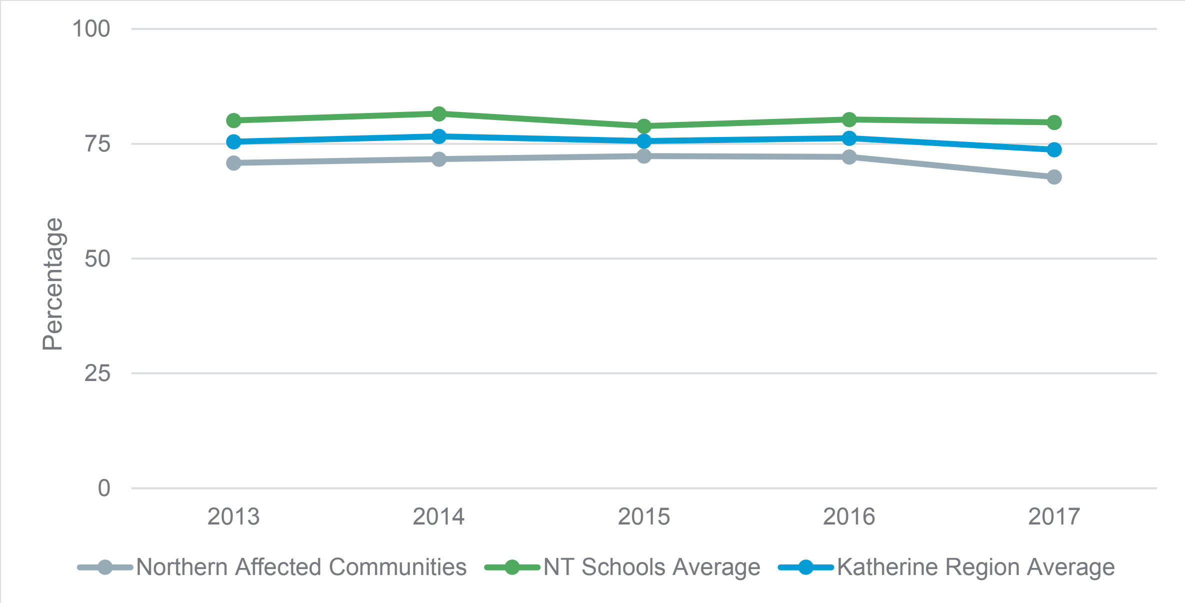


Source: ABS Census, 2016

Figure A5.17 Aboriginal and non-Aboriginal population of Affected communities (north)

Education

Each community has a primary and/or senior school, suggesting that educational facilities are accessible in all communities. The school attendance rate across the Roper Gulf Region is 10% to 15% below the Northern Territory rates, and 5% to 10% lower than the Katherine regional average, as shown in Figure A5.18.



Source: NT Department of Education, 2017

Figure A5.18 School attendance in Affected communities (north)

Figure A5.19 shows school attendance disaggregated by community. Attendance is relatively higher for Mataranka, Minyerri and Ngukurr, compared to Barunga, Beswick and Jilkminggan. Attendance for each community is fairly consistent across the last five years.

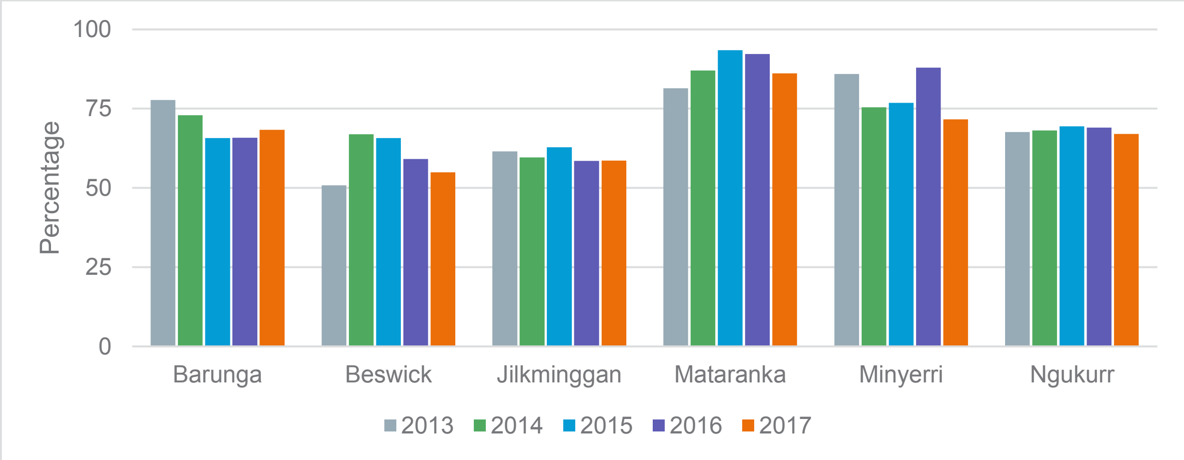


Figure A5.19 School attendance by community - Affected communities (north)

There are some youth services and programs available in the region. Ngukurr and Numbulwar have dedicated youth services, all northern affected communities have sport and recreation programs. Schools based in Bulman and Manyallaluk have nutrition programs. Ngukurr has a town swimming pool. Crèche services are lacking in the region, as they are only available in Beswick, Jilkminggan and Manyallaluk.

Centrelink agencies and Australian Post Offices are available in each of the communities in this social catchment. Training and employment of local people in Council operations occurs in each community, which supports local government as being the largest employer in the region. The Roper Gulf Shire provides aged care facilitates in limited communities.

Crime

Police stations are located in each of the communities, and crime statistics are aggregated under the NT Balance category in official statistics due to the low population numbers.

The NT Balance area has seen a slight decrease in crime against people over the last two years, and an increase in crime against property. Crimes against the person were committed at a rate of 2,942 per 100,000 population in 2016–2017, a 0.2% decrease from the previous year. Crimes against property were committed at a rate of 5,309 per 100,000 population in 2016–2017, a 12.8% increase (Northern Territory Police, 2017).

The rate of crime against the person in the NT Balance area is close to 60% of the rate in Katherine and close to 30% of the rate in Tennant Creek. The rate of crime against property is less than Katherine and significantly less than Tennant Creek. The Northern Territory has the highest offender rate in Australia.

Community services

Other services throughout the Roper Gulf Region include art centres, petrol stations and tourist accommodation in Mataranka, Daly Waters and Borroloola. Each community has at least one shop which sells food and an array of various retail goods. The range of retail goods is limited. Aboriginal communities have alcohol restrictions.

Health

Health clinics are located in each community and are generally bulk-billed. Doctors are available in clinics, with availability ranging from one day a fortnight to a full-time permanent basis. According to the 2015/2016 Sunrise Health Service Aboriginal Corporation Annual Report there were 56,094 episodes of care and 74,090 client contacts for the 2015–2016 period (Sunrise Health Services Aboriginal Corporation, 2016).

Mortality rates in the Roper Gulf Region are higher than the Australian average and life expectancy is much lower.

Infrastructure

Minyerri does not have mobile phone coverage though pay phones are available in the community. Other communities have Telstra mobile network coverage, however limited services are available outside the towns and communities.

The majority of local roads in the Roper Gulf Region are not sealed, though some communities have sealed streets. The Stuart Highway, part of the National Highway system, and the Carpentaria Highway are the major roads servicing the region. Much of the road network is subject to seasonal closure because of flooding. Unsealed roads are graded throughout the year. The Roper Gulf Shire spent $88,871 on local roads maintenance in 2015–2016 (Roper Gulf Regional Council, 2016). In 2016, the Roper Gulf Regional Council secured $2.31 million to deliver infrastructure to Ngukurr and Numbulwar, including sealed heavy vehicle routes and undercover laydown areas to the communities (ibid).

Public transport is very limited and expensive and private vehicle ownership levels are low, with 39% of people having no registered vehicle. This is much higher than the Katherine region where 19% of people do not own a registered vehicle (ABS Census, 2016).

All communities and towns have airstrips and a number of outstations have airstrips and/or helicopter access points.

5.2.2. SV2 Affordable lifestyle

The towns and communities in the Roper Gulf Region are remote, and as such the cost of living is higher than that of Darwin and Katherine. The Northern Territory Government Market basket survey (NT Department of Health, 2015) found that cost of a food basket in remote stores was $266 higher than the supermarket in the corresponding district centre ($817 compared with $599 in Katherine).

Personal average weekly income is $279, which is less than half of the Northern Territory average. Table A5.5 shows income and housing affordability statistics for the Roper Gulf Region. Personal income has remained steady between 2011 and 2016, while household income has risen 11%. Rental costs (as a proportion of income) have increased, although the cost of buying a home appears to have remained steady.

Table A5.5 Income and housing affordability statistics for the Roper Gulf Region

Category	2011	2016
Median total personal income ($/weekly)	$279	$279
Median total family income ($/weekly)	$717	$670

Category	2011	2016
Median total household income ($/weekly)	$1009	$1120
Median Rent	$50	$50
Households where rent payments are less than 30% of household income (%)	97.6%	94.8%
Households where rent payments are 30%, or greater, of household income (%)	2.4%	5.2%
Mortgage monthly repayments ($)	$806	$1733
Households where mortgage payments are less than 30% of household income (%)	99.6%	99.7%
Households where mortgage payments are 30%, or greater, of household income (%)	0.4%	0.3%

Source: ABS Census, 2016

5.2.3. SV3 Community identity and spirit

Mataranka is a tourist destination and attracts a large number of visitors each year to the town. As such, much of the town's businesses rely on and cater to tourists. The permanent population in Mataranka has a strong sense of community. An example of this is the Mataranka Better Half Club, which has been active in the community since 1977. This group has contributed to renovating the town hall, hosting community Christmas parties and a number of other community events which bring people from surrounding pastoral properties together (Rigby, 2017).

Barunga and Beswick communities both hold large annual community events. The Barunga Festival is held over the Queen's Birthday long weekend each year and attracts thousands of visitors from around the Northern Territory and Australia. The three-day event is a celebration of Aboriginal culture, sport and music. Sporting teams from across top end communities travel to the festival to compete in a range of events, such as AFL, baseball and basketball (Barunga Festival, 2017).

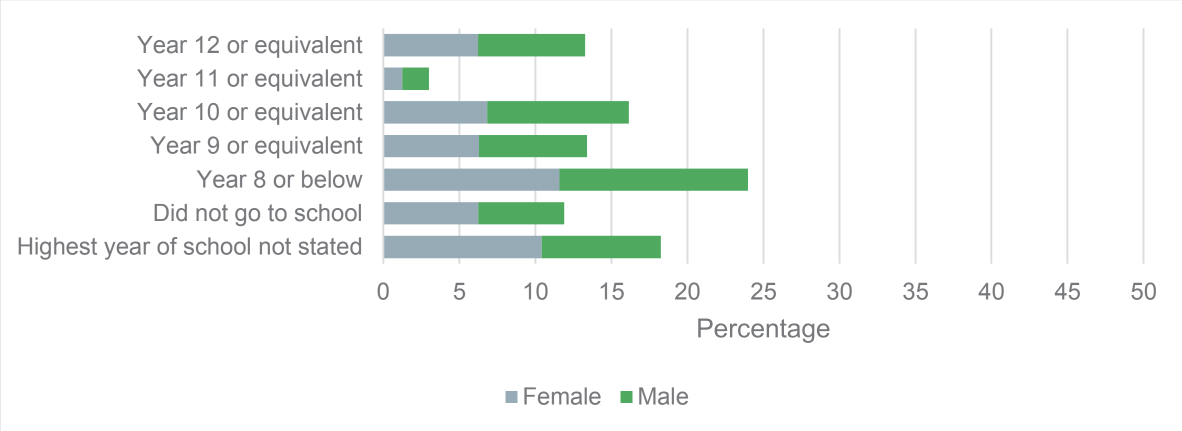
Beswick community holds the Walking with Spirits Festival each year in partnership with the Australian Shakespeare Company. The festival is a celebration of Beswick's culture and heritage through music, art and traditional corroborees from several Arnhem Land language groups (Djilpin Arts, 2017). These festivals enable people to visit, celebrate and learn from the communities.

Traditional owners in the Roper Gulf area have expressed concern over mining exploration activities in recent years. The Traditional Owners in Katherine and Ngukurr have voiced concern over exploration by Hancock Prospecting's Jacaranda Minerals and Minerals Australia in 2016. More than 6,500 square kilometers of Aboriginal-owned land in the McArthur Basin was announced in March 2016 as the first gas exploration permit on land managed by the Northern Land Council. The Traditional Owners have threatened legal action against the Northern Land Council for failing to properly consult the communities (Hope, 2016).

5.2.4. SV4 Capacity for sustainable economic activity

Educational attainment

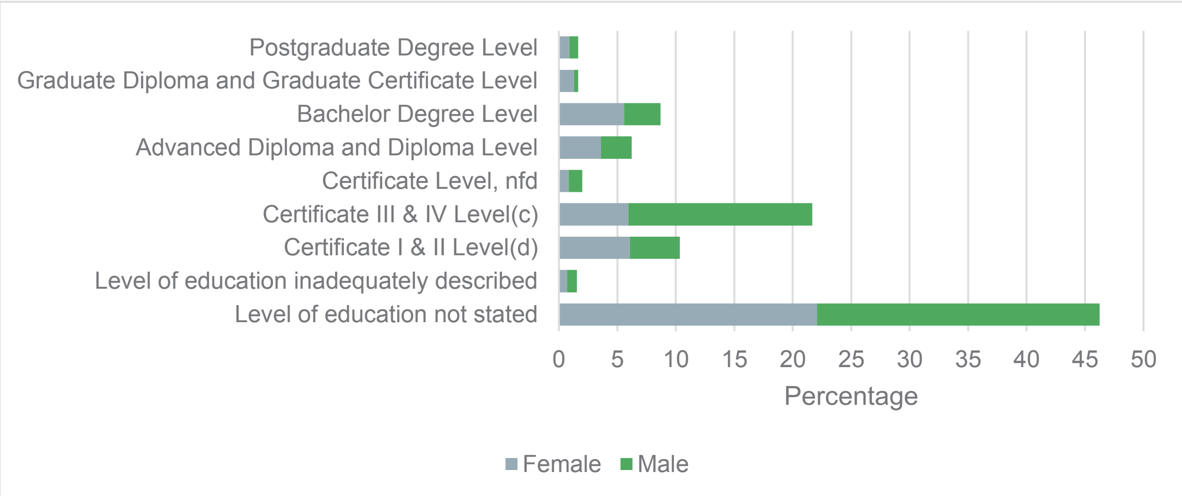
Within this social catchment, 53% of students left school during or before completing Year 10, and only 13% completed Year 12. Figure A5.20 shows that nearly a quarter of people indicated progressing no further than Year 8. This is significantly less than attainment rates within the Katherine Region, where Year 12 was the most common level of education achieved (28%).



Source: ABS Census, 2011

Figure A5.20 Highest level of education achieved within the Roper Gulf Region

For non-school qualifications, Certificate III and IV were the most commonly reported, with males achieving the majority of these qualifications (Figure A5.21). Overall, 60% of the population aged 15 years and older had no qualifications, compared with 51% for regional NT. Between 2006 and 2011 there was a decrease in the percentage of people holding vocational or tertiary qualifications (Regional Development Australia, 2016).



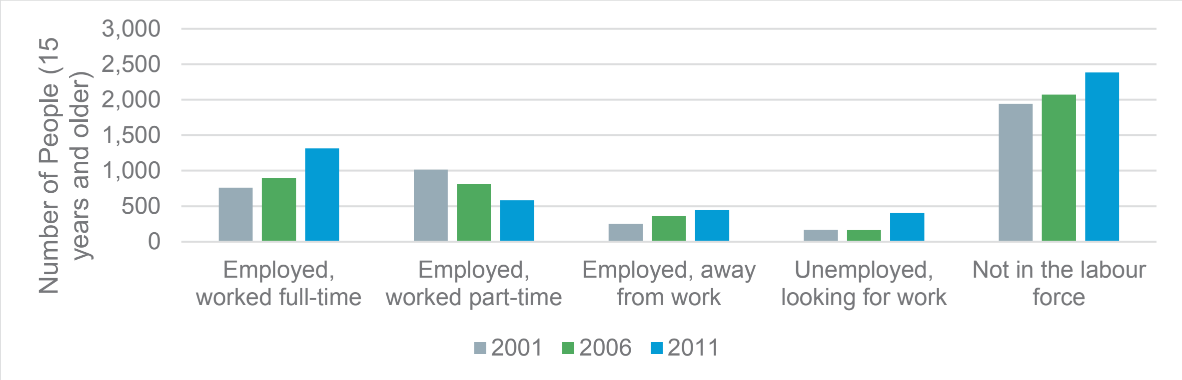
Source: ABS Census, 2011

Figure A5.21 Roper Gulf Region non-school qualifications

Workforce participation

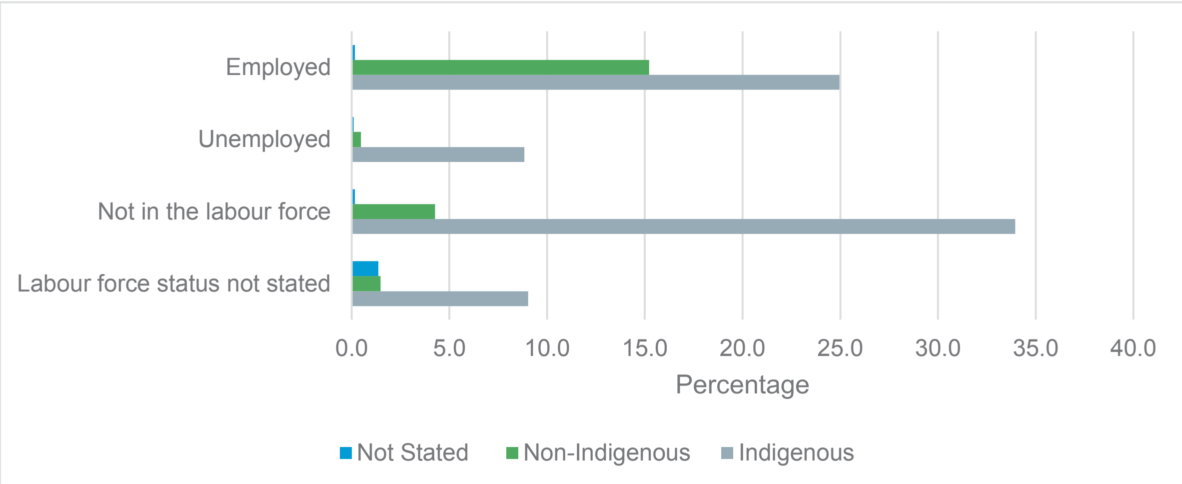
As Figure A5.22 shows, the majority of the population older than 15 years within this social catchment is not employed, and rising, with a 13% increase between 2006 and 2011. This is a similar trend to the wider Katherine Region, which saw an 11% increase over the same period. Conversely, there has also been a 31% increase in the number of people employed full-time in the Roper Gulf Region. This is much higher than the 10% increase seen in the Katherine Region. While there are a diverse range of employment opportunities in the region, the number of positions is small. Government administration, education and local retails provided the largest number of positions (EcOz, 2013).

As the largest of the communities in this social catchment, Ngukurr offers the greatest range of employment in the catchment. A jobs profile on Ngukurr (NT Department of Business, 2014c) indicated that jobs increased 30% from 2011 to 2014, to a total of 237 jobs. Approximately one quarter of these jobs were held by Aboriginal people (see Figure A5.23), and community and personal service workers made up the largest occupation group.



Source: ABS Census, 2011

Figure A5.22 Workforce participation in the Roper Gulf Region



Source: ABS Census, 2011

Figure A5.23 Aboriginal versus non-Aboriginal engagement in the workforce

Local industries

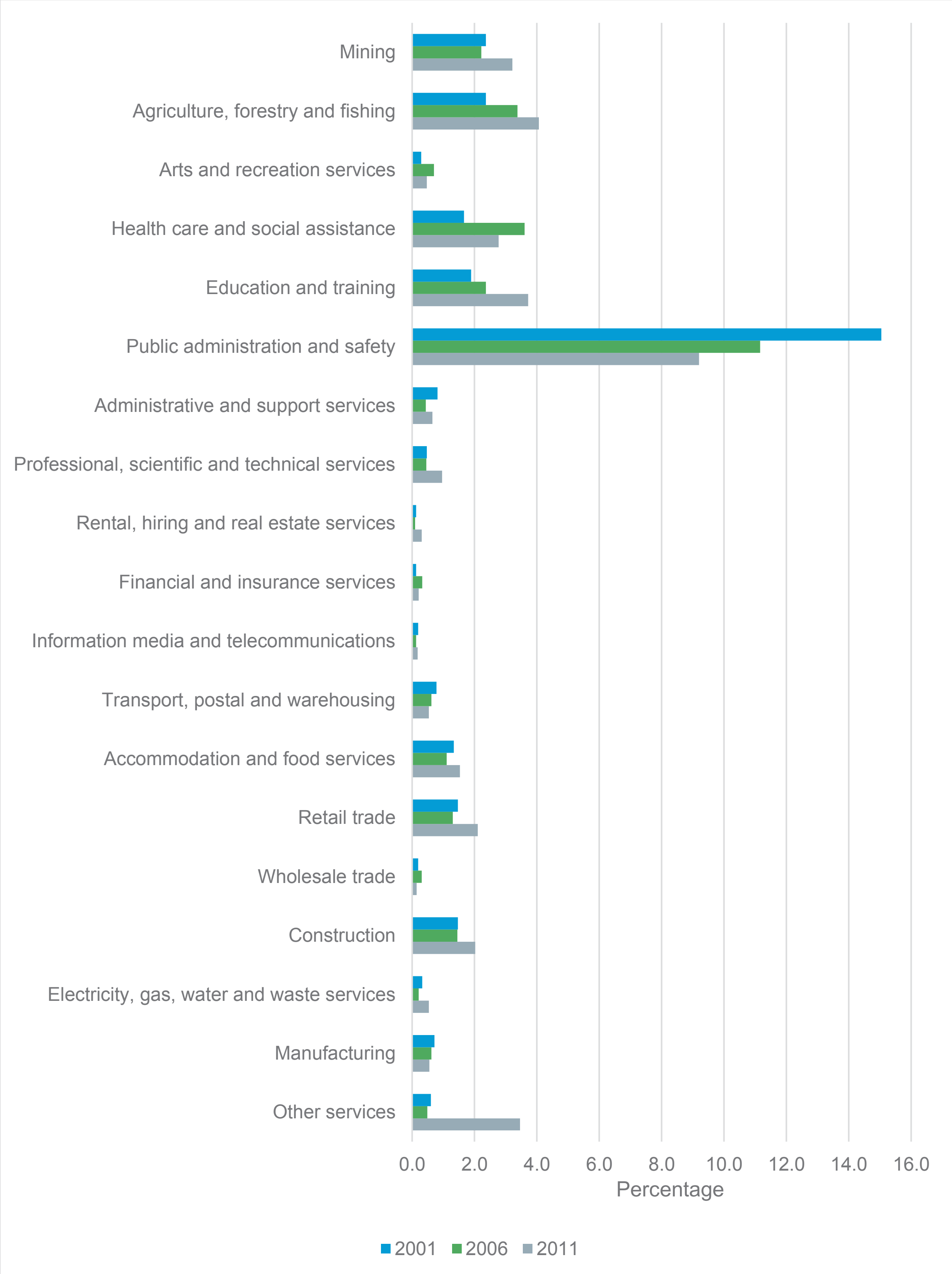
The Roper Gulf region is made up of a number of different land tenures. These include pastoral leases, mining leases, native title/Aboriginal Land and general township leases. These land tenure types influence the type of economic activity being undertaken in the region (EcOZ, 2013).

The rural land in the Roper Gulf Region is predominantly used for pastoral purposes, primarily grazing. The pastoral industry is a key part of the region's identity, with both Aboriginal and non-Aboriginal persons having strong connections to the industry (O'Brien, 2011). There are approximately 56 pastoral properties ranging from 440 to 5,000 square kilometers. As of 2011 these properties ran in excess of 200,000 cattle (O'Brien, 2011).

Government, tourism and mining are also key industries in the region. The GPD of the Roper Gulf Regional Council was $554 million, increasing 24% since 2012 (Regional Development Australia, 2011). The Roper Gulf Regional Council is one of the largest employers in the region. This is reflected in Figure A5.24, showing that 9% of people are employed in public administration (similar to the Katherine Region).

Figure A5.24 also suggests that, since 2001, there has been an increase in both agriculture and mining sectors. As discussed in Section 4, the McArthur River Mine is the largest mining operation in the region. Since 2007, the mine has employed 762 people, and has invested more than $12.3 million into the Roper Gulf Region through the MRM Community Benefits Trust and other community service initiatives (McArthur River Mine, 2017).

Mataranka is a tourist destination. In 2012, 146,300 people visited Elsey National Park, which includes Bitter Springs, Mataranka Thermal Pool and John Hauser Drive (NT Department of Tourism and Culture, 2017). This is the second most frequented park in the Katherine Region, after Nimiluk National Park.



Source: ABS Census, 2016

Figure A5.24 Roper Gulf Region – employment by industry

5.3. Affected communities (east)

This social catchment comprises two communities, Borroloola and Robinson River. Borroloola is located approximately 972 km southeast from Darwin, 655 km southeast of Katherine, and 940 km northwest of Mount Isa in Queensland. Borroloola is designated as a 'major remote town' by the Northern Territory Government.

Due to its size (871 people according to ABS Census, 2016), it functions as a regional hub and service area for surrounding communities, outstations and pastoral properties. Borroloola has four camps: Garawa Camp One, Garawa Camp Two, Yanyuwa Camp and Mara Camp. There are 26 outstations located in the surrounding regions which reply on services from Borroloola (see McArthur River Mine, 2017). There are four main Aboriginal language groups in Borroloola, the Yanyuwa, Garawa, Mara and Gurdanji.

The baseline profile focusses on Borroloola.

5.3.1. SV1 Liveable community

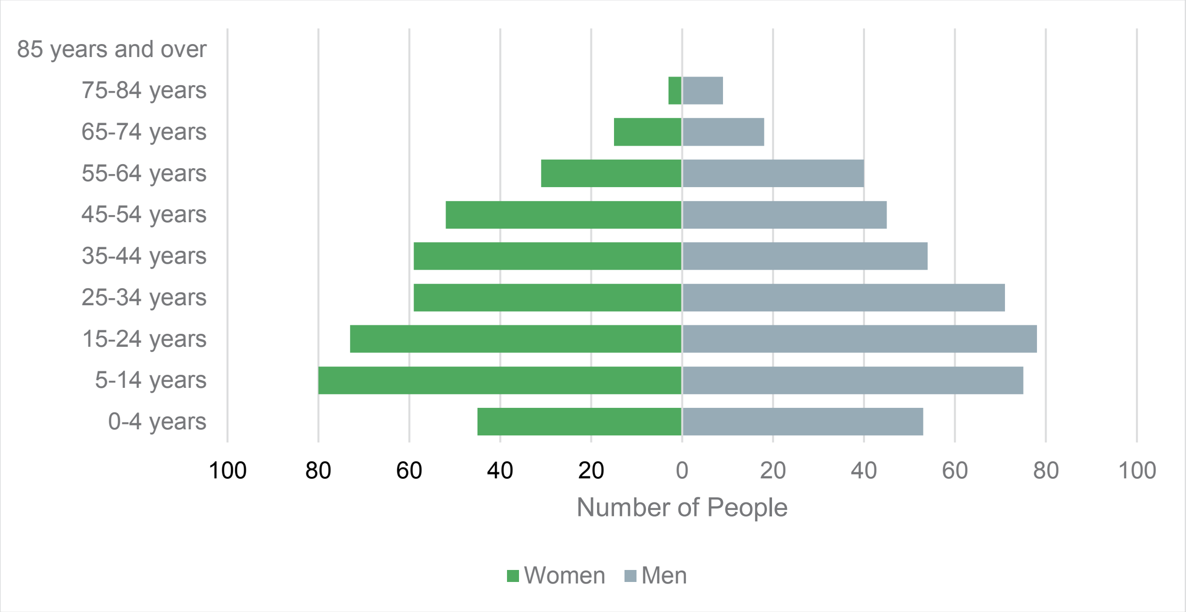
Population and demographics

Table A5.6 displays demographic statistics for Borroloola. Borroloola has a median age of 26, lower than the Northern Territory average of 31 years. Household sizes have decreased in the last 10 years. At 3.9 persons per household, the average household size is lower than the Roper Gulf average of 4.2. However, overcrowding would be expected in some households as the Northern Territory Government has planned for the construction of 22 new houses to alleviate housing issues, including overcrowding (Housing Action NT Policy, 2016).

Table A5.6 Demographic statistics for Borroloola

Category	2006	2011	2016
Median Age	25	26	26
Average household size	4.5	3.9	3.5
Average number of people per bedroom	1.9	1.8	1.6

Figure A5.25 is an age-sex pyramid for 2016, which shows a roughly pyramidal shape, except for disproportionately low numbers of children 4 years old and under.



Source: ABS Census, 2016

Figure A5.25 Combined age–sex pyramid for Borroloola

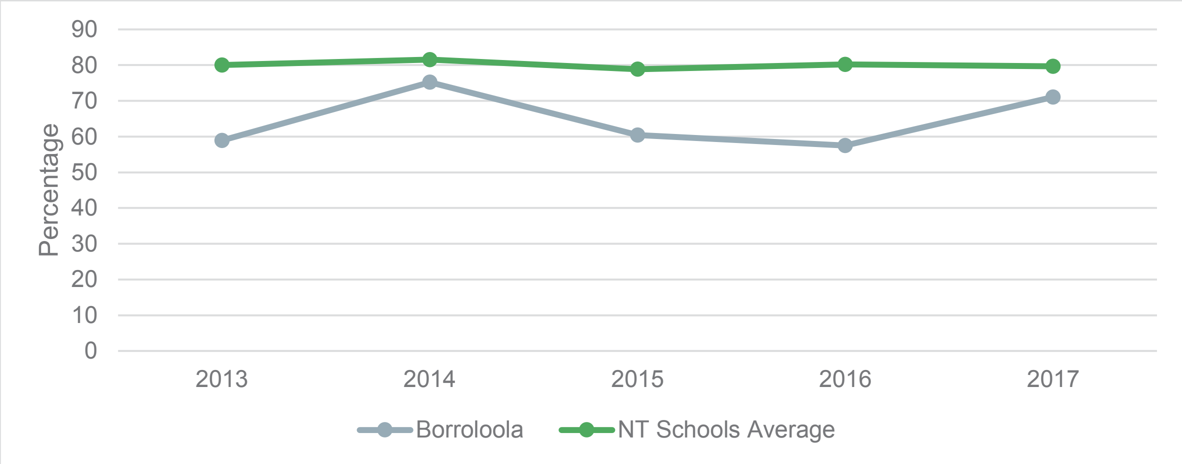
Borroloola has a mostly Aboriginal population (Figure A5.26), with the 2016 ABS Census reporting 77% of the population identifying as Aboriginal. Borroloola is an open township which has a steady tourism industry and is largely influenced by the McArthur River Mine.

Source: ABS Census, 2016

Figure A5.26 Aboriginal and non-Aboriginal population breakdown of Borroloola

Education and community services

There is one school in Borroloola. The attendance rate over the last five years is shown in Figure A5.27. Attendance fluctuates between nearly 60% and 75%, but generally lags behind the NT average. In 2015 and 2016, over $3 million was spent on building two new classrooms and refurbishments, as well as a Trades Training Centre (NT Department of Education, 2015).



Source: NT Department of Education, 2015

Figure A5.27 School attendance average of Borroloola compared with the Northern Territory

A key issue in the community is a lack of recreational activities, facilities and infrastructure for young people. The McArthur River Mine SIA (McArthur River Mine, 2011) indicated a high level of concern for this aspect in the region, with a number of stakeholders (particularly Aboriginal leaders) indicating they felt young people needed such facilities and services to help divert them from anti-social behaviour, such as drug and alcohol abuse.

One of the more prominent community infrastructure developments in Borroloola in recent years was the $2.1-million Borroloola Swimming Pool Complex, which opened in 2009. The complex features a 25 m swimming pool, wading pool for small children, and change room facilities servicing both the pool and neighbouring soccer club.

Crime

Crime data is as described in Section 5.2.1.

Health

Borroloola has one community health clinic, staffed by a general practitioner with nursing support services. In 2009–2010, Aboriginal patients accounted for over 90% of reported episodes of care (McArthur River Mine, 2011). The MacArthur River Mine Emergency Rescue Team provides emergency first aid assistance, as required. In the event of a severe medical emergency, a number of local airfields are available for use. The Borroloola Police Station coordinates emergency services. In addition to the Borroloola Health Clinic, a number of other health-related programs are currently in operation in the community, including (ibid):

- Meals on Wheels.
- Substance abuse support.
- School screening.
- Aged screening.
- Under-5 screening.
- Men and women general wellness checks.
- Immunisation.

- Chronic Disease Outreach.
- Maternity / child health.
- Communicable disease reporting and management.
- Home visiting services.
- Palliative care.

Additionally, Borroloola has three fuel outlets, three supermarkets, a post office, a caravan park (including guest house and hotel), airstrip, women's shelter and library.

Infrastructure

Road access to Borroloola is provided mainly by the Carpentaria Highway. It is a sealed highway with one lane in each direction. It is open all year but cyclonic weather or heavy monsoonal rains may close the highway for periods of up to one week. A 2WD is sufficient to get to the township during dry weather but a 4WD is necessary for some travel during the wet season.

A mail plane services the town three times weekly, which can take passengers.

5.3.2. SV2 Affordable lifestyle

Borroloola is a remote community. Personal average income is $424 per week which is significantly higher than the wider Roper Gulf region. This is likely influenced by employment opportunities at the McArthur River Mine. Similarly, the proportion of households who spend more than 30% of their income on rent has dropped in the last five years, which distinguishes this social catchment from the others reported on here. Table A5.7 provides an overview of income and housing affordability between 2011 and 2016.

While no data on food and grocery prices were available, in general, remote Northern Territory communities pay significantly more than urban centres. For example, a food basket in remote stores costs approximately $817 compared to $599 at a supermarket in Katherine (NT Department of Health, 2015).

Table A5.7 Income and housing affordability statistics in Borroloola

Category	2011	2016
Median total personal income ($/weekly)	$386	$424
Median total family income ($/weekly)	$938	$1050
Median total household income ($/weekly)	$1160	$1289
Median Rent	$50	$50
Households where rent payments are less than 30% of household income (%)	95.2%	97%
Households where rent payments are 30%, or greater, of household income (%)	4.8%	2.1%
Mortgage monthly repayments ($)	$0	$0
Households where mortgage payments are less than 30% of household income (%)	100%	100%
Households where mortgage payments are 30%, or greater, of household income (%)	0%	0%

Source: ABS Census, 2016

5.3.3. SV3 Community identity and spirit

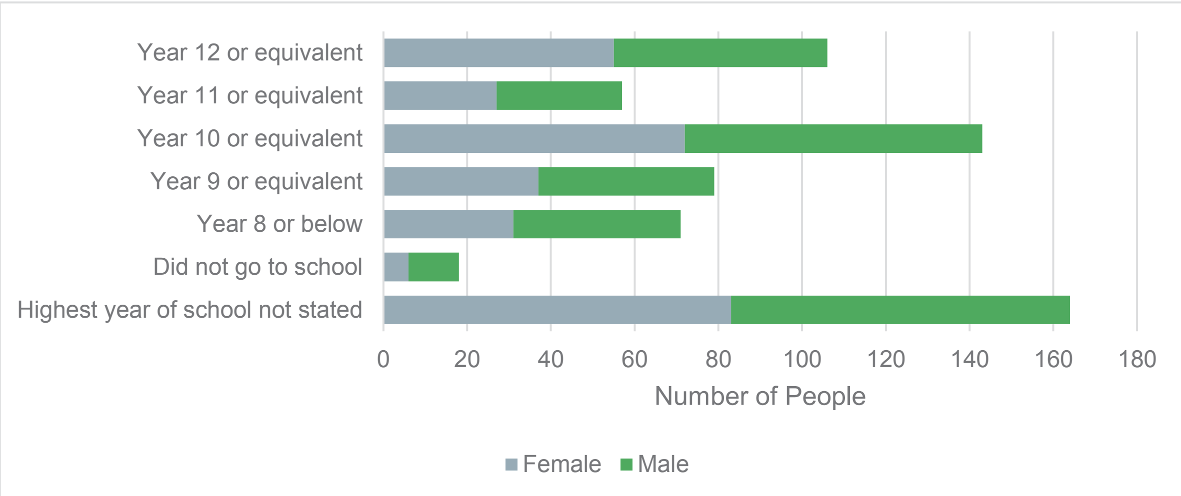
Recreational and cultural events play a role in the social fabric of Borroloola. Being a largely Aboriginal community, there is importance placed on encouraging the participation of youth in cultural events such as NAIDOC Week and Boonu Boonu Festivals (McArthur River Mine, 2011).

Borroloola's natural attractions, such as Butterfly Springs and the sandstone pillars of the Lost City, contribute to its community identity. King Ash Bay, located 50 km north of Borroloola, is a popular fishing destination which hosts the annual Easter Fishing Classic.

5.3.4. SV4 Capacity for sustainable economic activity

Educational attainment

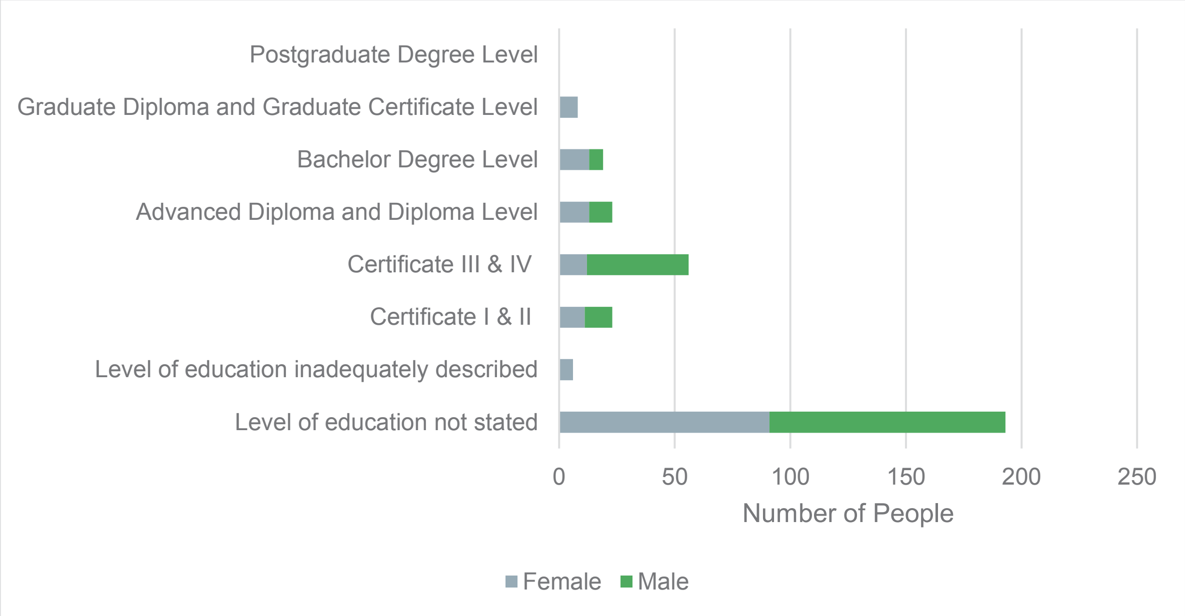
Within this social catchment, 19% of students left school during or before completing Year 10, and 26% completed Year 12. The remaining 26% did not indicate their highest level of schooling (Figure A5.28). These levels of attainment are comparable to the Katherine Region, where 28% of people had completed Year 12.



Source: ABS Census, 2011

Figure A5.28 Highest level of education achieved in Borroloola

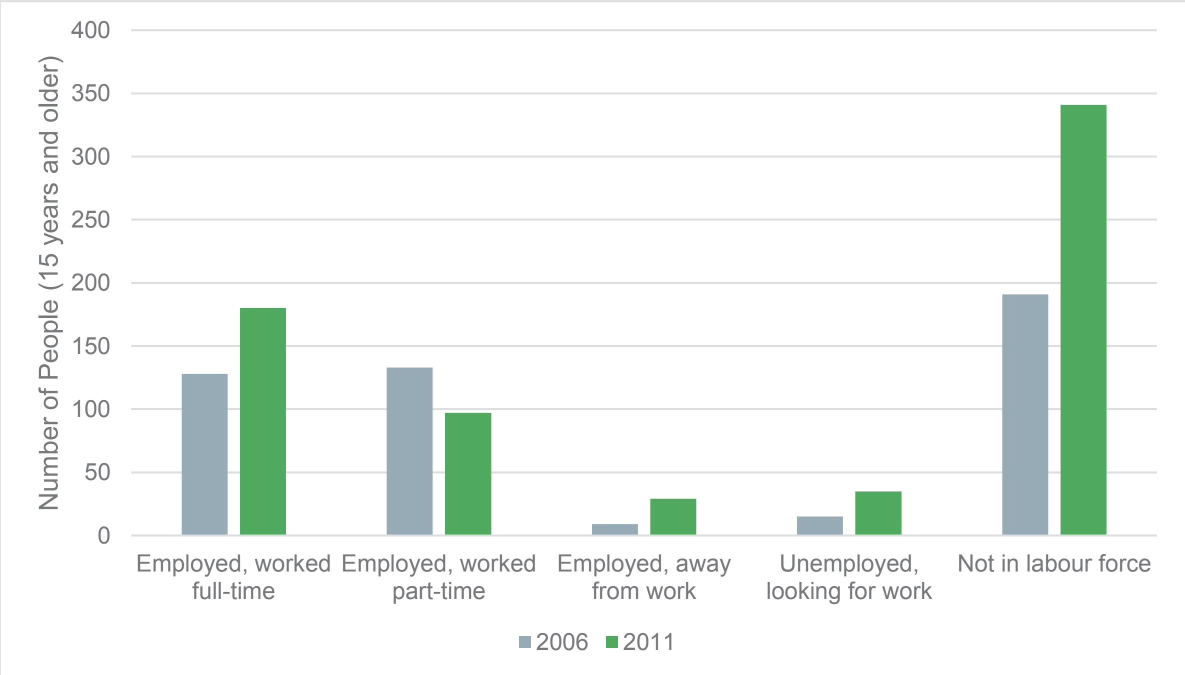
The rates of attainment of non-school qualifications is presented in Figure A5.29. Certificate III and IV were the most commonly completed, and predominantly by males.



Source: ABS Census, 2011

Figure A5.29 Non-school qualifications held in Borroloola

The majority of people in Borroloola indicated not working in the labour force (Figure A5.30). This number has grown by 79% (almost doubled) between 2006 and 2011. Full-time employment was the next most common employment type, which had also increased in number over the same period.



Source: ABS Census, 2011

Figure A5.30 Employment type in Borroloola

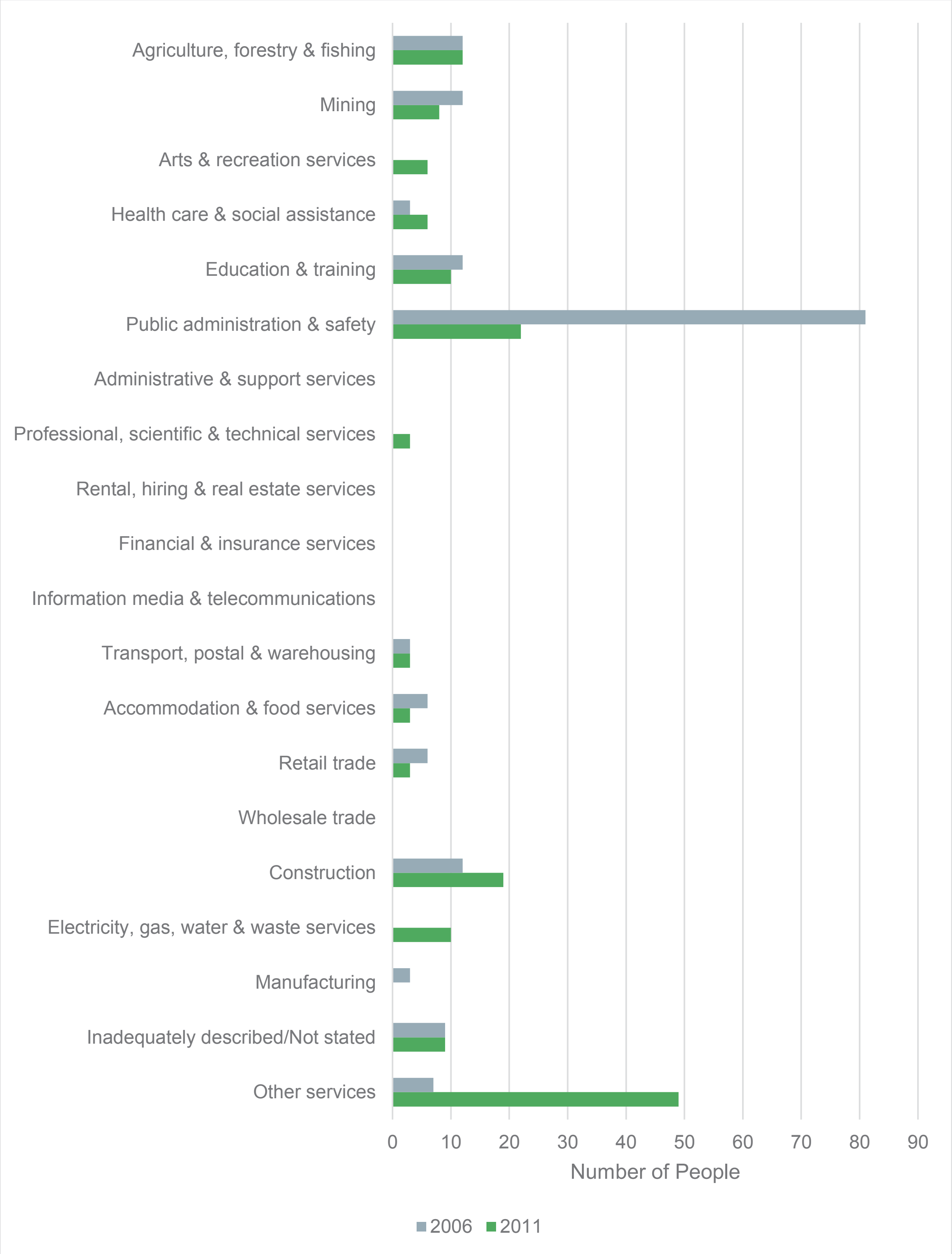
Local Industries

The most significant industry by economic output in the region is the McArthur River Mine (MRM), one of the world's largest zinc mines. While there has been a decrease in employment in the mining sector between 2006 and 2011 in Borroloola, MRM currently employs approximately 600, mostly FIFO and some local workers (Brardon, 2017).There is considerable community concern regarding environmental contamination by the mine, leading to significant community concern about a current proposal to expand the mine.

There are a number of pastoral properties around Borroloola in the Gulf of Carpentaria region. According to the EIS undertaken for the Sherwin Creek Iron Ore Project in 2013 most station owners (with the exception of Hodgson Downs) believe that their stations are underdeveloped and have the capacity to hold more cattle, but current economic circumstances make stocking with additional cattle unviable (EcOZ, 2013).

Borroloola is located on the Carpentaria Highway and is an attractive destination for tourists traveling between the Northern Territory and Queensland. There are a number of natural attractions, such as Butterfly Springs and the sandstone pillars of the Lost City. King Ash Bay is a popular fishing destination located 50 km north of Borroloola, and large numbers of tourists take part in the annual Easter Fishing Classic, held over three days. Emu Station and Lorella Springs offer tourists a cultural heritage and nature experience unique to the region.

These industries (mining, pastoralism and tourism) are key employers within this social catchment. Figure A5.31 indicates that, aside from 'other services', the largest employer (by sector) is the public administration and safety sector, potentially due to the number of people employed through the Australian Government-funded Community Development Employment Project (CDEP) program. The CDEP program aims to assist Aboriginal job seekers to gain skills, training and capabilities to find sustainable employment and improves the economic and social wellbeing of remote communities (NT Department of Business, 2014a).



Source: ABS Census, 2011

Figure A5.31 Employment by industry in Borroloola

5.4. Affected communities (central)

There are four communities and towns located along the Stuart Highway in this social catchment: Larrimah, Daly Waters, Newcastle Waters and Elliott.

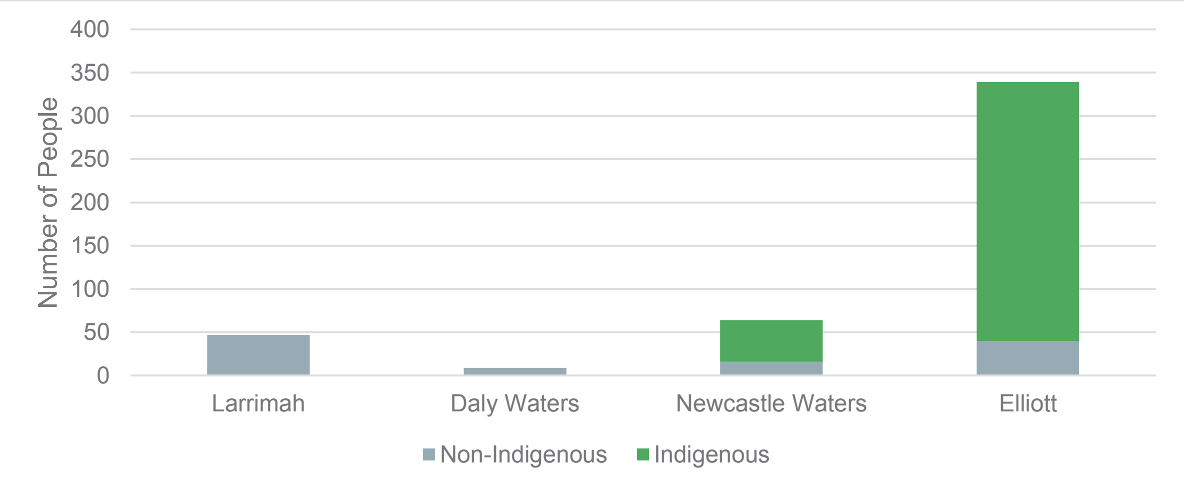
5.4.1. SV1 Liveable community

Population and demographics

Larrimah and Daly Waters have very small populations. According to the 2016 census, the population of Larrimah is 47 (median age of 41) while the population of Daly Waters is 9 (median age of 54). The key feature of Daly Waters is the Daly Waters Pub, which services locals and acts as a tourist information centre. The surrounding district is known as Birdum and has 86 people and a medium age of 34. There are 12 families in the area recorded in the 2016 census with an average of 1.3 children per family (ABS Census, 2016).

Elliott and Newcastle Waters are located within Barkly Shire along the Stuart Highway. The traditional name for the township of Elliott is Kulumindini. Elliott is the Barkly region's second largest town and sits on the edge of Newcastle Waters Station. Elliott is a stopover point on the Stuart Highway for tourists and local people (Barkly Regional Council, 2017). A small, self-sufficient community, the majority of the population lives in two town camps, known as Gurungu and Wilyuga. The Aboriginal persons residing in these camps are of the Mudburra/Djingila, Wambaya, Kutanyi and Wagai clans (Remote Area Health Corps, 2009). Newcastle Waters is a historic township located on Newcastle Waters Station. There is an Aboriginal community called Marlinja located on the station.

Figure A5.32 presents the Aboriginal and non-Aboriginal populations of the communities within this social catchment. The Aboriginal population in Elliott and Newcastle Waters is significantly greater than Larrimah and Daly Waters.



Source: ABS Census, 2016

Figure A5.32 Aboriginal and non-Aboriginal population of Affected communities (central)

Table A5.8 indicates the median age of Elliott and Newcastle Waters is significantly younger than Larrimah and Daly Waters and is more comparable to communities in Affected communities (east) and Affected communities (north). Larrimah and Daly Waters have significantly higher median ages compared to all affected communities. This high median age is likely a reflection of these communities acting as more of a service centre, rather than a residential community.

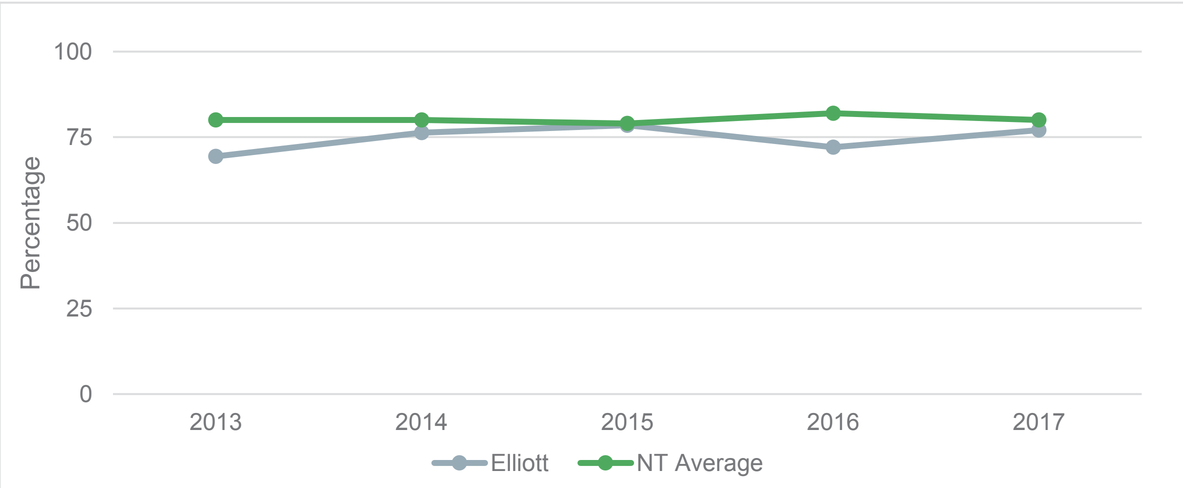
Table A5.8 Median age and household demographics for Affected communities (central)

Category	Larrimah	Daly Waters	Newcastle Waters	Elliott
Median Age	41	54	22	24
Average household size	2.1	1.4	3.4	4.1
Average number of people per bedroom	0.9	0.8	0.9	1.3

Source: ABS Census, 2016

Education and community services

There are no schools located in Daly Waters or Larrimah. The closest school to these communities is located in Mataranka. The School of the Air provides educational services to communities in this social catchment. Elliott has one school which caters for students from pre-school to middle school. As can be seen in Figure A5.33**Error! Reference source not found.**, school attendance in Elliott f luctuates below the Northern Territory average. No data was available for the other communities in this social catchment.



Source: NT Department of Education

Figure A5.33 School attendance in Affected communities (central)

Adequacy of housing is an issue in Elliott and Marlinja. The Northern Territory Government has invested in upgrading houses in both locations (Department of the Chief Minister, 2016). Houses in Elliott and Marlinja outstation are being upgraded through the Department of Local Government and Community Services Homelands and Town Camps program. The work focuses on urgent repairs, functional upgrades, and extending living areas, and will focus on local employment and training and Aboriginal employment on the project. Two local work crews have been working under the close supervision of a qualified builder and tradespeople to undertake the refurbishments (ibid).

Infrastructure in Elliott includes workshop yards to service the communities of Wilyuku, Gurungu and Marlinja outstation, a sport and recreation centre, aged care services, safe house, police station, BP service station, art centre, play group, library, post office, Elliott School, caravan park and community store. The population in Marlinja access these services.

Daly Waters and Larrimah have very limited services and infrastructure compared to most other towns and communities in the region and Australia. The Roper Gulf Regional Council provides a range of local government services including maintenance and upgrade of infrastructure, weed control and fire hazard reduction in and around the township, as well as providing governance support. Both towns act as a road stop along the Stuart highway; as such, there are stores with fuel available, caravan parks and motels, pubs, and an air strip suitable for light aircraft.

Crime

Crime data is as described in Section 5.2.1.

Health

Communities in this social catchment are susceptible to the health issues affecting the Katherine region more broadly (see Section 4). Within this social catchment, there is one community health clinic located in Elliott. 'MiTrack', which is funded by the Department of Social Services, is a free service in the Alice Springs region to the south, for children and youth up to the age of 18 who are at risk of or experiencing early signs of mental illness (Mental Illness Fellowship of Australia, 2017).

Access to health and social services is restricted for the Daly Waters and Larrimah populations. To access medical support people need to travel hundreds of kilometers to either Mataranka or Elliott and further to Katherine or Darwin for more serious health issues. This makes people vulnerable in times of emergencies.

Infrastructure

Daly Waters is accessed via the Stuart Highway, which is sealed and accessible all year. Most roads in the region are not sealed. Surrounding properties may be vulnerable to isolation during the wet season. The Daly Waters Pub and Larrimah Hotel are key places for both tourism and as a place for local people to meet and socialise.

5.4.2. SV2 Affordable lifestyle

The remoteness of this social catchment drives up the cost of living compared to urban areas within the Northern Territory. The average cost of a food basket in remote stores in the Northern Territory is $817, compared with $844 in Alice Springs supermarkets (NT Department of Health, 2015). People from Elliott and Newcastle Waters would typically visit Tennant Creek or Alice Springs for shopping or access to higher levels of service. The cost of transport in accessing goods and services contributes significantly to the cost of living.

5.4.3. SV3 Community identity and spirit

Elliott and Marlinja's community identity is different in its demography and history than Larrimah, Newcastle Waters and Daly Waters. The country around Elliott belongs to the Jingili desert people with the Wambaya people to the east and southeast, the Yangman and Mangarrayi to the north, the Mudbura and Gurindji to the west, and the Warlpiri, Warlmanpa and Warramungu to the south and southwest. The Aboriginal people have strong spiritual connections to the country through ceremony and important dreaming tracks (Barkly Regional Council, 2017). Each year, the community of Elliott come together to celebrate Mardi Gras with a float parade and costumes. The event is now in its twelfth year and attracts visitors from across the Northern Territory and Australia.

Newcastle Waters, Larrimah and Daly Waters are more service hubs than townships. These communities are focused around providing services along the Stuart highway than as a standalone community.

The historic township of Newcastle Waters was a gathering place for drovers on their overland cattle drives. It is located at the junction of three major overland stock routes. The historic town is not inhabited, but is it located on the actively run Newcastle Waters Station. The town attracts tourists for its history and bird watching.

Daly Waters holds a number of key social events for the region. The Daly Waters Pub is central to these events and provides a valuable meeting and socialising point for the region. The pub is an iconic feature of the area and draws a number tourists to the district.

The Daly Waters' rodeo and camp draft is held over three days and attracts large crowds from across the Northern Territory and Australia. Stations around the Daly Waters district provide help in setting up and running the event. The Daly Waters Ball is held over Easter each year and attracts mostly young crowds from across Australia. Crowds can reach upwards of 400 people at the festivities. Daly Waters has both camping and cabin accommodation for visiting tourist (Zillman, 2015).

Larrimah played an important supply and logistical role in World War II, which is celebrated in the Larrimah Museum. The town has a number of quirky tourist attractions, including the Big Stubby and the Pink Panther sitting on a chair outside the Larrimah Hotel.

5.4.4. SV4 Capacity for sustainable economic activity

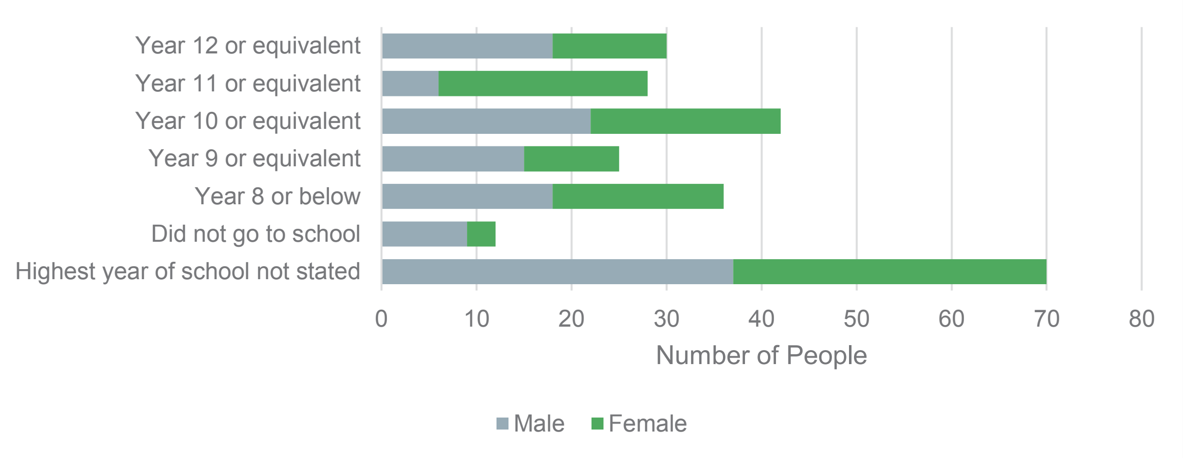
The primary industry in the Larrimah and Daly River region is pastoral grazing. In the 2011 census (relevant data from the 2016 census has not yet been published), there were 66 cattle properties in the Birdum region and 58.9% of people were employed in agricultural businesses (ABS Census, 2011).

Employment in the Larrimah and Daly River region is split between pastoral grazing and businesses in the towns (ABS Census, 2011). Accommodation and pubs/taverns/bars were the second highest employment industries (ibid).

The Daly Waters and Larrimah townships are heavily dependent on the tourism industry. The towns businesses, such as the pub, store and fuel station are reliant on tourist traffic for income. The Daly Water Pub has marketed itself as a tourist destination and allows people to leave their mark on the pub by leaving a personal item behind. Larrimah's tourist attractions include the Old Police Station Museum, Teahouse and the Pink Panther outside the historic pub. The tourism industry is seasonal and is therefore much quieter from October to April (during the wet season).

In Elliot, there is a limited number of employment opportunities due to its size and remote location. According to the 2014 Jobs Profile Elliott (NT Department of Business, 2014b) there were a total of 93 jobs available in Elliott. Of these jobs, 54 were filled by an Aboriginal person. There was a decrease of 25 jobs between 2011 and 2014. In 2011, public administration and safety was the highest area of employment, followed by education/training and agriculture, forestry and fisheries (ibid).

Figure A5.34 indicates that data is scarce on educational attainment levels in Elliot, with almost 30% not disclosing the highest level of schooling attained. Fifteen percent of the population indicated not progressing further than Year 8. The level of education in Elliott may impact people's ability to engage in higher-skilled economic activity.



Source: NT Department of Education

Figure A5.34 Educational attainment in Elliott

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Appendix B - Scope of work

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3. SCOPE OF SERVICES

3.1 BACKGROUND TO THE INQUIRY

On 14 September 2016 the Chief Minister of the Northern Territory, the Hon Michael Gunner MLA, announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs in the Northern Territory. At the same time, the Chief Minister announced that a *Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory* (the **Inquiry**) would be established and released draft Terms of Reference, which were open for public comment for four weeks.

On 3 December 2016 the Northern Territory Government announced the final Terms of Reference for the Inquiry and the composition of the panel that will be undertaking the Inquiry (the **Panel**).

The Inquiry was established under section 4 of the *Inquiries Act 1945* (NT) and is comprised of a judicial chair, the Hon Justice Rachel Pepper, and ten scientists with expertise in areas ranging from hydrogeology to social science.

The Inquiry's final Terms of Reference can be read in full on the Inquiry's website (www.frackinginquiry.nt.gov.au).

On 20 February 2017 the Inquiry released a *Background and Issues Paper*, also available on the Inquiry's website, which was followed by hearings and community meetings in March 2017 in various town centres and remote communities across the Northern Territory. The Issues Paper includes a timeline for the Inquiry, which indicates that an interim report will be released in mid-2017, a draft final report will be released during the last quarter of the year, and a final report will be released in December 2017.

The Hydraulic Fracturing Taskforce (the **Taskforce**) has been established in the Department of the Chief Minister to support the Panel.

3.2 TERMS OF REFERENCE FOR THE INQUIRY AND THE SOCIAL IMPACT THEME

The Panel has divided the work of the Inquiry into the following themes: water, land, air, social impacts, economic conditions, cultural conditions, human health, land access, and the regulatory framework. This request for tender relates to the social impacts theme only, however, there are overlaps with the economic, cultural and regulatory framework themes.

The Terms of Reference for the Inquiry require the Panel to do the following:

(a) determine and assess the impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the associated activities;

(b) determine whether additional work or research is required to make that determination;

(c) for each risk that is identified, advise the level of impact or risk that is acceptable in the Northern Territory context;

(d) describe methods, standards or strategies that can be used to reduce the impact and risk to acceptable levels; and

(e) identify what government can do, including implementing any policy, regulatory or legislative changes, to ensure that the impacts and risks are reduced to the required levels.

The *Background and Issues Paper* includes a non-exhaustive list of the potential risks and benefits associated with the social impact theme at page 21.

The Terms of Reference make it clear that the Panel must not only look at the impacts of hydraulic fracturing and the associated activities on social conditions in the Northern Territory – the Panel must also consider the social impacts of the onshore unconventional gas industry *as a whole* on the Northern Territory. This is made clear in the following extract from the Terms of Reference, which has been amended to include the relevant language only:

"When the inquiry makes a determination… about whether or not there has been an impact or risk on … social conditions, the inquiry will … consider the impacts and risks of the development of the onshore unconventional gas industry, including exploration activities such as seismic surveys and aerial surveys, land access and costs and benefits of the industry. This may be undertaken through a social impact assessment or similar activity."

In accordance with the definitions in the Terms of Reference, a reference to an "unconventional reservoir" in this document is a reference to a reservoir where the rock formation is *shale*. There is currently no gas being produced from shale reservoirs in the Northern Territory. The Amadeus Basin is currently producing gas from conventional reservoirs.

3.3 STEERING COMMITTEE

A Steering Committee has been established to oversee the work of the supplier. The Steering Committee is comprised of the Hon Justice Rachel Pepper, Dr David Ritchie, Prof Peta Ashworth and the Executive Director of the Hydraulic Fracturing Taskforce. The point of contact for all matters will be the Executive Director of the Hydraulic Fracturing Taskforce.

3.4 PROBITY ADVISOR

The Territory has appointed a Probity Advisor to oversee the Territory's processes in relation to the stages of this process. The Probity Advisor's role is to ensure that fairness and impartiality are observed throughout, and that the evaluation criteria stated in any related documentation are consistently applied to all submissions.

PART A – SOCIAL IMPACT ASSESSMENT

3.5 DEVELOPMENT AND IMPLEMENTATION OF A SOCIAL IMPACT ASSESSMENT FRAMEWORK

3.5.1 The supplier must develop a leading practice framework for the identification, assessment and management of the social impacts associated with the development of onshore unconventional gas in the Northern Territory.[1] The framework:

(a) must include a requirement for public participation;

(b) may include components of both strategic and project-level social impact assessment; and

(c) must operate in conjunction with the Northern Territory and Commonwealth environmental assessment frameworks in a way that minimises unnecessary duplication and inconsistency.

3.5.2 The supplier must explain why the proposed framework is leading practice and in doing so must refer to the literature and leading practice social impact assessment frameworks used in other jurisdictions, including overseas jurisdictions.

3.5.3 The supplier must describe the current policy and regulatory regime in the Northern Territory for the identification, assessment and management of social impacts associated with onshore unconventional gas development.

3.5.4 The supplier must identify the structural, policy, regulatory and legislative reforms that must be made to the current regime in the Northern Territory to implement the social impact assessment framework described above.

3.5.5 The supplier must describe how the framework will operate in conjunction with the Northern Territory and Commonwealth environmental assessment frameworks in a way that minimises unnecessary duplication and inconsistency.

3.6 BEETALOO SUB-BASIN

3.6.1 The supplier must identify the people or groups of people that are most likely to be impacted by the development of unconventional gas resources in and around the Beetaloo sub-basin, shown in **Attachment B**, which may include, without limitation, community members, pastoralists, Aboriginal organisations and local businesses (the **Affected Communities**).

3.6.2 The supplier must describe the methodology used to identify the Affected Communities.

3.6.3 The supplier must describe the Affected Communities (that is, describe the community profile or baseline conditions), which must include a description of the values listed at **Attachment A** and how such information was collected.

[1] A "social impact" is defined as a change to any of the values or conditions set out at **Attachment A** and must include cumulative social impacts.

3.6.4 The supplier must describe the type of potential social impacts, issues, concerns, risks and benefits that may arise from the development of the unconventional gas industry in the Beetaloo sub-basin on the Affected Communities. In identifying the potential impacts the supplier must consider:

(a) the list of social impacts, risks and benefits described in sections 7.5, 7.6, 7.7, and 7.8 of the *Background and Issues Paper*;

(b) submissions made to the Panel in connection with the *Background and Issues Paper*;

(c) social impacts, issues, benefits and risks typically associated with the development of onshore unconventional gas resources that have been identified in the literature and in other jurisdictions; and

(d) issues that have been identified in other social impact assessments and related studies that have been completed in or around the Beetaloo sub-basin, including those listed at **Attachment C**.

3.6.5 For each potential impact identified, the supplier must, to the extent possible:

(a) assess the potential impact (or risk) in terms of likelihood and consequence (high, medium, low);

(b) identify a potential measurable indicator, which can be qualitative or quantitative, and develop a methodology for the collection of appropriate baseline data in the Affected Communities so that changes in social values or conditions as a result of any unconventional gas development can be measured over time;

(c) collect such baseline data;

(d) identify ways to avoid, mitigate and/or manage the risk over time (including the entity that should be responsible for the management and monitoring of such risk) and predict what the level of risk will be following mitigation; and

(e) indicate whether or not the level of risk following mitigation would be deemed acceptable, and why.

3.6.6 For every potential social benefit that is identified, the supplier must recommend strategies to realise and maximise such benefit.

3.6.7 The supplier must identify any issues that must be addressed in subsequent project-based social impact assessments associated with the development of unconventional gas in the Beetaloo sub-basin.

3.6.8 The supplier must develop and implement a leading practice community consultation program to support its responses to section 3.6. The supplier must consult, without limitation and where practicable, the Aboriginal Areas Protection Authority; the Northern Land Council; the Departments of Primary Industry, Resources and Trade, Business and Innovation, and Tourism NT; local and regional councils; the Northern Territory Cattleman's Association; NT Farmers, and petroleum operators and titleholders in the Beetaloo sub-basin. The Steering Committee must approve the program prior to implementation.

PART B - SOCIAL LICENCE TO OPERATE

3.7 The supplier must describe, with reference to the literature and examples from other jurisdictions:

(a) the concept of a "social licence to operate" as it applies to the onshore unconventional gas industry in the Northern Territory;

(b) the nature and extent of any potential risks to affected stakeholders, including the Northern Territory Government, petroleum titleholders and operators in the Northern Territory, the Northern Territory community, and the communities affected by development, where industry has not obtained and/or maintained a social licence to operate;

(c) the measures that onshore unconventional gas industry and government can take to enable industry to earn and maintain a social licence to operate in the Northern Territory; and

(d) how industry's social licence to operate can be measured in the Northern Territory, including a part of the Northern Territory.

3.8 The supplier must identify, to the extent practicable, the measures that the petroleum titleholders and operators in the Beetaloo sub-basin have taken in the past, and can take in the future, to earn and maintain a social licence to operate in the Affected Communities.

3.9 TIMELINES AND REPORTING

3.9.1 The work must be in the form of a written report.

3.9.2 The report must include a literature review that includes all references used in section 3.5 and 3.6.

3.9.3 At the end of each calendar month following the award of the tender the supplier must provide the Steering Committee with a written progress report and a verbal presentation within five working days of receipt of the report.

3.9.4 The supplier must provide the Steering Committee with a draft final report and a verbal presentation to the Steering Committee on or prior to 1 September 2017.

3.9.5 A final report must be provided to the Steering Committee by 15 September 2017 and the supplier must present the final report to the Panel on a date to be determined.

3.9.6 The Inquiry will publish the final report on the Inquiry's website on a date to be determined.

ATTACHMENT A

The *International Association for Impact Assessment* defines "social impacts" as changes to one or more of the following:[2]

(a) people's way of life – that is, how they live, work, play and interact with one another on a day-to-day basis;

(b) their culture – that is, their shared beliefs, customs, values and language or dialect;

(c) their community – its cohesion, stability, character, services and facilities;

(d) their political systems – the extent to which people are able to participate in decisions that affect their lives, the level of democratisation that is taking place, and the resources provided for this purpose;

(e) their relationship with their environment – the quality of the air and water people use; the availability and quality of the food they eat; the level of hazard or risk, dust and noise they are exposed to; the adequacy of sanitation, their physical safety, and their access to and control over resources;

(f) their health and wellbeing – health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity;

(g) their personal and property rights – particularly whether people are economically affected, or experience personal disadvantage which may include a violation of their civil liberties; and

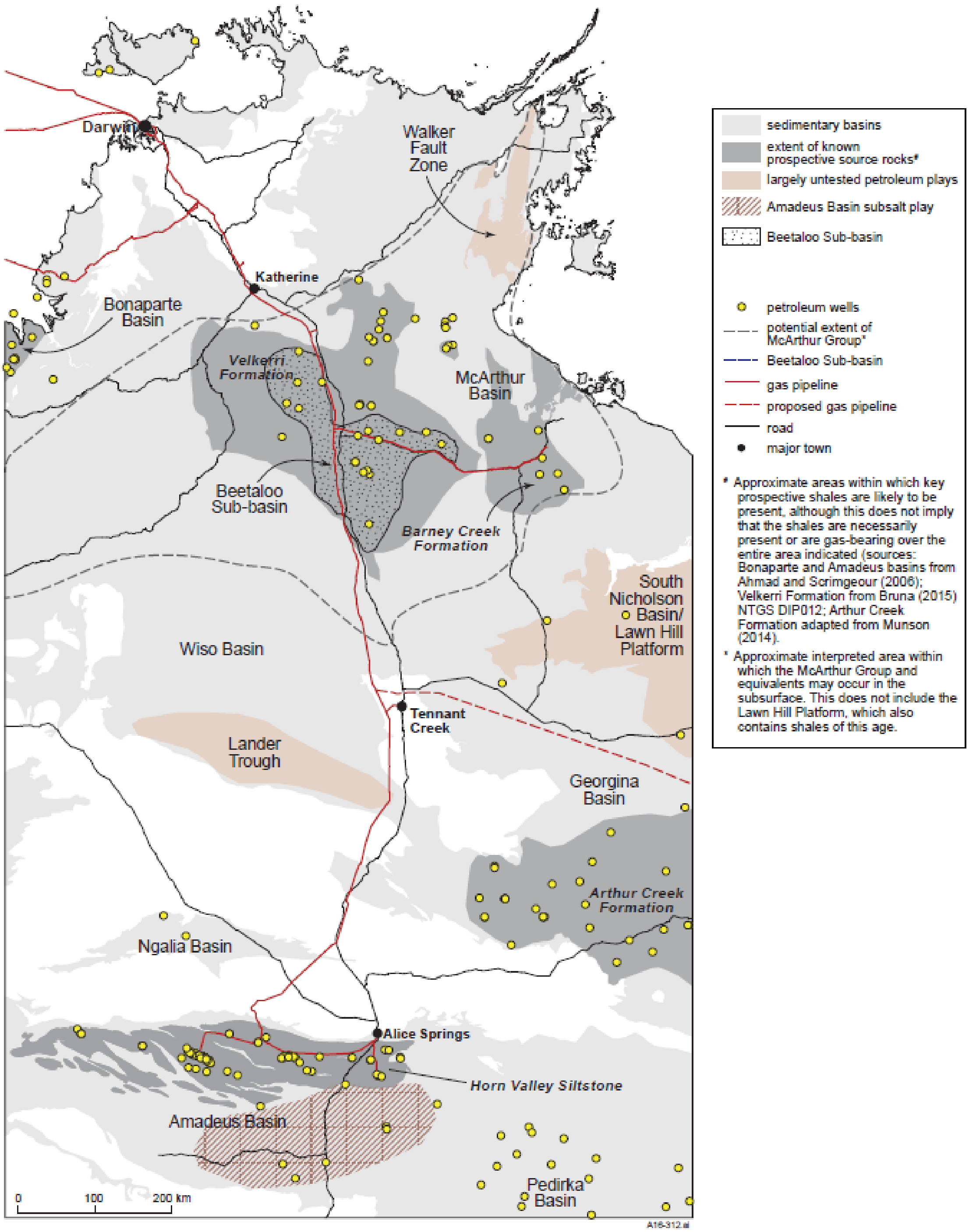
(h) their fears and aspirations – their perceptions about their safety, their fears about the future of their community, and their aspirations for their future and the future of their children,

in each case, to the extent such impact would not otherwise be assessed as part of an environmental impact assessment under Northern Territory or Commonwealth legislation.

[2] Adapted from Vanclay, F. 2003 International Principles for Social Impact Assessment. *Impact Assessment and Project Appraisal* 21(1), 5-11 (available at http://dx.doi.org/10.3152/147154603781766491 last accessed 21 April 2017)

ATTACHMENT B (1)

Northern Territory petroleum potential

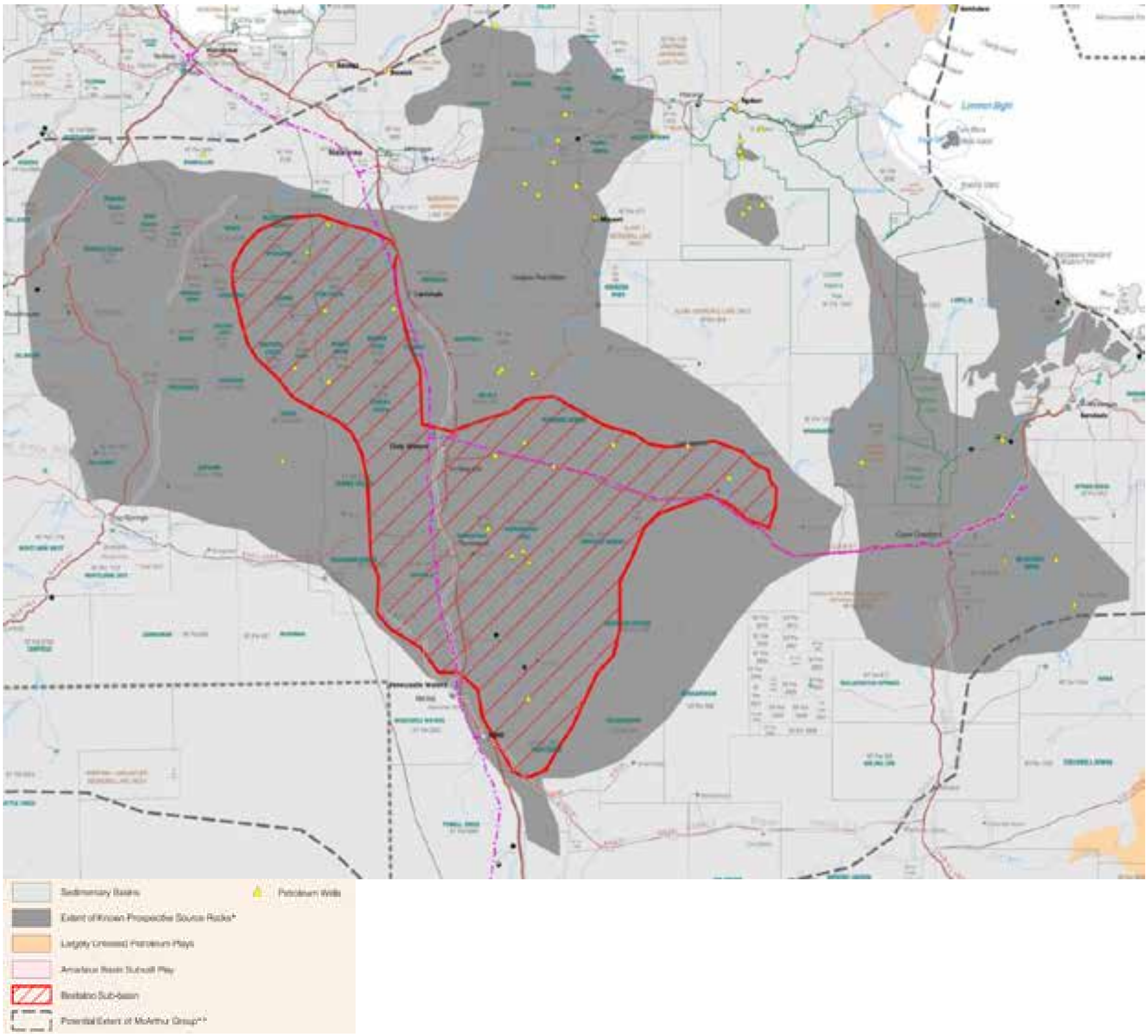


Dec 2016

Northern Territory Geological Survey
Department of Primary Industry and Resources

AUSTRALIA'S NORTHERN TERRITORY

ATTACHMENT B (2)



ATTACHMENT C

1. The research monograph entitled Ngukurr at the Millenium:" A Baseline Profile for Social Impact Planning in South East Arnhem Land, by J. Taylor, J. Bern, and K.A. Senior.
2. Social Impact Assessment undertaken by EcOz in connection with the Western Desert Resources Roper Bar Iron Ore Project.
3. The Economic and Social Impact Assessment undertaken by EcOz in connection with the Sherwin Creek Iron Ore Project.
4. The Social Impact Assessment Scoping Study and the Economic and Social Impact Assessment undertaken by Circle Advisory in connection with the Northern Gas Pipeline.

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Social licence to operate in the Beetaloo Basin and Northern Territory

Citation

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Important disclaimer

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Figures

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Acknowledgments

This report was produced for the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory.

Executive summary

This report provides an overview of social licence to operate (SLO) in the context of the Northern Territory (NT) gas industry and the deployment of hydraulic fracturing (‘fracking’) technologies. The report is structured to provide:

- A brief review of literature relevant to SLO
- NT specific data from a 2016 national survey of citizen attitudes toward the extractive industries conducted by CSIRO
- A 2006-2016 comparative analysis of family income inequality (calculated as a gini co-efficient) based on NT census data
- A summary of conversations with industry, community and government stakeholders in the NT gas industry detailing key issues and challenges
- A discussion regarding approaches for measuring and monitoring SLO in the NT

Research presented in this report details the key drivers of trust and acceptance for the extractive industries in the NT, and across other jurisdictions and commodities. These include feeling heard, respected and involved in decision making processes (procedural fairness), feeling that the benefits (and impacts) of extraction are shared fairly (distributional fairness), that government has the capacity and will to ensure public interests are protected and industry held to account (governance capacity), that physical and social impacts are managed effectively and appropriately, and that interactions between company personnel and community members is a positive experience (contact quality).

Analysis of family income inequality for the NT, calculated using 2006 and 2016 census data, revealed that the NT has declining family income equality. This is a baseline measure that allows for reflection on how the development of the gas industry may assist in redressing this trend, while the risks of exacerbating it were also discussed.

Engagement with industry, community and government stakeholders in the gas industry in the NT revealed that uncertainty about how the industry would look and fracking as a technology was a locus of attention for all of these stakeholders. There is a broad recognition that these technologies are not well understood beyond those that have been directly engaged by industry or have technical background. Reducing this uncertainty in a framework supported by government appears to be of real interest to most of those spoken with. And extending this, that government plays a more active and creative role in the discussion and engagement of these issues and the development of the industry itself.

A measurement and modelling framework for SLO is described, focusing on the following principles for its development:

- *The engagement of a trusted third party* – CSIRO's Gas Industry Social and Economic Research Alliance (GISERA) offers one such model
- *Protection of community rights and safety* – ethical and privacy standards are applied under the National Statement on Ethical Conduct in Human Research (2015), placing the safety of participants first
- *Longitudinal design* – placing the experiences of community at the centre of the process, and to identify issues before they become conflicts
- *Accessibility of data* – transparency of process and data provision back to community and other stakeholders in central to building trust that this is a vehicle for community voice
- *Inclusiveness of process* – it is important that vulnerable, marginalised and special status groups are included in SLO research using appropriate methods.

1 Introduction and structure of this report

There are few more (socially) controversial issues in the extractive industries than hydraulic fracturing ('fracking') to facilitate the exploitation of gas and oil reserves. The perceived and potential consequences from the application or proposed application of this mature technology is material in state based Australian moratoriums on the gas industry as a whole, Commonwealth intervention (through the Environment Protection and Biodiversity Conservation Act 1999 'water trigger' provisions), and industry efforts to engage and reassure government and communities of interest regarding potential impacts. More specific to this report, the potential impacts of fracking have been a locus of community based push back against the onshore gas industry in Australia, as it has been in other jurisdictions.

This report will focus on the community perspectives regarding the extractive industries, and where available, the onshore gas industry in the Northern Territory. The concept of social licence to operate (SLO) will be used a framing device and mechanism for exploring the influence of community sentiment on development trajectories and what research in this area indicates is effective and required to build and maintain a SLO. Conversely, the issues that erode SLO and lead to rejection of extractive industries will also be discussed.

As per the scope of works defined by the inquiry, this report will:

- Provide context for SLO in the Northern Territory through a literature review
- Introduce current, independent community survey data regarding attitudes toward the extractive industries in the Northern Territory
- Introduce socio-economic analysis of the Beetaloo Basin with a Northern Territory context
- Discuss local level community engagement data collected through field work for this report
- Outline mechanisms for measuring and monitoring SLO in the Beetaloo Basin and NT more broadly

- Discuss key considerations in this area that should inform how future work takes place to ensure the rights and welfare of community members are of primary concern in any future work
- Provide guidance on a proposed framework for measuring and monitoring SLO in the Beetaloo Basin and Northern Territory.

2 Social licence to operate and the extractive industries: a brief review of literature

The influence of community members in development trajectories is the topic of considerable writing and discussion. While the gas industry has technology and development characteristics that are unique, there are lessons to be understood from research conducted across a range of extractive industries. Increasingly, community concerns strongly influence the way the extractive industries operate, how governments regulate them, and the manner in which broader development responsibilities are met. It is now increasingly understood that the voice of citizens must be heard if extractive developments are to achieve broad social acceptance. This has largely been brought about by changing societal expectations over recent decades, which have fundamentally influenced the way the extractive industries conduct operations around the world.

The shift toward more socially acceptable extractive development has emerged, in part, as a result of the increasing pressure and scrutiny these industries face regarding their environmental impacts and social performance. For example, throughout the 1990s, there was a fundamental shift in the way that the environmental and social impacts of the mining industry were perceived, with highly publicised tailings dam failures, chemical spills, and conflicts with communities impacting negatively on the industry's reputation (Schloss, 2002; Thomson & Boutilier, 2011). More recently, resistance to the extraction of gas has been articulated through effective use of social media platforms, popular culture mechanisms such as film, and 'grassroots' campaigns involving diverse communities of stakeholders.

Given the term 'social licence to operate' originated in the mining industry in the mid 1990's, coined by a senior mining executive (Thomson & Joyce, 2000), the development of the concept in this industry is instructive. At the same time as the mining was under pressure for its physical impacts through the mid 1990's, societal values and attitudes toward the natural environment and the industries impacting negatively on it were changing (Joyce & Thomson, 2000). Increasingly, the concerns of society were also being translated into direct action against mining projects at a local level. Such conflict with communities has been shown to have high financial, opportunity, and personal costs to mining companies and their personnel (Franks et al., 2014).

These pressures on industry also signalled that communities were becoming more active in challenging the nature and fairness of the impacts and benefits associated with mining developments (ICMM, 2012). This was further reflected in communities demanding more involvement in decision-making around such operations, having clear expectations about receiving a greater share of the benefits from these operations, and requiring assurances that the industries involved were being appropriately regulated (Prno, 2013). Thus, not only have community expectations about the performance of the minerals industry increased over time, so too has the direct involvement of citizens in decision-making about industry development (Harvey & Brereton, 2005). This has seen community relations and participation now recognised as a strategic part of managing risk and opportunity (Humphreys, 2000). This combination of increasing pressures on industry performance and the associated social acceptance of mining operations has been widely referred to as the industry's 'social licence to operate'. However, the drivers of acceptance for the mining industry and the gas industry are complex and operate across scales.

Social acceptance at multiple scales

At the local scale, an extractive operation is said to have a social licence when it achieves ongoing acceptance or approval from the local community and other stakeholders who can affect its profitability (Graafland, 2002). Without this social acceptance, it is very difficult for a mine or gas development to operate effectively or profitably. At this local scale, it is well understood that social (or community) acceptance of an operation is a reflection of the quality of the relationship a company has with their host community (Thomson & Boutilier, 2011; Lacey & Lamont, 2014; Parsons et al., 2014; Moffat et al., 2015a; Cooney, 2017). Community relations are an integral part of successful operations and where these interactions are effective, they tend to foster mutual understanding, trust and support between a company and the host community (Kemp et al., 2006; Holley & Mitcham, 2016). Research further demonstrates that where such interactions are perceived to be procedurally fair, the increased trust created in these company-community interactions tends to lead to higher levels of acceptance of mining and gas operations (Moffat & Zhang, 2014; Lacey et al., 2017).

Similarly, at a national scale, social acceptance of the extractive industries reflects the distribution, and perception of distribution of risks and benefits arising from the industries' activities. Frequently, the acceptability of operations at the local and regional scales can be affected by what happens at national or even international scales. For instance, local rejection of some mining projects has been fundamentally strengthened by the involvement of 'outsiders' or distal communities across national and even international boundaries, leading to the loss of support in a number of projects (e.g. Kirsch, 2007; Prno & Slocombe, 2014). Hence, local acceptance of an extractive project cannot be obtained and maintained in isolation from what happens at national and international scales (Zhang et al., 2015). Similarly, what takes place at the local scale can also impact perceptions of and attitudes toward extraction at the national and international scales. The performance of a particular project, either positive or negative, can affect the reputation of the industry it belongs to and shape the general public's perceptions of and attitudes toward extraction more generally.

In many ways, the drivers of social acceptance of mining across these scales reflects the evolving nature of the relationships between industries and their communities and other stakeholders. The variables operating at these multiple scales are intertwined, effectively influencing both the acceptance of extractive projects at the local scale and of the extractive industries at the state and national scale. Hence, there is real value in understanding how the general public's attitudes toward extraction can influence the local conditions for acceptance of an operation, and how local issues influence decision-making by companies and governments at the national scale. It is also critical to be able to bring citizen voice into decision-making about resource development, which has traditionally been the domain of industry and government alone.

Applied research to identify the drivers of social acceptance

Applied research can play a critical role in developing the evidence-base for a detailed knowledge of the drivers of trust and social acceptance (i.e. SLO) of the extractive industries across scales and how they operate. For example, research to date has quantified the critical role of trust for social acceptance including how the relational aspects of stakeholder interactions can influence this. Key findings to date have already identified that:

- As stakeholder expectations and experiences of mining impacts converge, acceptance and approval of an operation increases (i.e. when companies do what they say they will do acceptance is high)
- Procedural fairness (i.e. influence over decisions made by company, respect shown to community) is a strong predictor of trust
- Relationship quality rather than the amount of contact with company personnel is key to building trust.

Such insights can assist industry, communities and governments understand what drives increased trust and, in turn, support stronger relationships between these stakeholders that will lead to better outcomes for all parties and more sustainable and efficient industry. The remainder of this review draws on surveys of more than 14,000 community members conducted in eight countries, summarising recent applied research to measure and model the drivers of trust and social acceptance of extractive industries across scales, how these variables interact, and identifies implications for improved practice.

The drivers of social acceptance of the extractive industries

There is significant qualitative research documenting processes of community relations practice and the successes and failures of citizen engagement around extractive sites. Such failures can arise even where communities are explicitly involved in consultation processes around new or existing resource development, where the potential for mismatched expectations among the stakeholders in these operations is high (Kapelus, 2002; Prno & Slocombe, 2012; Bice, 2013; Kemp & Owen, 2013). For example, in a study of mining affected communities in Australia, Cheney et al. (2001) found that local communities often felt marginalised in what was perceived to be a pre-determined development trajectory defined together by government and mining companies.

Community members have also reflected that companies and communities tend to hold distinctly different value sets and worldviews. This is even more likely in the context of negotiations with Indigenous peoples on whose land extractive project development may be taking place (Banerjee, 2000), particularly where a stakeholder approach which involves ‘providing a seat at the table’ may reduce a radically distinct and prior historical claim to one among a series of other interests to be traded off, effectively limiting the possibility of reaching understanding with key cultural and community groups. This difference in values and worldviews between companies, communities and government may also lead to fundamental misalignment of expectations regarding the terms of their relationship with each other and what is deemed socially acceptable to each party (Thomson & Joyce, 2006). While Nelson and Scoble (2006) see the path to social acceptance through industry maintaining positive corporate reputation and educating local stakeholders about a project, Thomson and Joyce (2006) point out that community members, in their experience, tend to be more concerned about whether they are respected, listened to, and whether they are allowed to participate in the development of an operation. These criteria summarise the distinctly relational aspects of procedural fairness in company-community interactions but these differences also bear out the powerlessness that Cheney et al. (2001) observed among community members, and reflect a more general disconnect between a key company driver to 'make a deal' and that of community to establish an equitable relationship of exchange (Joyce & Thomson, 2000).

Thus, even when all key stakeholders are explicitly invited into a conversation regarding the nature and shape of extractive development, asymmetric power relations between parties, and differences in values, worldviews and perspectives are still likely to create opportunity for mistrust and conflict. As Swain & Tait (2007) observe, creating and sustaining trust among parties with conflicting goals and deeply different underlying values remains one of the major challenges of effective participatory processes, and this equally relates to the engagement and dialogue that underpins the social acceptance of extractive resource development. What emerges from this is that it is most often the relational factors that play a critical role in determining the quality of the interactions and relationships between companies, communities and other stakeholders in minerals development. Put another way, very often, the physical and financial impacts (positive and negative) of extractive development are less important to a social licence than these relational characteristics. The importance of these relationships underpins how communication take place and how negotiations can be reached.

There is little doubt that operations and communities vary widely across contexts and industries. This diversity of experiences with extraction means that the nature of stakeholder interactions can also look very different based on differences in local priorities (for a company, a community or both), the nature of the extractive activity and its history in a place, or even the demographic profile of a community and the mix of other industries comprising the economy. For example at the local scale of impact, mining developments can create adverse environmental and amenity impacts associated with increased noise, dust, pollution or other disturbances. While these negative impacts are often managed through formal instruments such as Environmental and Social Impact Assessments and other regulatory instruments, it is has been demonstrated that a community's experience of those localised social, environmental and economic impacts of extraction and a company's ability to reduce those impacts voluntarily in response to community feedback plays a role in determining their acceptance of mining operations (Moffat & Zhang, 2014). For the NT, its particular set of largely unique characteristics also make generalisation of lessons learned in other jurisdictions challenging. A relatively sparse and unevenly distributed population, a very strong emphasis on the role of water in livelihoods and connection to place, the importance of Indigenous peoples and their connection to country (and legal rights to refuse consent), and the role of pastoralism in local and state based economies, add complexity and nuance to considerations of the nature of social acceptance in that place, and how to understand it.

Similarly, these contextual differences can influence how extractive operations are perceived at the national scale. For example, extractive industries tends to be associated with a range of costs and benefits. The nature and extent of these costs and benefits play a role in the level of acceptance of mining. For example, in a national survey of Australian citizens' attitudes to extraction industries (Moffat et al., 2014a), the three main areas of impact and benefit, respectively, were found to be:

- Impacts on the environment (including climate change), costs of living, and negative impacts on other sectors (including manufacturing, agriculture and tourism)
- Employment and other regional benefits, general economic benefits (personal, family and national wealth), and development of regional infrastructure.

Routinely, similar research in different contexts around the world tends to find similar patterns in how citizens assess the impacts and benefits of the extractive industries (Moffat et al., 2014b; Zhang et al., 2015) (i.e. environmental impacts are routinely perceived as the most negative impact associated with extraction whereas the economic contributions of the sector are considered to be the most positive benefit).

The way citizens perceive these impacts and benefits does influence their acceptance of extraction, such that the more negative citizens believe the impacts are, the less inclined they are to accept the industry; and the more positive citizens perceive the benefits to be, the higher their acceptance of the industry. While these large scale surveys of citizen attitudes provide an evidence base for confirming how such impacts and benefits are perceived, what tends to be more revealing is assessing the strength of the relationships between them. For example, in the 2014 Australian national survey, citizens were also asked to consider whether they felt the benefits of mining (including gas extraction) outweighed the impacts (i.e. was it worthwhile having a mining industry in Australia?), to understand how this influenced their acceptance of the extractive industries. The results from this analysis revealed that weighing up the impacts and benefits was a strong positive predictor of social acceptance over and above the other individual impact and benefit measures. This suggests that citizens hold a nuanced view of the impacts and benefits of extraction and that where the balance of benefits is seen to outweigh the impacts, acceptance will likely be higher (Moffat et al., 2014a & 2014b; Lacey et al., 2017).

However, what is more interesting is that the most significant predictors of trust in the industry and acceptance of the industry have tended not to be related to impacts and benefits at all. Rather, at both the local and national scales and in diverse extractive contexts around the world, what has emerged is that strong acceptance tends to be about building trust between industry, government and society. There is a growing understanding that the way people are treated in decision-making processes, the ways that benefits are distributed from mining and the role of governance in setting the rules for mining, are most important for developing strong trust and acceptance (Moffat et al., 2014a; Zhang et al., 2015). This confirms the observations of Joyce and Thomson (2000). Despite differences in the experiences and conditions of extraction around the world, research conducted over several years has now identified a common set of relational variables that underpin social acceptance, or social licence, at local, state and national scales. These critical relational variables (i.e. focusing on stakeholder interactions) include: (i) contact quality between company personnel and community members, at the local scale; (ii) distributional fairness (particularly in relation to benefits), across scales; (iii) procedural fairness, across scales; and (iv) citizen confidence in the governance arrangements around extraction, at the national scale. Each of these variables is summarised below.

Contact quality between company and community members

At the local scale, the quality of contact between company personnel and community members can have a significant influence on the quality of company-community interactions. Extensive research demonstrates that positive contact or interactions between groups can improve intergroup relations and increase trust between those groups (Pettigrew & Tropp, 2006; Tam et al., 2009; Hewstone & Swart, 2011). This has been shown to be equally true when tested in mining contexts. For example, in a longitudinal survey of community attitudes to coal seam gas extraction in Queensland, Moffat and Zhang (2014) found that the quality of contact between CSG company personnel and community members was a significant predictor of trust in the company and acceptance of its operation. What made no difference to trust and acceptance was the amount of contact between the company and community. Their findings corroborate those of Kemp et al. (2011) who also found that the nature and quality of the interface between individuals, plays a key role in mitigating social conflict in mining contexts.

Distributional fairness

Distributional fairness refers to the extent to which the benefits of an extractive operation are perceived to be distributed fairly within a community or society, more broadly (Kemp et al., 2011; Zhang et al., 2015). Empirical studies have also shown that people express greater satisfaction when they believe that they receive a fair share of the benefits in a given situation, or they will tend to reject the arrangement (McComas & Besley, 2011; Siegrist et al., 2012). In the extractive context, the fair distribution of industry related benefits has been shown to be a significant predictor of trust and acceptance of both local operations and the industry, more broadly (Moffat et al., 2014a). For example, communities may benefit through direct compensation, royalty payments or participation in joint ventures (O'Faircheallaigh, 2002). Other benefits may include the industry's contribution to employment and training opportunities (Measham & Fleming, 2014) or investment in local and regional infrastructure (Michaels, 2011). At the national scale, such benefits may be reflected in macroeconomic consequences such as increased revenues resulting from export markets or taxation regimes (Battelino, 2010).

Procedural fairness

Procedural fairness can be achieved in many ways but it routinely requires the implementation of processes that are considered to be fair by all involved, are transparent and inclusive of diverse perspectives and priorities, allow the public to access information and debate, and to feel respected and listened to in that process (Lacey et al., 2017). Procedural fairness also refers to whether individuals believe that they have had a reasonable voice in decision-making processes (Tyler, 2000; Besley, 2010). Perceptions of fairness in processes leading to decision outcomes increase trust between those who are involved in negotiating decisions and ultimately, the acceptance of the outcomes of those decisions, even among those who may be disadvantaged by such outcomes (Lind & Tyler, 1988; Tyler, 2015). Given the increased participation of communities in decision-making about how mining operations will be developed, designing and implementing fair processes has become a critical part of creating equitable participation, creating meaningful dialogue among stakeholders, diffusing conflict and achieving sustainable resource management decisions (Kemp et al., 2011; Holley & Mitcham, 2016; Lacey et al., 2016).

Governance

At the national scale, governments around the world play a major role in regulating the extractive industries and stipulating how extractive activities should be conducted in their jurisdiction. The regulations are often introduced in the form of legislation, and approval and reporting processes. This also includes regional and national laws governing environmental assessment and public participation processes (MMSD, 2002; Solomon et al., 2008). From the public's perspective, these are the major formal mechanisms for managing the social and environmental impacts of extractive activities. When the public believe that the governance arrangements in place are not capable of ensuring responsible resource development, their attitudes toward extraction tend to be less favourable. Indeed, research has shown that public perceptions of the governance arrangements around extraction moderate the relationship between their concerns over environmental impacts and their acceptance of the industry (Zhang & Moffat, 2015). More specifically, when citizens strongly believe that existing regulation and legislation has the capacity to hold the extractive industries to account for their actions (i.e. strong governance), there is an increased likelihood to accept industry compared to those who perceive governance arrangements as being weak, irrespective of their views on the environmental impacts of industry (Zhang et al., 2015).

How the drivers of social acceptance interact in practice

There is clear evidence that the interactions between these relational drivers of social acceptance can be systematically modelled and measured at local and national scales by conducting large scale surveys of citizen attitudes (Moffat & Zhang, 2014; Moffat et al., 2015b; Zhang et al., 2015).

Social acceptance at the local scale

At the local operational level, for example, Moffat and Zhang (2014) have developed an integrative, quantitative model to understand the paths to community acceptance of extractive operations. Their analysis reveals that building trust with local communities is crucial for resource companies to obtain and maintain support and acceptance of those operations. This trust is fundamentally shaped by the contact quality (but not quantity) and procedural fairness through which companies deal with communities, as well as perceptions of how fairly the benefits of extraction are distributed in the community.

Figure 1 illustrates how these relational variables interact in practice at the local scale, with positive relationships between the three relational variables indicating that the more distributional fairness, contact quality and procedural fairness perceived by communities, the greater the level of trust in and acceptance of operations is realised. The model and the relationships illustrated in Figure 1 have been developed based on a range of theoretical and applied research (e.g. Kemp et al., 2006 & 2011; Thomson & Boutilier, 2011; Kemp & Owen, 2013; Lacey & Lamont, 2014; Moffat et al., 2014a & 2015a; Moffat & Zhang, 2014; Zhang et al., 2015; Lacey et al., 2017) and empirically validated in multiple contexts including Australia, New Zealand, and South Africa, and in multiple commodity contexts including gas extraction. The arrows represent the predicted interactions between the variables that can be measured and modelled using structural equation modelling (an advanced statistical modelling technique). A positive symbol indicates that increased levels in one variable is expected to lead to increased levels of another (e.g. increased procedural fairness predicts increased trust). The strength of these predictive relationships often varies between contexts but the elements themselves have been found to remain unchanged across highly differentiated contexts. These three relational variables were also found to be strongly correlated with each other suggesting that increased procedural fairness can positively influence perceptions of contact quality and distributional fairness, and vice versa.

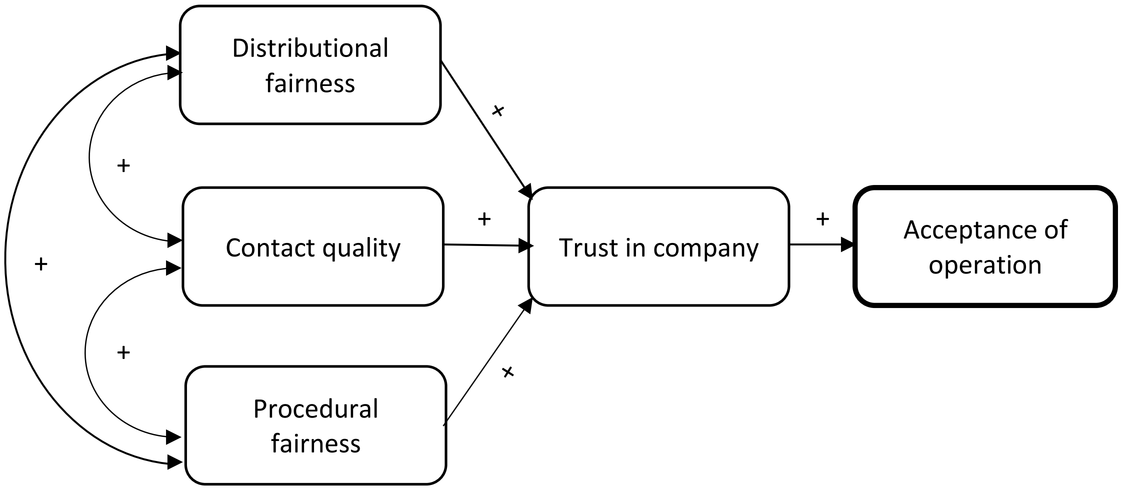

Figure 1 Conceptual model of the drivers of trust and acceptance of local extractive operations

This model challenges some key assumptions about the drivers of trust in company-community relations. For example, all communities surveyed tend to express the view that the environmental and social impacts of mining matter a great deal to them. However even though these concerns are important across all contexts, they are rarely found to be the main predictors of trust or acceptance of a company or its operations. This is significant because it highlights that the relationships between the stakeholders needs to be strong and supported to enable effective negotiations around matters such as the social and environmental impacts of extractive operations.

Social acceptance at the national scale

Similarly, large scale survey research at the national scale assessing citizen attitudes towards the extractive industries (as opposed to localised impacts) also reveal the key predictors of trust in industry, and in turn, the drivers of social acceptance of extraction. Figure 2 illustrates an empirically validated model of social acceptance that highlights procedural fairness, distributional fairness and confidence in governance as the three most significant predictors of trust, and in turn acceptance of the industry (Zhang et al., 2015). This model was developed based on over 14,000 citizen responses testing attitudes to the mining sector (including gas extraction) collected in Australia, Chile, China and Zambia over a two year period.

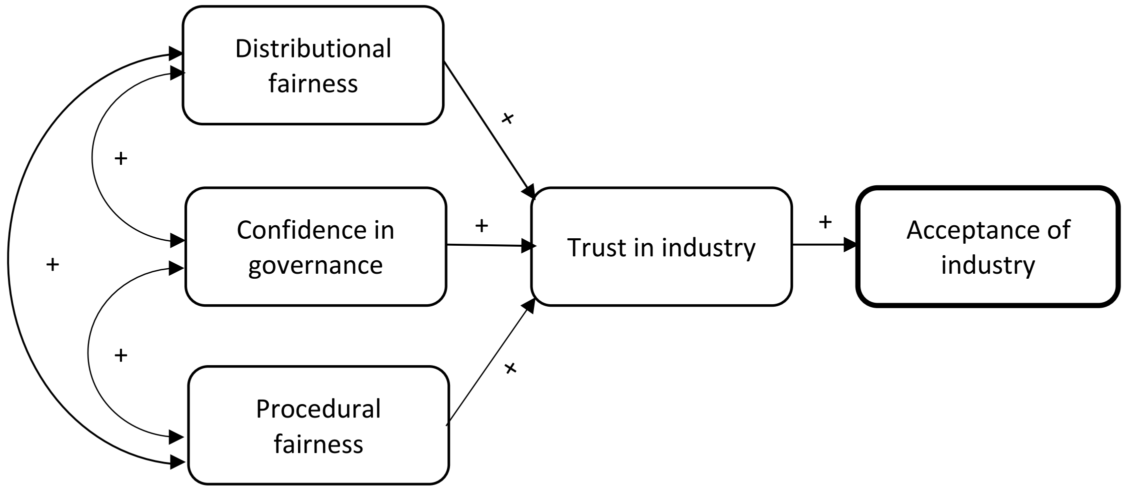

Figure 2 Conceptual model of the drivers of trust and acceptance of national scale extractive industries

At this scale, a measure such as contact quality ceases to become relevant (i.e. most citizens in a nation do not live near operations) but the citizenry's expectations of government tend to come to the fore more strongly as the drivers of trust in and acceptance of the industry. A key message from this research and its interpretation, is that in effect, social licence is everyone's business. The interrelationships between procedural fairness (determined in this work by industry behaviour), faith in governance (determined by government behaviour), and distributional fairness (what may be seen as an interaction between industry and government behaviours) are strong, even as each drives trust and acceptance individually. Neglecting one component erodes the relationship between the others and trust/acceptance. Equally, industry working with community to build faith in governance capacity, for example, improves the likelihood of greater trust and social acceptance for the industry as a whole.

SLO and ownership of risk

The work around SLO in the literature and by CSIRO speaks clearly to the direction of the risk associated with loss of community acceptance. Where SLO is degraded or lost such that a company or industry is rejected, the risk lies predominantly with that company or industry. As mentioned briefly above, conflict with communities leads to high financial, opportunity, and personal costs to mining companies and their personnel (Franks et al., 2014). Where communities do not have a constructive way to express concerns about the impacts and processes associated with large scale development, they may choose to exert influence on these development processes in more creative ways. Franks et al (2014) provide the most systematic and methodical examination of these risks in a mining context, demonstrating that apart from the significant financial costs of shutting down development, this conflict also impacts directly on the capacity of companies to conduct their core business. Executives in particular are required to manage the actual and reputational costs such rejection may bring, taking them away from their core roles and creating additional opportunity costs.

For communities that already see little local benefit from development, particularly in its early stages, the costs of rejection may be seen to be less severe. Conflict with companies is likely to lead to reduction or cessation of investment into communities, as has been the case in the Northern Territory during the moratorium. There are also opportunity costs for communities relating to local investment, investment uncertainty and fractures within communities that conflict creates or exacerbates. However, with respect to loss of social licence, the risk lies predominantly with the companies and industry(ies) that lose it.

3 Northern Territory specific data

In late 2016 and early 2017, a second national survey of citizen attitudes toward the extractive industries (including minerals and gas in a broad definition of 'mining') was conducted by CSIRO. The aim of this work was to provide a comparative dataset to that collected in 2014 and detailed in part above. For the purposes of this report, this 2016/17 data has been analysed to allow comparisons between states in Australia. Data was collected from communities where the extractive industries are present and operating, from non-extractive communities and from urban communities in Australia's capital cities (Table 1 describes the number of participants by location category, Table 2 describes location of respondents by state or territory and Figure 3 shows where participants were located spatially, by postcode). In total, 8,020 Australians completed the online survey, 227 of whom were in the NT.

Table 1 Respondents by region: Mining, non-mining and metropolitan

Region	Freq.	Percent
Mining	1,780	22.19
Non-Mining	2,384	29.73
Metro	3,856	48.08
Total	**8,020**	**100**

Table 2 Respondents by state and territory

State	Freq.	Percent
ACT	70	0.87
NSW	2,470	30.86
NT	227	2.84
QLD	1,850	23.11
SA	762	9.52
TAS	266	3.32
VIC	1,612	20.14
WA	747	9.33
Total	**8,004**	**100**

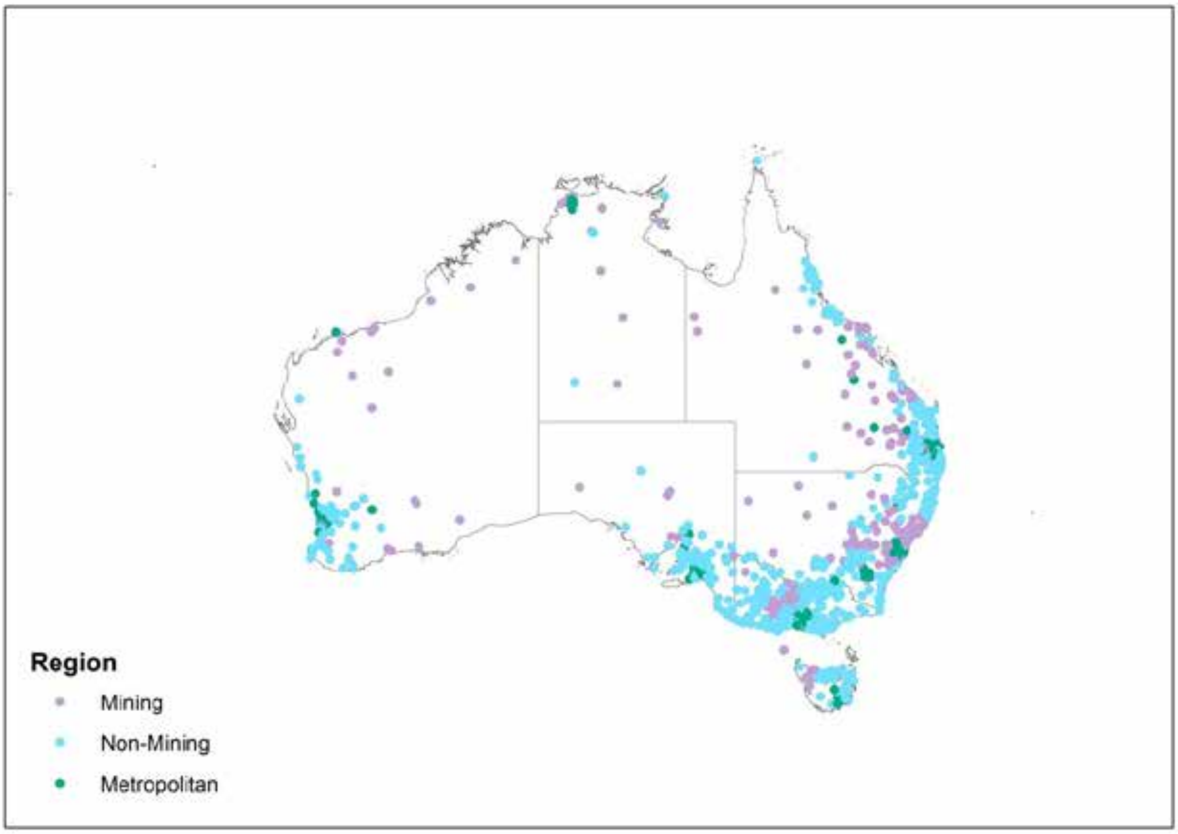

Figure 3 Distribution of survey participants in 2016-17 across regions and states in Australia

A broad range of topics was covered in the 2016/17 survey, including acceptance of extractive industries overall, acceptance at the local community level, and trust in a range of industry actors. Distributional fairness, procedural fairness and governance capacity were also assessed as per previous work in this area. Finally, for the purposes of this report, data relating to community perceptions of a range of benefits and negative impacts of the extractive industries are reported (Table 3 details the mean responses of community members overall for each item assessed, by state).

3.1 Descriptive data key findings

Acceptance of extractives

Mining (inclusive of gas) is generally accepted in the NT, though Western Australia (WA) has significantly higher levels of acceptance overall. NT residents were, however, significantly less accepting of mining activity were it to be in their own local community. This phenomena is consistent across states and territories, and acceptance of mining in one's own local community is around 3 on average (i.e. the mid-point of the scale, where 1 reflects very low acceptance and 5 reflects very high acceptance).

Acceptance was also mapped spatially by postcode across the NT. While this is a course method for representing a relatively small set sub-set of data, it illustrates a broader trend for the NT: that acceptance is higher in larger population centres than in less populated areas. In Figure 4, levels of acceptance around the mid-point of the scale used (3) can be seen as yellow. South of Tennant Creek acceptance can be seen to be lower than in several areas around Darwin.

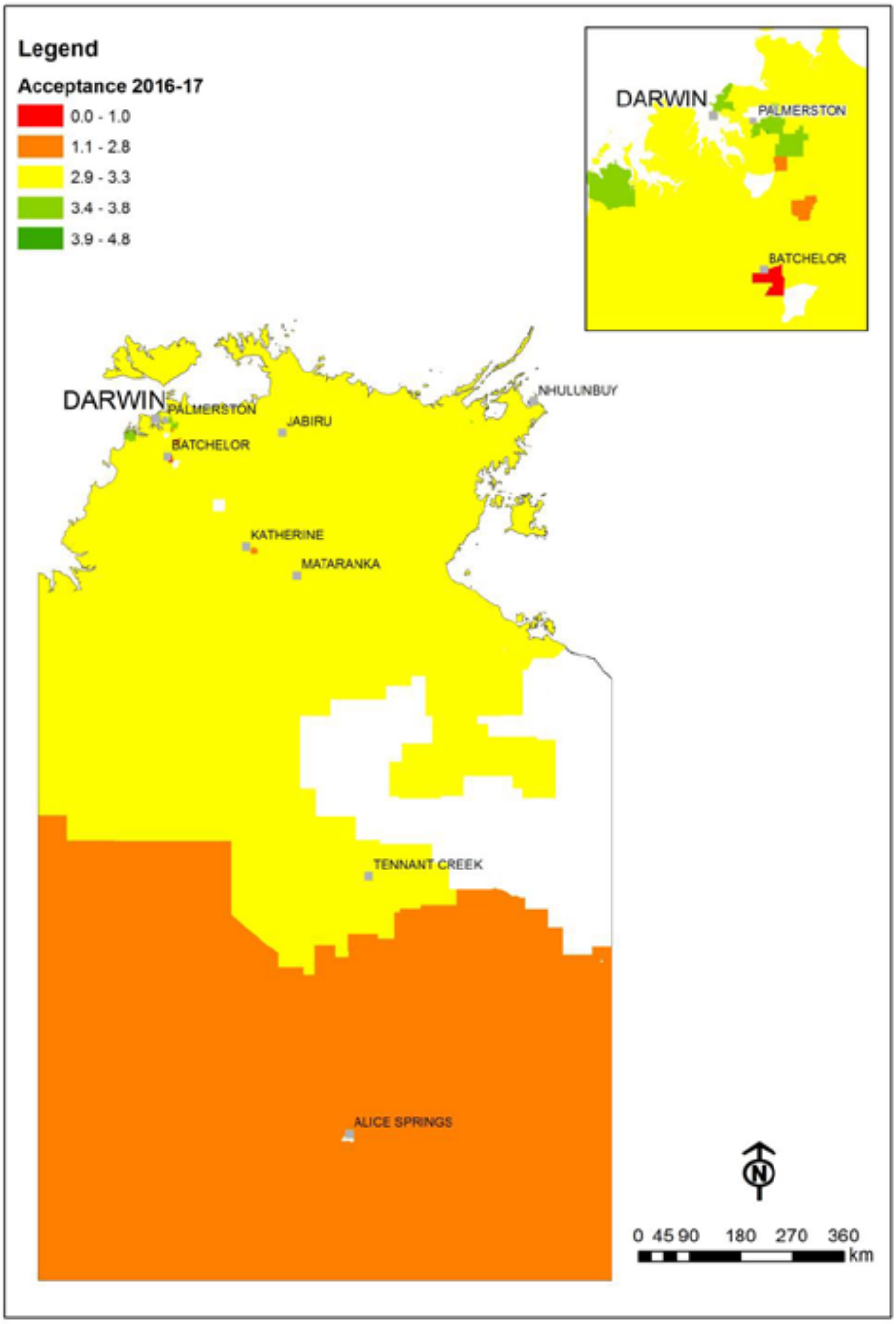

Figure 4 Spatial representation of NT acceptance data

Governance capacity

Perceived governance capacity of governments at state/territory and federal levels is unfavourable across Australia, on average. This is particular the case among residents of the NT, who perceive governance capacity significantly poorer than those respondents from all other states and territories. This relates to being able to rely on legislation, regulations, and governments at the territory and federal levels to ensure mining companies do the right thing and are accountable.

Trust

NT residents also have low trust in the extractive industries and governments, marginal trust in advocacy groups, but higher trust in research organisations relative to residents in all other states. Low trust in government is a common phenomenon across states, as is low trust in the extractive industries. NT residents, however, trust the extractive industries significantly less than residents in other states.

There are marginal levels of trust in advocacy groups, which is common across states and territories, though this would vary between individual advocates and advocacy groups (the survey did not explore this issue by different advocacy groups).

Procedural and distributional fairness

Low trust perceptions are underpinned by low perceptions of procedural and distributional fairness (midpoint = 4). Perceptions of procedural fairness (feeling heard, respected and included in decision making processes) and distributional fairness (that the benefits of extractive industries are spread fairly) were significantly lower in the NT when compared to all other states.

Impacts, benefits and the value proposition for extractives

Even though there is low trust in the extractive industries, and associated negative perceptions of procedural and distributional fairness, and even though there is low trust in government and associated governance, residents across the states and territories still see consider the balance of benefits over costs to be favourable on average. This was particularly the case in WA.

Regional infrastructure, employment and local community benefits were particularly favourably perceived in the NT, while financial benefits at the individual, family, and general public levels were less influential. This was also true in other states, though their residents generally rated higher employment and local community benefits flowing from extractives more positively.

Perceived environmental impacts were the most negatively viewed industry impact, with these views significantly more negative in the NT than in all other states and territories apart from New South Wales (NSW). This was followed by impacts on living costs in the NT, and then impacts on other sectors (e.g. tourism, manufacturing). Residents in other states also saw impacts on the environment as the most concerning for the industry, though were less concerned about impacts on living costs.

Table 3 State based comparison of mean community responses

	NT	NSW	VIC	QLD	SA	WA	TAS	Aus.	Mid-point
Acceptance of mining generally	3.34	3.30	3.30	3.34	3.36	**3.61**	3.32	3.34	3
Acceptance in local community	3.07	2.93	**2.87**	2.96	3.00	3.22	3.06	2.96	3
Governance capacity	2.62	**2.86**	**2.85**	**2.84**	**2.83**	**2.92**	**2.83**	2.85	3
Trust in state/territory government	2.44	2.55	**2.63**	2.56	2.54	**2.74**	**2.63**	2.59	3
Trust in federal government	2.51	2.57	2.62	2.59	2.57	**2.71**	2.52	2.59	3
Trust in research organisations	3.74	**3.51**	**3.52**	**3.46**	**3.53**	**3.50**	**3.53**	3.51	3
Trust in advocacy groups	3.06	3.04	3.01	2.96	2.97	2.97	**2.83**	2.99	3
Trust in mining industry	2.42	**2.67**	**2.70**	**2.68**	**2.69**	**2.86**	**2.65**	2.69	3
Procedural fairness	3.32	**3.74**	**3.75**	**3.72**	**3.83**	**3.86**	**3.75**	3.74	4
Distributional fairness	3.12	**3.74**	**3.74**	**3.66**	**3.75**	**3.65**	**3.75**	3.69	4
Balance of benefits over impacts	5.00	4.93	4.89	5.04	5.12	**5.29**	5.00	5.00	4
Impacts on living costs	4.66	**3.25**	**2.80**	**3.16**	**2.96**	**4.16**	**2.52**	3.21	4
Environmental impacts	5.01	4.74	**4.61**	**4.61**	**4.55**	**4.57**	**4.54**	4.65	4
Impacts on other sectors	4.06	4.27	4.08	4.11	4.09	3.89	3.88	4.12	4
Financial benefits	3.79	3.61	**3.46**	3.56	**3.48**	3.85	**3.41**	3.57	4
Regional infrastructure benefits	4.85	4.73	4.68	4.77	4.78	4.93	4.79	4.76	4
Employment and community benefits	4.87	5.01	4.91	**5.03**	5.03	**5.15**	5.05	5.00	4

Note: Bolded means are significantly different from NT; the scale midpoint is 3 in the top half of the table up to and including 'trust in mining industry' and it is 4 in the rest of the table; comparisons with ACT are excluded due to the relative small mining industry and sample size.

3.2 Modelling social acceptance of extractives in the Northern Territory

While descriptive data (above) provide very useful comparisons of respondent views in the BY relative to other states on key variables related to SLO, it is also important to understand how these variables relate to each other. In other words, it is important to understand what drives trust and acceptance of the extractive industries in the NT. A statistical technique called structural equation modelling was used to establish the relative importance of these key drivers in the NT data. To do this, a comprehensive model of trust and social acceptance of extractives was developed by CSIRO at the national level and then this model was applied to the NT data. At both the national and NT level, the model performed very well, predicting more than half the variation in 1) individual levels of trust in the mining industry, 2) perceptions of benefits over impacts, and 3) respondents' overall social acceptance of the industry in the Northern Territory (57%, 57%; and 67% respectively; see Figure 5 below).

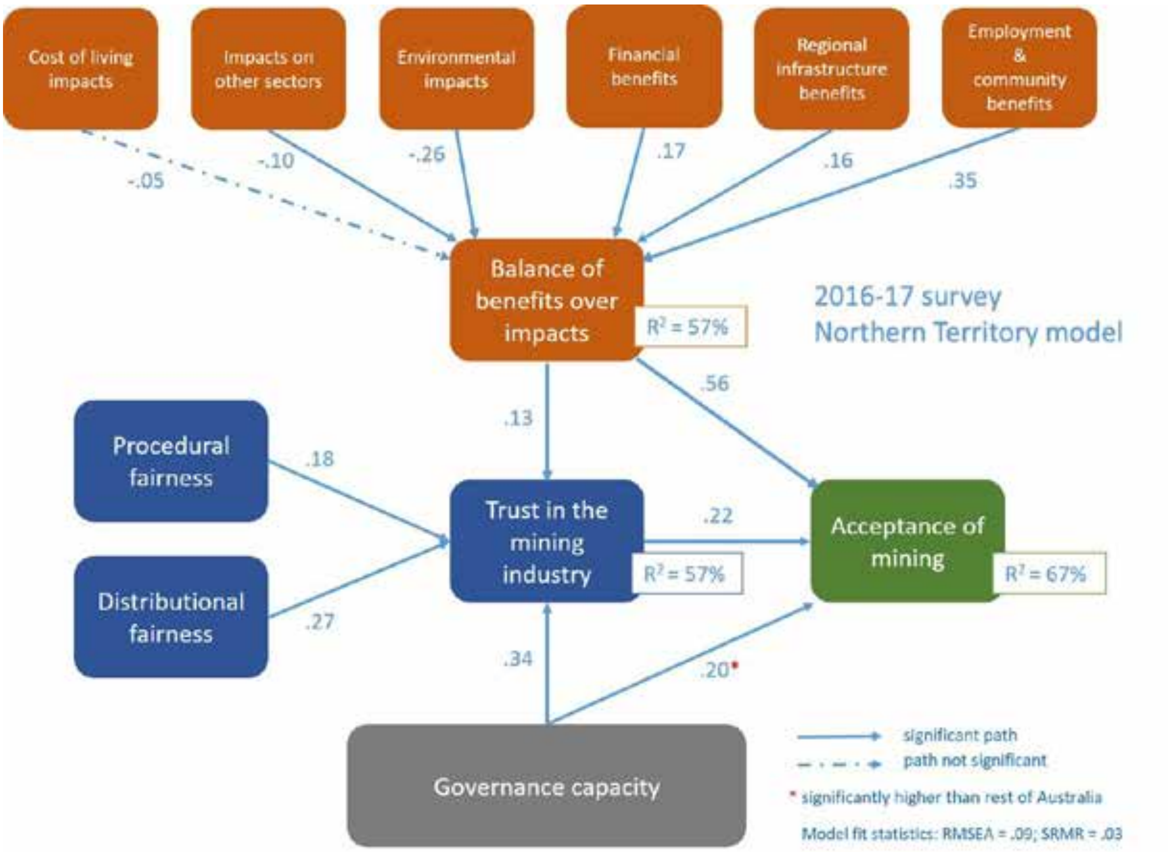

Figure 5 Comprehensive model of NT data predicting trust and acceptance of the extractive industries (higher numbers indicate stronger relationships, a positive value indicates more of one variable leads to higher levels of another variable)

For residents of the NT, good governance was significantly more important for social acceptance of the extractives than for residents in the rest of Australia. Governance was approximately as important as trust in the mining industry as a direct predictor of social acceptance, and it was also an important predictor of trust in the mining industry. Thus governance has both direct and indirect effects on social acceptance of extractives.

Trust in the mining industry is also influenced by perceptions of procedural and distributional fairness. Since both of these are rated unfavourably in the NT, improving these perceptions of fairness are also opportunities for improving trust in, and social acceptance of, extractives in the NT.

However, the most important predictor social acceptance was perceived balance of benefits over impacts of mining, or its value proposition for the Territory and its people. Like the rest of Australia, perceived employment from extractives and financial community benefits was the highest predictor of 'balance of benefits over impacts' variable. The balance of benefits over impacts with respect to extractives was viewed quite positively in the NT, in line with the national average. Only residents of WA rated this ratio of impacts to benefits significantly more positively than residents of the NT.

Regarding perceived costs, the impacts of mining on living costs was seen as relatively high in the NT, but it was not a significant predictor of the perceived benefits over impacts and so it is less important for overall social acceptance than other impacts. The most important negatively perceived impact related to the environment, which were also seen as relatively high in the NT. This means the environment is an important issue for social acceptance of mining in the NT.

3.3 Inequality in the NT

In addition to community sentiment analyses for the NT, CSIRO also calculated a measure of socio-economic inequality for the NT based on census data collected in 2006 and then 2016. The gini co-efficient is intended to represent the income or wealth distribution of a nation's residents, and is the most commonly used measure of inequality. With respect to SLO in the NT, the level of inequality across the Territory speaks to potential social divisions that may be exacerbated by resource development, or positively affected by it, depending on how development progresses. For those residents that already perceive low distributional fairness in the way the industry operates, low levels of community, family and personal economic benefit form extractives, and high levels of impact on the environment, for example, high levels of general inequality may interact with these perceptions of the industry to undermine levels of acceptance of the industry (i.e. it's SLO).

For interpretation, it is important to note that there are no clear thresholds for what represents very high or low inequality and that the colours used in the following figures are used for illustration purposes only. Calculations of the gini co-efficient were based on total family income, regardless of employment status and includes both couple and one parent families with children.[1] The gini co-efficient varies between 0 and 1, where the closer to 1 the co-efficient is, the more unequal the income distribution is.[2]

Figure 6 illustrates the gini-co-efficient across the NT by Local Government Area (LGA) for the 2006 and 2016 census data sets. The Beetaloo Basin location is marked. It appears that across most of the NT, and for the LGA within which the Beetaloo Basin is located, has increased over the preceding six years.

Figure 7 reflects the change in gini co-efficient over this time. Only Katherine has seen little change in levels of inequality in this period, with all other LGAs in the NT experiencing growing levels of family income inequality in this time.

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[1] For the highest income bracket the open-ended class median is calculated based on the algorithm described by Parker and Fenwick (1983). By using the Parker and Fenwick (1983) method, truncation error is avoided (c.f. Fleming and Measham, 2015).

[2] It is also important to note that calculations are based on available data, and census data collection methods disproportionately exclude Aboriginal Australians in remote Australia.

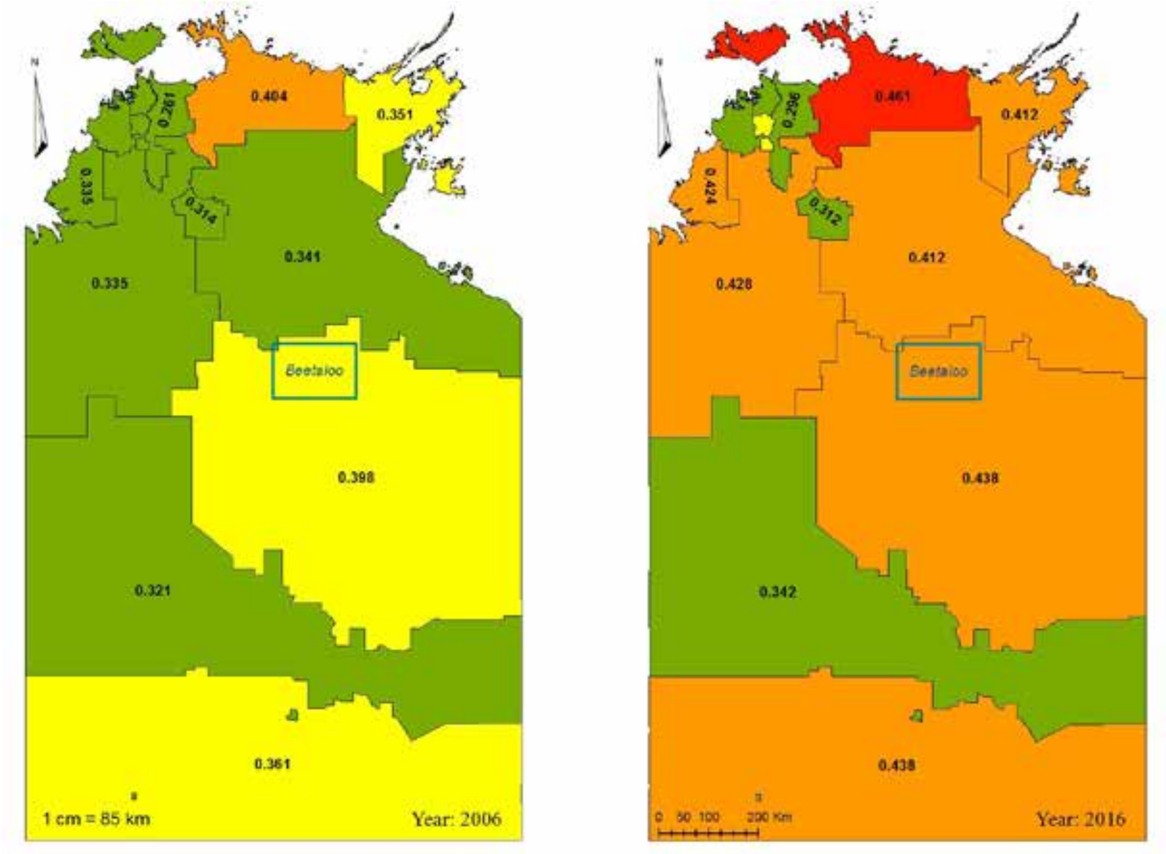

Figure 6 Local Government Areas coefficient of inequality in 2006 and 2016 (calculations based on 2016 Census data). Data sources: (Australian Bureau of Statistics, 2016; Geoscience Australia, 2017)

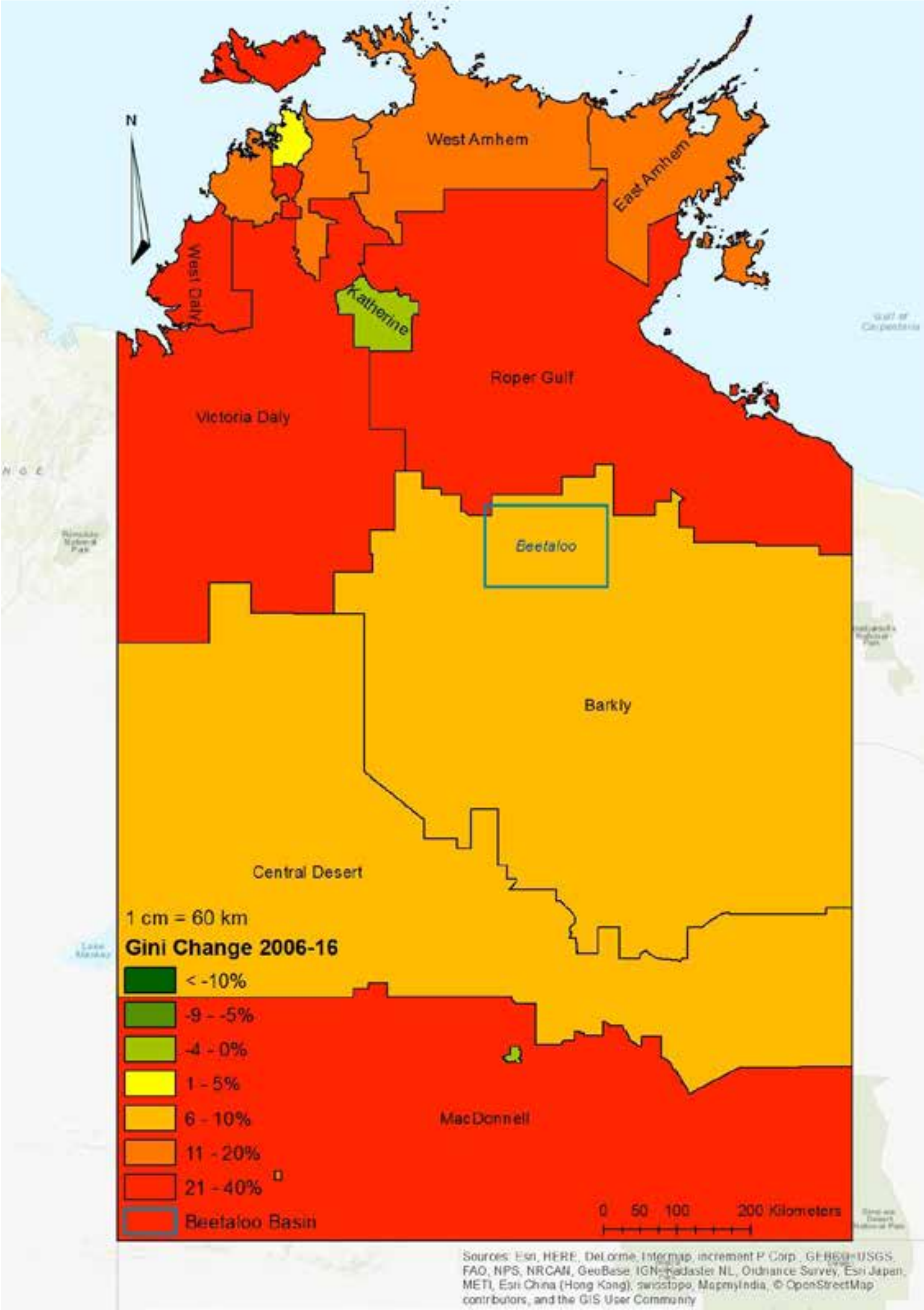

Figure 7 Inequality (Gini) coefficient change in Local Government Areas, 2006 – 2016 (calculations based on 2016 Census 2016). Data sources: (Australian Bureau of Statistics, 2016; Geoscience Australia, 2017)

3.4 Community and company perspectives: interviews and fieldwork

In order to ground the data presented above in a more local context, a range of stakeholder engagement activities were conducted as part of the broader scope of work that this SLO report sits within. The authors of this report conducted a limited number of interviews and discussions with industry and government stakeholders, and used the outputs from community engagement activities conducted in the NT by University of Queensland (UQ) researchers, to inform the following section. These data collection activities are limited, as reflecting the challenges of conducting primary research in remote Australia and the scope of CSIRO's component of work. The purpose of this section, therefore, is to provide some context for the data included above, while acknowledging the clear limitations of the engagement conducted within the scope of this project and development of this SLO report more specifically.

A consolidated list of groups consulted in the course of the whole project is contained in the Coffey Social Impact Assessment report (Coffey, 2017). To inform the current SLO report, seven detailed discussions of approximately an hour duration were conducted with industry and government department representatives (Table 4 details CSIRO discussants by sector). These were not formal interviews, but used by the lead researcher to gain context and perspective on issues that are evident in the survey and economic data presented above. In addition, detailed interview notes were made available for use in this report by UQ researchers who engaged community members and other stakeholders in Boroloola and Elliot during their field work component (Table 5 details the location of UQ interviewees, and Table 6 the Indigenous status of UQ interviewees). Notes from five interviews conducted in Boroloola and three in Elliot were used in this report.

Table 4. Discussion participant sector and number of discussants

Participant	Organisations	Discussants
Industry company or representative body	5	9
State government department	1	1
Private sector company (non-gas)	1	1
Total	**7**	**11**

Table 5. Interviewee role by location

Interviewee	Borroloola	Elliot	Total
Small business employee	2	2	**4**
State government agency/service member	3	0	**2**
Local Indigenous leader	0	1	**1**
Total	**5**	**3**	**8**

Table 6. Indigenous status of interviewees by location

Interviewee	Borroloola	Elliot	Total
Indigenous	4	3	**7**
Non-Indigenous	1	0	**1**
Total	**5**	**3**	**8**

In conversation with a range of industry, community and government stakeholders in a NT gas industry, several key themes emerged that are relevant to SLO. These include that existing social challenge and tensions within and between Indigenous and non-Indigenous communities in the Beetaloo Basin, and for the NT more broadly, risk being further exacerbated by large scale development that is not carefully planned and managed. For example, as the gini co-efficient data presented above indicates, there is increasing inequality in family income in the NT; any potential royalty payment scheme for new development must be designed carefully to ensure that an industry sharing economic benefit with local Traditional Owners doesn't exacerbate underlying trends in family income inequality in novel ways.

The potential benefits of the gas industry developing at scale were discussed. For industry these are self-evident, but for communities these benefits were less clear. At a Territory level, community benefit is well understood in terms of various revenues, employment, and industry and government investment in infrastructure, to name a few. However, at local levels the potential balance of impacts and benefits was less clear and perhaps less equitable. While jobs and training are desirable for these communities, and companies expressed commitment to working with local communities in traditional and creative ways to deliver local benefit, the reality is complex. Careful thought and planning as to how local communities may participate in extractive roles in culturally appropriate ways, develop foundational capacity from which to build these skills, and considering opportunities that align with cultural interests and values (e.g. environmental management through the ranger scheme) are important. Local community members expressed the fact that despite previous development initiatives in the past, local benefit had not be realised to any large degree.

Uncertainty was a dominant theme of conversation in discussion of SLO. The process of resource exploration and development is inherently uncertain as to its outcome and the shape of future projects. Managing this uncertainty is a genuine challenge in all communities engaged by the extractives industry, but particularly where ‘fracking’ is employed. Community, industry and government contributors indicated that popular culture material and information (e.g. the film Gasland) relating to the deployment of similar technologies in other places was influencing how communities were thinking about fracking technologies and potential impacts in their own country. Uncertainty was seen to lead to anxiety, which in turn resulted in a ‘better safer than sorry’ approach to its deployment in the NT among some communities and individuals. This was particularly the case as the technology relates to water quality and quantity in the NT.

Community members themselves expressed strong interest in resolving or at least addressing their uncertainty through accessing information from industry and government regarding deployment of hydraulic fracturing technologies in the Beetaloo Basin, but some expressed frustration that there appeared to be no one to ask. In contrast, it is clear that the industry representative body has been providing an opportunity for the general public in more populated centres of the NT to access such information from technical experts. There seems to be a gap in who is actively seeking information to resolve uncertainty and where this information is being made available, however, based on the limited consultation summarised in this report.

Companies conducting exploration or preliminary work in the Beetaloo Basin reported strong engagement locally with potentially affected community members and Traditional Owners. Companies indicated that where they were able to meet regularly with community members, discuss and explore uncertainties together and opportunities for future benefit, relationships were sound. Reflecting the role of ‘contact quality’ in previous SLO research, this demonstrates that while resource intensive, such efforts are effective in building mutual understanding if not acceptance. However, comments from community regarding the lack of engagement in areas alongside or even overlaying company tenements also demonstrates the need for broader, more inclusive definitions of who is ‘community’ in this context.

All stakeholders engaged discussed the role of government as being critical to how the industry does or does not progress. There was a perception that government and its departments had been largely absent from the discussion about gas development in the NT for some time, but that greater involvement was not only welcome but vital to meet the challenges communities in particular face. This is again reflective of the NT specific data modelling described above, with articulated the role that faith in governance plays in directly and positively predicting acceptance of the extractive industries in the NT; without clear boundaries around development activity that reassures communities that the government is actively protecting their interests, community members indicated they would find it difficult to build trust in government, industry or the technologies it uses.

Constructively, many interviewees discussed ways in which government could be more effective for all stakeholders in the NT gas industry. First, that regulation should be creative, modern, and learn from the experiences of other jurisdictions to create a NT relevant framework for gas development. It should reflect the needs of stakeholders to articulate and share their perspectives without regulating too closely the process by which this takes place. Second, the need for careful and deliberate planning was expressed. While planning around infrastructure and regional industry capacity is well developed within governments generally, skills around planning for social infrastructure and capacity are less well developed but important here. What services will be required to build the capacity of community members for work and participation in new opportunities, services to support a potential influx of construction personnel, how community dynamics may change were all areas that were seen to be important in managing SLO issues through good planning. Third, there was a desire from community and from some industry participants, for government to play a more active role in engaging community. While trust needs to be established in government in this role for messages to be heard, the government was viewed as important in helping to manage perceptions of agenda-driven information provision by industry and also anti-development groups.

Clear in all of the conversations feeding into this report was a need to develop 'the NT way' in managing the gas industry should the moratorium be lifted. While there is much to be learned from the experiences of all actors and stakeholders in other jurisdictions that have experienced the growth of gas development, there was a clear feeling that the NT has some unique characteristics and cultural norms that mean these lessons are not able to be directly applied without reflection. However, research on SLO in many contexts around the world demonstrates that there are usually many more similarities across contexts and commodities in the way community acceptance is developed and maintained over time, than there are differences. More likely, the issues of relevance to communities (e.g. water quantity and quality) and the factors that are known to be important in building trust and acceptance (e.g. procedural and distributional fairness, contact quality) will also be central in the NT, but how strategies for their development and engagement plans are executed would benefit greatly from contextualisation.

4 Limitations of this report

There are a number of limitations with the current report. Two of these are detailed below to provide a constructive context for future work around SLO in the Beetaloo Basin and NT more generally.

Availability of data

The national survey dataset held by CSIRO contains 8,020 responses yet only 227 of these come from the NT. While this is certainly enough data to conduct the analyses provided in this report, it lacks face validity when speaking to the broader social context of the NT. In addition, none of these 227 NT respondents reported their location as being in the Beetaloo Basin. This is not surprising given the CSIRO survey was not conducted to meet the needs of the NT Fracking Inquiry, it speaks to a broader issue of data availability from regional and remote Australia. It is very difficult and expensive to collect meaningful amounts of quantitative or qualitative data from the NT. However, SLO is about voice and agency of community, and gaps in data that allow meaningful research around SLO in specific regions are a denial of voice and agency for those that are excluded.

Engagement of community members

The number of community members engaged for this report is small. While in part this reflects the scope for this particular component of work, it also reflects the difficulty in engaging community members in remote Australia in meaningful ways. Genuine research regarding SLO involves placing the community member at the centre of the research process and ensuring that participation has real benefit and no greater risk for them than they experience in their day to day lives. For Indigenous community members, these concerns are even greater and must also be considered within a context of existing and past research of this group of Australians which is extensive. Any primary research in this area must reflect a longer term commitment to listen and respond to what is said by community, to be transparent about the purpose of the work and that the research framework they are being asked to participate in is worthy of their trust and time.

Future research

Future research or work in the area of SLO must consider these two critical areas if it is to be successfully conducted. A value proposition for participation should be established that reduces the number of times community members are engaged to provide the same information to external actors, that reflects real and immediate benefit for them as participants, and is appropriate to culture and norms regarding sharing of information. The NT, however, is a place that would benefit strongly from high quality provision of data in different forms for the purpose of understanding SLO for the gas industry, and other industrial activities that intersect with community member's lives. Such a framework of research may also be deployed to explore the views of Territorians about a range of other issues that are important to their lives, like provision of government services, where voice and agency are also less than optimal for many people living outside of the major NT population centres.

5 Measuring and monitoring SLO in the Beetaloo Basin and NT

Measuring and monitoring community sentiment in the Beetaloo Basin, and the NT more broadly, regarding gas development in a meaningful way is critical. Such an activity has value for the straight forward reason that community voice is often largely absent from discussions and decision making processes that shape development trajectories in the extractive industries, and this lack of voice is at the heart of much community-company conflict. Legislated and less formal consultative processes are often felt by communities to have pre-determined outcomes while communities also express concerns about ‘survey fatigue’, with multiple companies often regularly asking the same communities similar questions over time. Our own practice, supported by ‘listening tours’ conducted by the Queensland Resources Council (QRC, 2016), would suggest that it is not fatigue with participating in survey research that communities are frustrated by, but the lack of even basic feedback or transparency about the way their data is used and how it has or has not affected decision making processes they themselves have little knowledge of. By successfully measuring and modelling the critical elements leading to social acceptance, companies can also prioritise their activities and investment in a way that maximises the creation of trust between an operation and the communities it works alongside. This also allows communities, companies and government stakeholders to engage with each other on the issues that matter before they reach a critical point and lead to conflict.

As requested by the panel, a process for measuring and monitoring SLO in the NT with respect to gas is detailed below, based on previous similar programs of work conducted by CSIRO:

5.1 Establishing trust in the framework

Measurement of SLO begins with understanding context and building trust in the measurement process. Establishing a trusted third party provider of this framework and measurement process is an important cue for community that the only interest being served by the collection of data is theirs; as a vehicle for their voice into the decision making context around gas development. To achieve this, funding arrangements and governance structures around collection and provision of community sentiment data must be established transparently, and any conflicts of interest (perceived or actual) explained, along with strategies to mitigate these.

Specifically, CSIRO conducts research activities with many companies, government departments and other actors in the resource extraction industry. How the organisation places the interests of community participants at the centre of its approach to human research is fundamental to the trust that it develops in new work that is initiated.

A chief mechanism for achieving this is having the independent CSIRO Human Research Ethics Committee review and approve the proposed research design. As with universities, CSIRO research that involves people can only proceed where it has ethical approval, and this approval comes with explicit conditions and provisions about the way that is must be executed that place the rights of participants first and ensures no harm will come to them. This is fundamentally important in building in establishing trust in the process. The ethics committee is then updated with any new information or developments as they arise through the initiation and execution of the research process to ensure that the conditions placed on the work are consistent with the needs of community members.

The boundaries of the measurement framework would also be established in this phase, determined ideally by the nature of the issues under investigation. In the case of SLO, this is a multi-scale issue. While members of communities in the Beetaloo Basin are clearly of central interest, community members in adjacent areas are important to include, as are residents in towns that will service the industry (e.g. Katherine, Tenant Creek), and Darwin. Sample sizes and emphasis may differ depending on location, but the social acceptance of the gas industry in the Beetaloo Basin is dependent on the views and experiences of people from all over the NT.

A CSIRO research team then works to understand the context in which this research is to be conducted in more detail. This stage involves:

- Meeting with key community stakeholders and understanding their value proposition for participating in the research process (i.e. why is it important to speak up about these topics? What do individuals and groups want in return for their participation? How can participation assist communities directly?)
- Building awareness of the intended program of work within the community more broadly through a range of communication channels (e.g. web site, radio, traditional media, social media, letterbox drops)
- Communicate how CSIRO does its work and protects the interests of community members that choose to participate

- Developing methodologies to ensure the research process is inclusive of all individuals and groups that choose to participate

5.2 Establishing the methodology

Once the context is understood clearly, the methodological tools required to provide voice to community members can then be developed. For the NT, this needs to be a mixed-methods approach. It is recommended that a survey methodology is used to collect most data within this framework, with the data collection method varied by social context.

Where literacy levels are sound and there is access to the internet, an online methodology may be used to collect the majority of data that will feed in to this SLO measurement and monitoring framework. The power of a survey methodology is that quality of data is generally higher and can be determined by researchers, data collection is more likely to be completed in private, and the data collected is quantitative allowing statistical analysis.

Where literacy levels are low and internet access is limited or non-existent, a different approach should be taken to ensure participants provide informed consent to participate, it is inclusive, and accurately reflects what people think. In this context then, two approaches are recommended. The first involves verbal completion of a stripped back survey instrument, facilitated by a trained researcher. This would involve the researcher asking questions of participants verbally, and inputting their response into a survey template using a tablet device. Data is then uploaded when the tablet comes into wifi range, or manually uploaded by the researcher. There are limitations in this approach and the selection of researchers and approach to data must be carefully conducted to reduce bias in its collection.

Where community members have little experience in completing surveys, low literacy levels or there are cultural reasons why survey methods are inappropriate or ineffective, a different approach must be taken. This approach should be developed with community members and not prescribed. For example, small group semi-structured discussions may be appropriate and effective to bring the voice of excluded and marginalised groups into a conversation about gas development. However, Aboriginal communities in particular are the subject of extensive research and engagement processes by many actors. A clear benefit for their participation must be developed in collaboration with these groups and a methodology for the inclusion of their voice developed by a trusted research agency, institution or other entity.

5.3 Conducting a benchmarking survey

It is important to understand not just what community members think about gas development but also why they think this way. As described in the literature review above, the mechanics of SLO are as important to understand as the baseline levels of each variable measured if an effective strategy for addressing concerns is to be developed. This requires the collection of a detailed baseline survey within the local and state populations, complemented by the more qualitative approach to groups where this is less appropriate.

In this survey, the following measures are recommended for inclusion:

- Demographic variables (age, gender, education, income, location, connection to place)
- Level of uncertainty around a range of potential positive impacts from gas development (e.g. employment, tax revenue, infrastructure development, local business benefits)
- Level of uncertainty around a range of potential negative impacts from gas development (e.g. impacts on ground and surface water, cultural heritage impacts, road traffic)
- (for local communities) experiences of interactions with existing companies in the gas industry, and other industries that also operate in the region
- Community wellbeing (e.g. life satisfaction, community suitability for a range of groups, affordability, amenity and liveability)
- Community expectations of companies operating in the gas industry
- Faith in governance institutions to protect the interests of community members
- Procedural and distributional fairness concerns
- Trust in a range of actors (e.g. the gas and other industries, government at different levels, small business owners, interest groups)
- Acceptance of a range of industries

It is recommended that key members of the community are supported to assist in encouraging members of their groups and networks to contribute their voices to this process. An incentive structure for participation that provides for community level rewards, rather than individual financial reward, should be strongly considered.

Data analysis may then be conducted, using an understanding of context developed through the engagement phase and the literature to guide the relationship tested. There are sophisticated methods available that allow the kind of analysis described in the literature review above that may be utilised in this process. The aim should always be to understand not just what community members think about particular topics or issues, but the mechanisms that underpin these perspectives. In SLO measurement and monitoring, the challenge is always to be thinking about how data can continually and dynamically inform better practice rather than typical academic outcomes.

5.4 Accessing the data

The data collected is only effective in the context of SLO if it informs and supports better understanding within the relationships that constitute an SLO. To this end, feeding back results to community and other stakeholders in multiple ways, through multiple channels, in a language they can understand, is fundamentally important. Online platforms are very effective in providing data back to communities and stakeholders in an interactive and accessible form. The time between collection and provision should be as short as possible, even if that means staging the release of data as it is analysed. Other more traditional channels of communication are also effective and important, such as short graphical summaries of key themes in the data, bite sized segments of tailored for specific groups that may be designed as a postcard, or provision of embeddable charts for PowerPoint, are just a few examples of ways to enable community and stakeholders to access, digest and use the data collected. Examples of CSIRO work in this area are publicly accessible at https://research.csiro.au/localvoices/. This includes interactive data embedded in websites that allow community members to explore their own data for their area, explanation of key results in an accessible infographic format, and clear line of sight regarding who to contact if community have concerns or would like more information.

5.5 Reading the pulse of community

SLO exists in the dynamic everyday relationships that companies, government and citizens have with each other. Traditional forms of research in this area mismatch methodology to the phenomena being observed: A framework for measuring and monitoring SLO should seek to reflect the dynamism of these relationships through periodic data collection rather than static (i.e. yearly or biannually).

Depending on the nature of the issue or state of the relationship, this may vary between monthly and quarterly 'pulse' surveys. These pulse surveys should be much shorter than the baseline survey, taking less than five minutes to complete compared to best practice of around 20 minutes for a comprehensive baseline survey.

Pulse survey content is developed based on the key insights derived through the baseline survey, and may consist 8-10 items or questions completed online, by telephone or in person depending on group engaged and data collection processes employed.

Once enough pulse data has been collected over a period of time, longitudinal analysis of trends and patterns in the data may then be conducted to establish, for example, how effective government has been in building trust in the regulatory process, or the extent to which company engagement has increased reported knowledge of the industry and reduced local community uncertainty.

Typically, CSIRO conducts these types of measurement activities in a three-year cycle of activity, with a baseline survey followed by pulse surveys in the first year, continued pulse surveys for the balance of the three-year cycle and then a follow up baseline survey in year four.

5.6 Scaling data in a Territory based framework for SLO

For the NT, there is an opportunity to think about how a framework for SLO in gas may also be used as a framework for SLO across multiple industries and locations. Figure 8 illustrates how a system of scalable data collection may operate at a state or territory level. With consistent measures and methodologies, data collected at local community levels may be aggregated to provide basin or region level summaries, and then aggregated again to provide a Territory level summary of the current state of SLO. Integrating baseline and pulse data, this provides both the mechanism for improving SLO and the current level of each SLO attribute in close to real time to anyone that has an interest in it. Using contemporary technology platforms, these data may be made available in interactive dashboard formats through a secured or public web portal. By using the approach across multiple sectors, the per unit cost of data collected about gas may be reduced significantly.

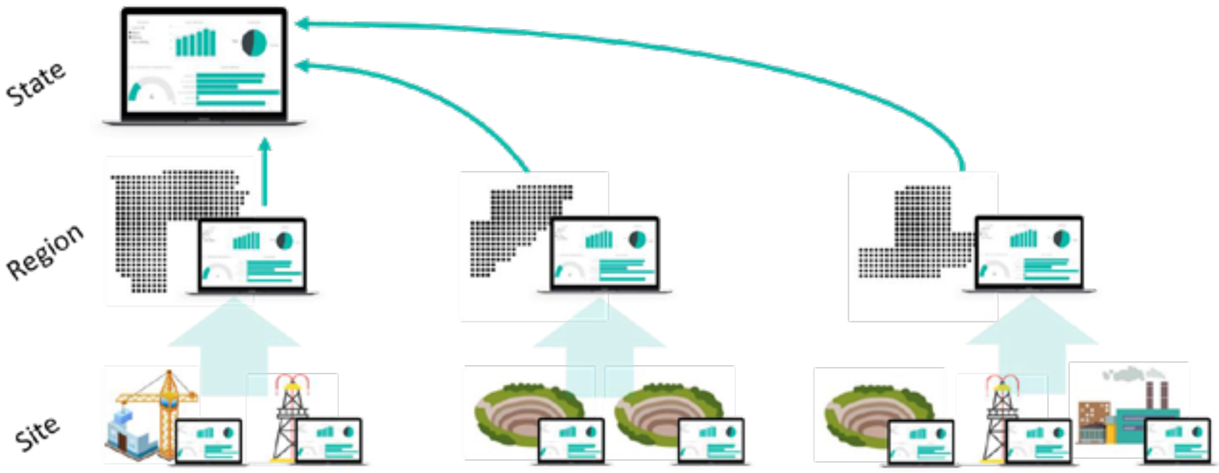

Figure 8. Illustrative example of how scalable data may work for SLO in the NT

5.7 Publication of results

Distinct from the publication of data for public and stakeholder consumption, the data itself should be published in a formal research output that is also available publically. This is important as it acts as a resource that sits behind the public facing measurement and monitoring framework, and provides confidence through peer review that the research is robust and has been tested independently.

5.8 The 'NT way'

Through establishing clear localised datasets, a NT framework for measuring and monitoring SLO, and Indigenous specific methods for reflecting the voices of remote and marginalised groups, it is then possible to create a context specific way of addressing SLO concerns. The information and importantly the process, of seeking and responding to community perspectives around gas development, provides the inputs required to create an 'NT way' for managing industrial development around gas and for other industries as well. There is a clear leadership role for the NT government here to establish this framework and support an agency or actor to conduct this work for the benefit and engagement of Territorians. This is challenging but required if trust in government is to be addressed meaningfully and the role that government may play in developing the gas industry in a manner that is acceptable to the citizens it represents. For industry, there is genuine challenge in making themselves somewhat vulnerable through such a framework and process. However, trust itself is dependent on vulnerability, and demonstrating that industry and government is open to exploring and responding to challenging perspectives allows the establishment of an NT way for managing SLO that seeks to establish and develop trust between its key actors.

For regulators, this kind of framework provides invaluable input and guidance to provide to companies seeking to develop resources in the Territory and to inform a regulatory framework that is flexible and adaptive. It provides specific understanding about the mechanisms for building trust that engagement strategies should reflect (e.g. participation in decision making processes that affect communities), the issues that genuinely effect trust and acceptance of industry locally (e.g. it may be issues that are only evident through careful and sophisticated data analysis), and a way to determine the efficacy of regulated and suggested interventions by companies in their social context. These are not issues or processes that can be proscribed without sound data on which to base them, but through the collection of data across time in a framework such as the one described, this data is available to all and the rationale for action is clear and transparent.

6 Conclusion

Resources development is a complex and contested activity. Without local and broader community acceptance, or some kind of SLO, the development of an extractive industry is challenging. This is particularly the case for gas extraction utilising hydraulic fracturing technologies in a social context of uncertainty about the likely and potential impacts of these technologies on assets of significant community value, such as water quality and quantity in the NT. Yet there are clear markers in research examining SLO across multiple scales, commodities and jurisdictions that provide guidance around the issues that matter to communities and that drive the development of trust in an industry and its operators, and acceptance of their work.

Research presented in this report details the key drivers of trust and acceptance for the extractive industries. These include feeling heard, respected and involved in decision making processes (procedural fairness), feeling that the benefits (and impacts) of extraction are shared fairly (distributional fairness), that government has the capacity and will to ensure public interests are protected and industry held to account (governance capacity), that physical and social impacts are managed effectively and appropriately, and that interactions between company personnel and community members is a positive experience (contact quality). Analysis of family income inequality for the NT, calculated using 2006 and 2016 census data, revealed that the NT has declining family income equality. This is a baseline measure that allows for reflection on how the development of the gas industry may assist in redressing this trend, while the risks of exacerbating it were also discussed.

Engagement with industry, community and government stakeholders in the gas industry in the NT revealed that uncertainty about how the industry would look and fracking as a technology was a locus of attention for all of these stakeholders. There is a broad recognition that these technologies are not well understood beyond those that have been directly engaged by industry or have technical background. Reducing this uncertainty in a framework supported by government appears to be of real interest to most of those spoken with. And extending this, that government plays a more active and creative role in the discussion and engagement of these issues and the development of the industry itself.

Finally, there are well developed methods and models for measuring and monitoring SLO that may be applied to the NT. Key principles were described that should underpin such a framework, including: independence and strong governance of any research, transparency of process and provision of data to all stakeholders, ensuring work is conducted under strict guidelines for ethical research practices, and that such research should aim to connect stakeholders through common understanding rather than isolate them in oppositional silos.

There is great opportunity for the NT to determine the conditions under which any future gas industry is developed, taking the best and most current lessons from other jurisdictions and defining 'the NT way' forward. With respect to SLO, an industry won't be possible without achieving some level of acceptance in local communities and the Territory more broadly. But SLO is not a tangible, one-off requirement; SLO is about relationships, sharing decision making power and supporting communities to have constructive ways to influence development trajectories. Without these constructive mechanisms, communities and interest groups will find creative ways to achieve influence.

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ACIL ALLEN CONSULTING

FINAL REPORT TO
SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY
OCTOBER 2017

THE ECONOMIC IMPACTS OF A POTENTIAL SHALE GAS DEVELOPMENT IN THE NORTHERN TERRITORY

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Interpreting this report

ACIL Allen Consulting (‘ACIL Allen’) was engaged by the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (‘the Inquiry’) to conduct an economic study into the impacts and risk of an unconventional shale gas industry in the Northern Territory. As one part of its scope of works, ACIL Allen has conducted a series of modelling tasks, including the development of a commercial financial model.

All economic modelling is subject to uncertainty, and should be treated with caution. ACIL Allen Consulting (‘ACIL Allen’) considers the modelling presented in this report is subject to higher than usual uncertainty. This is because of the unusual nature of the task ACIL Allen has undertaken.

The development of a shale gas industry in the Northern Territory is at the very earliest possible stages. To date, there has been one fracture stimulated horizontal well that has been tested in a near-production setting – Origin Energy’s Amungee NW-1H well, in the Beetaloo Sub-Basin of the McArthur Basin. While the well delivered a positive production test result, significant further testing is required to determine the precise scale, scope and qualities of shale gas production potential in this sub-basin alone, let alone the remainder of the Northern Territory.

However, in order to conduct economic impact assessment modelling, it has been necessary for ACIL Allen to develop a commercial financial model of an industry in the Northern Territory. This model has been built using a range of assumptions, and does not represent an assessment of the commercial viability of a shale gas industry development in the Northern Territory. It is not possible to conduct such modelling at this point in the industry’s life cycle, as even the most basic information regarding the quantity and quality of gas in situ is unknown.

Ultimately, ACIL Allen was engaged by the Inquiry to articulate the potential **economic** benefits, impacts and risks of a shale gas industry in the Northern Territory. We have done this using our best estimates of what a successful development may look like, based on:

- the views of the Northern Territory Government, potential industry operators, non-gas industry stakeholders, Traditional Owners and native title holders, non-government organisations, and representative bodies;
- our own expertise in gas market and economic impact modelling;
- the experience of shale gas industry development in analogous regions across the world; and
- the latest research, data and insights of shale gas industry economics.

ACIL Allen has developed a framework that has allowed it to deal with the uncertain nature of our task, which is presented in Chapter II of this report. However, as a result of the significant information limitations, ACIL Allen advises those who read this report to treat the results with higher than usual caution. The modelling prepared and results presented in this report should be treated as what they are – **an estimate of the economic impacts of a shale gas industry development –** and not for what they are not – an assessment of the commercial viability of a shale gas industry development in the Northern Territory.

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EXECUTIVE SUMMARY

The Inquiry

Hydraulic fracturing for onshore unconventional gas has been subject to significant debate in the Northern Territory in recent years. Following a change of government in 2016, the Northern Territory Government announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs including the use of hydraulic fracturing for exploration, extraction, production and including Diagnostic Fracture Injection Testing (DFITs).

On 3 December 2016 the Northern Territory Government announced an independent Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory. The Inquiry is investigating the environmental, social and economic risks and impacts of hydraulic fracturing ('fracking') of onshore unconventional gas reservoirs and associated activities in the Northern Territory.

ACIL Allen Consulting ('ACIL Allen') was appointed on 24 May 2017 to assist the Inquiry understand the potential economic benefits, impacts and risks of the development of an onshore unconventional gas industry in the Northern Territory. An abbreviated version of the scope of works is presented below, and the full terms of reference included in Appendix A.

ACIL Allen has been engaged by the Inquiry and this, our Final Report, has been released for public consumption.

Our scope of works

ACIL Allen Consulting has been appointed by the Inquiry to assess the actual and potential direct and indirect economic benefits, risks and impacts of fracking on the Northern Territory under the current regulatory regime.

To facilitate this, ACIL Allen's scope of works gives regard to three distinct scenarios:

1. Scenario 1, or the baseline scenario, where the moratorium on hydraulic fracturing of unconventional shale gas reservoirs remains in place (the 'base case')
2. Scenario 2, which involves the development of the onshore unconventional shale gas industry in the Northern Territory (the 'unconstrained case')
3. Scenario 3, which involves the development of unconventional shale gas reservoirs in the Beetaloo sub-basin only.

In order to do this, ACIL Allen will complete two main tasks:

— **Conduct economic impact assessment modelling, using ACIL Allen's suite of in-house economic models**, including models of the national gas and electricity markets. To complete this task, ACIL Allen will develop credible, evidenced-based scenarios for the development of shale gas projects in the

Northern Territory under a set of assumptions which are agreed by the Inquiry. The outcome of this task will be quantitative economic impact assessment results under each of the three scenarios listed above.

— **Research, analyse, articulate and discuss the potential impacts on the Northern Territory economy's other industries**, including but not limited to tourism, agriculture, horticulture and pastoral. This will centre on findings of stakeholder consultation and a review of relevant international literature and case studies. The outcome of this task will be a chapter or chapters in the final report of this engagement that outlines the economic risks and provides suggestions on policy initiatives the Inquiry may recommend to the Northern Territory Government in the Inquiry report.

Scope variation – 18 July

Following the completion of its initial research and round of stakeholder consultation in the Northern Territory, ACIL Allen presented the Inquiry with a proposal to vary its scope of works.

The key finding of our initial research and consultation was that it was not possible to conduct economic modelling giving regard to the three scenarios as requested by the Inquiry in its scope of works. This was primarily due to lack of information about the size or scope of commercial shale gas reserves in the Northern Territory (both in the Beetaloo sub-basin and in the Northern Territory more broadly), and the embryonic stage of the industry's life cycle. The scenarios as described by the Inquiry implied a precision which ACIL Allen was not comfortable providing.

ACIL Allen proposed to conduct modelling on the basis of **five** scenarios, briefly outlined below and explained further in this report.

1. **"Baseline":** The moratorium remains in place
2. **"Shale CALM":** The moratorium is lifted, and exploration and appraisal activity occurs. However, the results of testing indicate the resource is not commercial, and no further activity takes place.
3. **"Shale BREEZE":** The moratorium is lifted, and exploration and appraisal activity occurs. A relatively small scale development occurs, targeting production of 100 terajoules (TJ) per day.
4. **"Shale WIND":** The moratorium is lifted, and exploration and appraisal activity occurs. A moderate scale development occurs, targeting production of 400 TJ/day.
5. **"Shale GALE":** The moratorium is lifted, and exploration and appraisal activity occurs. A relatively large scale development occurs, targeting production of 1000 TJ/day.

Complementing these scenarios is a qualitative probability matrix, which is intended to articulate the subjective likelihood that a given scenario would come to fruition under a series of moratorium lifting scenarios. This is presented at the end of this summary.

ACIL Allen considered that the scenarios as described above would achieve the objectives of the scope of works while also dealing with the lack of information and articulating the significant uncertainty which currently exists regarding the prospects of a shale gas industry in the Northern Territory.

No other aspects of the engagement were proposed to change. The Inquiry agreed to the scope variation post this meeting, and these are the scenarios ACIL Allen has adopted for its economic modelling and policy analysis tasks.

Our methodology

ACIL Allen has completed two discrete but related tasks to meet the objectives of this scope of works.

Economic impact assessment modelling

We have completed **an economic impact assessment** on the five scenarios above, where the four "Shale" scenarios are compared to a baseline assessment of the modelled growth of the Northern Territory economy absent the development of a shale gas industry. In order to complete the economic impact assessment, ACIL Allen conducted an iterative process of modelling across four models:

1. **Gas Market Modelling:** Understanding the supply and demand for gas from a Northern Territory shale gas industry under each scenario, to determine the volume of gas that could be placed in the market at

market prices each year of the study. This task was completed using ACIL Allen's *GasMark* model of the east coast gas market.

2. **Project Development Modelling:** Understand the production and infrastructure requirements to meet the volume of gas to be placed in the market, using a bespoke shale well production schedule model. This model required two major inputs: an assumed single average type curve of a hypothetical shale well (different for each scenario) and a series of assumptions regarding the infrastructure required to enable production to occur (wells, pads, gathering pipes, roads, water, camps, labour). This occurred in two streams:
   a) "ProjectCo": the hypothetical development company responsible for exploring, appraising and developing the shale gas industry in the Northern Territory.
   b) "PipelineCo": the hypothetical builder, owner and operator of new pipeline infrastructure required to facilitate the sale of ProjectCo shale gas to market.

   ProjectCo and PipelineCo are separate entities, but interact via tariffs paid by ProjectCo to PipelineCo for the provision of pipelines to transport gas to market.
3. **Project Cash Flow Modelling:** Understanding the financial implications of the development using assumptions regarding the cost of development of ProjectCo and PipelineCo, and volume and price data derived from *GasMark*. ACIL Allen has built a bespoke discounted cash flow model that takes into account all features of ProjectCo's finances, including estimates of taxation. PipelineCo is built as a simple discounted cash flow model with capital investment, ProjectCo tariffs revenue and operating expenditure.
4. **Economic Impact Assessment Modelling:** The summary inputs and outputs of the ProjectCo and PipelineCo cash flow modelling are converted to a national accounting framework and processed through ACIL Allen's *TasmanGlobal* computable general equilibrium (CGE) model. The four development scenarios are compared to the baseline assessment of the future growth of the Northern Territory economy to produce estimates of the potential economic impacts of each development scenario as a discrete set of outputs.

   Outputs are presented at the Northern Territory and Australia level, under the Australian Bureau of Statistics National Accounting framework for income, expenditure and output – including at ANZSIC major industry level. This ensures a comprehensive understanding of both positive and negative impacts of an industry. This process is described at length in Sections II and III of this report.

Perspectives on economic policy issues

We have also completed a qualitative research exercise centred on understanding the potential economic policy implications of a shale gas industry in the Northern Territory. This is informed somewhat by the outputs of the economic impact assessment modelling, as these articulate the potential "pressure points" that may emerge at an industry level.

ACIL Allen has completed this in two chapters of this report.

1. A **literature review** centred on current academic research and practical insights of sustainable resources industry development, with an Australian bent.
2. A **discussion of six key policy issues** that were raised during stakeholder consultation. We have included examples of onshore gas industry development and other resources industry development in other jurisdictions, as our literature review indicates resources-related developments have similar benefits and costs.

   ACIL Allen has not sought to develop a policy reform program to help capture benefits and mitigate risks, as this is beyond the scope of works we have been asked to complete.

Economic impact assessment summary

ACIL Allen has conducted this economic impact assessment under five scenarios; a base case, and four scenarios which are independent deviations from this base case.

The base case is ACIL Allen's assessment of the future growth of the Northern Territory and Australian economies under current policy settings, which is effectively an assessment of the economy if the moratorium on fracking was to remain in place. The four scenarios are in line with the cash flow modelling results presented in this report.

In line with ACIL Allen's scope of works, the modelling outputs have been presented for three regions: Northern Territory, Rest of Australia, and Australia (which is the sum of the first two regions), and under the following macroeconomic variables:

— Real income (Gross Real Income)
— Real output (Gross State Product and Gross Domestic Product, and change in industry output from the base case)
— Real final demand (State Final Demand and Domestic Final Demand)
— Real investment (Business Investment)
— Real exports (for the Northern Territory, international and interstate; for Australia, international only)
— Real employment (FTE employment and employment by industry)
— Real wages
— Population
— Taxation (by major heads of taxation)

Base case

In order to assess the economic impact of a potential shale gas industry, it has been necessary to define what the Northern Territory economy will look like without a shale gas industry in the future. This is known as the "base case" scenario, which projects the long term growth of the Northern Territory economy.

The Northern Territory's recent economic performance has been driven by the impact of INPEX's Ichthys offshore gas and LNG facility development. To this point, the impact has been mostly centred on the initial surge and subsequent fall in construction activity, with the lift in production and export still on the horizon. ACIL Allen has included a projection of the impact of Ichthys' production phase on the Northern Territory economy in its base case.

Other foreseen events for the Northern Territory included in the base case include:

— The impact of the Northern Territory Government's **10 Year Infrastructure Plan**
— **Project Seadragon**, and the significant impact on the Northern Territory Government's aquaculture industry
— The highly likely development of an offshore gas project to support the **backfill of DLNG** as existing supplies deplete
— An **expanded horticulture sector**, in line with research presented by NT Farmers and the perspective of Northern Territory Government stakeholders

In Gross Territory Product (GTP) terms, ACIL Allen's base case projects the Northern Territory economy will grow by an average of 2.9 per cent over the forecast period (2018-2043) (Figure ES1, Panel 1). This is lower than the average GTP growth of four per cent recorded over the past decade, which was mostly influenced by the impact of first the DLNG project and then the Ichthys LNG project.

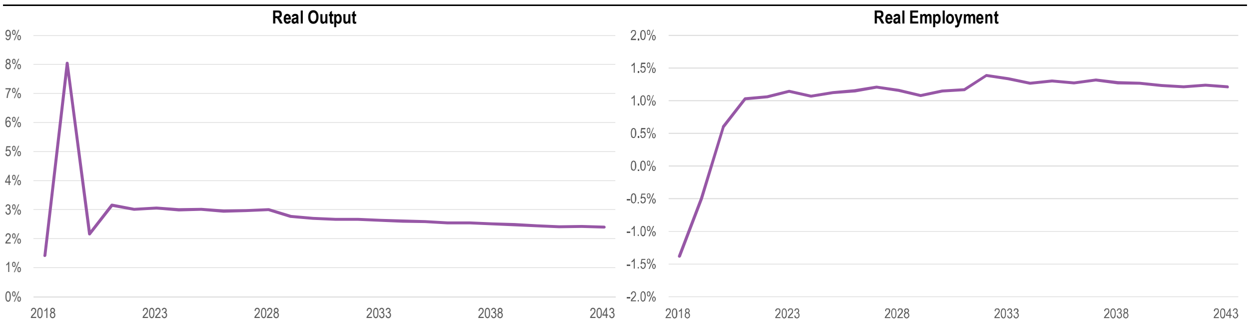
Growth is forecast to spike in the short term, with GTP growth of eight per cent forecast in 2019 on account of the ramp up in Ichthys LNG production. This manifests as an increase in the Petroleum sector's output, and a lift in the real export base of the Northern Territory economy. As LNG production ramps up and then reaches a steady-state level of production, this is only anticipated to have a one year impact on the Territory's growth rate.

Following the ramp up of Ichthys LNG Project, ACIL Allen forecasts there will be a period of slightly above average growth through the 2020s, as the Territory's aquaculture and horticulture industries grow faster than the rest of the economy, and the Northern Territory Government's 10 Year Infrastructure Plan plays out. The impact of the new offshore gas development to back fill DLNG is somewhat limited, as much of the supplies and services for an offshore development are by necessity imported. This manifests in a strong increase in Business Investment (and therefore State Final Demand), but a commensurate increase in imports, therefore a near-zero impact on overall GTP.

Beyond the 2020s, ACIL Allen projects the Northern Territory economy will grow in line with population growth, labour force participation and productivity growth. All up, the Northern Territory economy is projected to grow from a $23.4 billion economy (2018 dollars) in 2018 to a $47.9 billion economy by the end of the forecast period.

ACIL Allen's base case assumes total employment in the Northern Territory economy will grow by an average of one per cent per annum over the forecast period (Figure ES1, Panel 2). Short term employment growth follows the trajectory of the unwinding of the remainder of the Ichthys LNG project, with employment forecast to fall by 1.4 per cent in 2018 and 0.5 per cent in 2019. Thereafter, total employment is forecast to grow by an average of 1.2 per cent per annum.

FIGURE ES 1 BASE CASE HEADLINE RESULTS, REAL OUTPUT AND REAL EMPLOYMENT, ANNUAL PERCENTAGE CHANGE, FORECAST



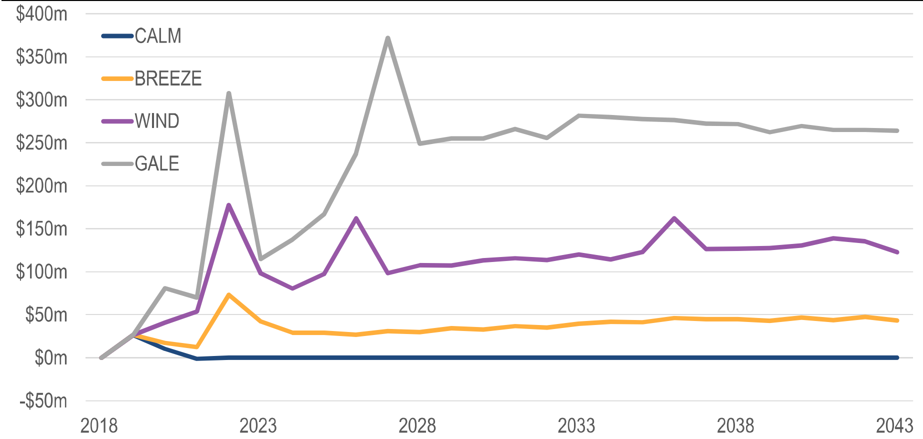
SOURCE: ACIL ALLEN CONSULTING

Economic impact assessment results

ACIL Allen's economic impact assessment illustrates the potential economic upsides and downsides in the event of small, medium and large scale shale gas industry developments in the Northern Territory, and the flow on effects to the rest of the Australian economy. While the base case and CALM scenarios, where no shale gas industry development occurs, show the Northern Territory economy is set to grow in the years ahead, the development scenario modelling shows the shale gas industry could have an overall net positive impact on the future growth of the Northern Territory economy.

ACIL Allen projects a shale gas industry development could result in a net real income (a measure of the overall wealth impact of the industry's development) increase of between $937.2 million (BREEZE), $2.8 billion (WIND) and $5.8 billion (GALE) for the Northern Territory over the modelling period, or between $36 million, $108.4 million and $222.2 million per annum. This equates to a net real income per capita increase of $146, $439 to $903 per capita (based on the Northern Territory's 2018 population) over the modelling period, which is mostly caused by increased Northern Territory Government revenue. The rest of Australia also sees a lift in real income, of between $3.4 billion (BREEZE), $9.1 billion (WIND) and $12.5 billion (GALE) over the modelling period, on account of the flow on impact of lower gas prices across the economy and the increase in Commonwealth taxes associated with the development (refer to Figure ES 2).

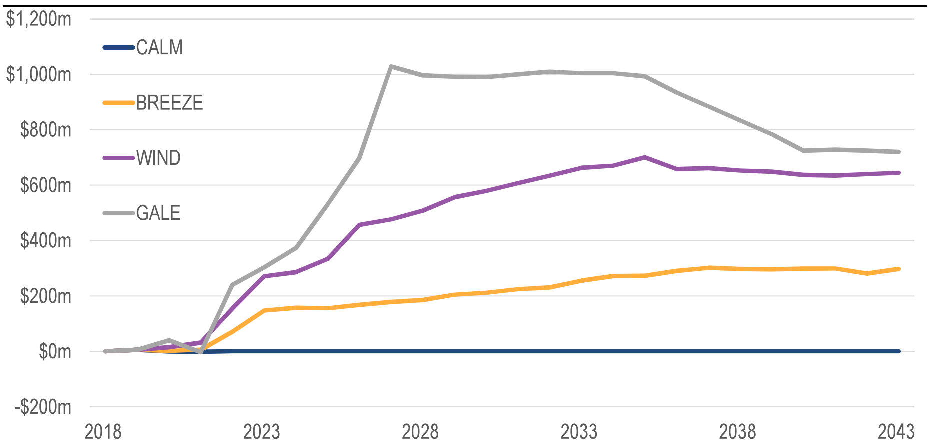
FIGURE ES 2 REAL INCOME, ANNUAL DEVIATION FROM BASE CASE, A$ MILLION, REAL TERMS



SOURCE: ACIL ALLEN CONSULTING

The net economic benefit (in terms of increase to the Northern Territory's Real Gross Territory Product) to the Northern Territory ranges from $5.1 billion in the BREEZE scenario ($196.5m per annum), to $12.1 billion ($466.4m per annum) in the WIND scenario, to $17.5 billion ($674.4m per annum) in the GALE scenario, in real 2018 dollar terms. In annual average terms, this is the equivalent of an additional 0.8 per cent, 1.9 per cent to 2.9 per cent of the Northern Territory's forecast Gross Territory Product in 2018 (Figure ES 3).

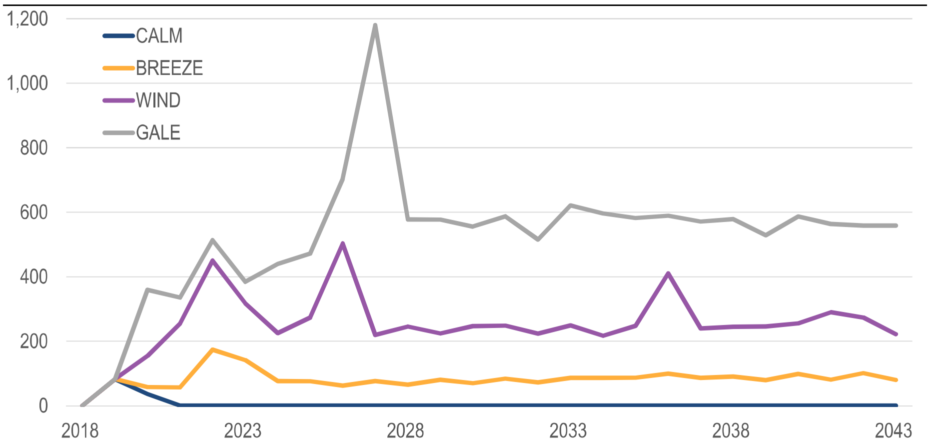
FIGURE ES 3 REAL OUTPUT, ANNUAL DEVIATION FROM BASE CASE, A$ MILLION, REAL TERMS



SOURCE: ACIL ALLEN CONSULTING

This additional economic activity will generate employment opportunities for Territorians, with an estimated 2,154 FTE jobs (BREEZE), to 6,559 FTE jobs (WIND) to 13,611 FTE jobs (GALE) generated by the various development scenarios over the forecast period – over and above the existing employment growth ACIL Allen has forecast in its base case (Figure ES 4). This equates to between 82 FTEs, 252 FTEs, and 524 FTEs of net employment growth in each year on average. This includes indirect employment generated by the local spending of the industry. While modest in the context of the overall Northern Territory labour market, this represents the capital intensive nature of the shale gas industry and modelling assumptions (see Section 6).

FIGURE ES 4 REAL EMPLOYMENT, FTE JOB YEARS, REAL TERMS, BY SCENARIO

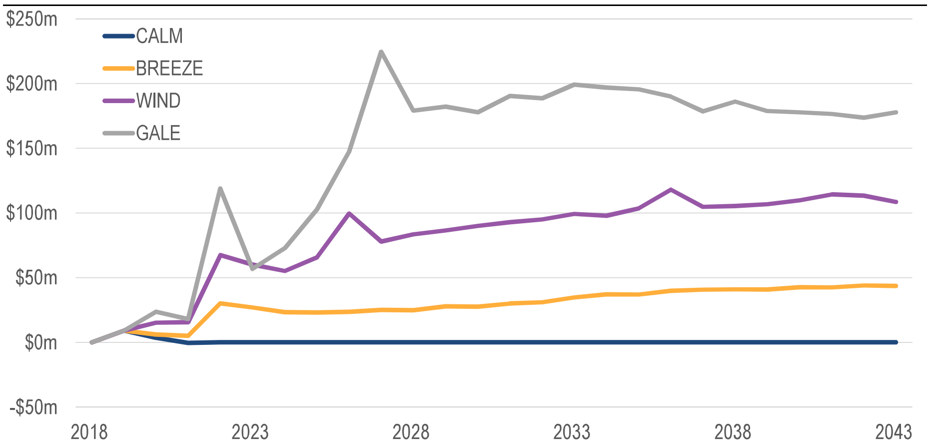


SOURCE: ACIL ALLEN CONSULTING

For Territorians, the most visible channel of economic impact likely to be seen is an increase to Territory Government revenue. ACIL Allen estimates a successful shale gas industry development could generate between $757 million (BREEZE), $2.1 billion (WIND) and $3.7 billion (GALE) in additional revenue for the Northern Territory Government over the 25 year modelling period, or between $29.1 million, $80.6 million, and $143.2 million per annum (Figure ES 5). In the larger case, this represents a sizeable increase to the Northern Territory's recurrent revenue base of 2.2 per cent, or more than eight per cent if Commonwealth Government grants are excluded. ACIL Allen has modelled royalty revenue, payroll tax and implied GST raised in the Northern Territory.

ACIL Allen's analysis shows a shale gas industry could also deliver windfall growth in Commonwealth revenue, even as the cascading impact of reduced gas prices from the development reduces the income earned by the gas sector outside of the Northern Territory. ACIL Allen has modelled company income tax, personal income tax and PRRT revenue.

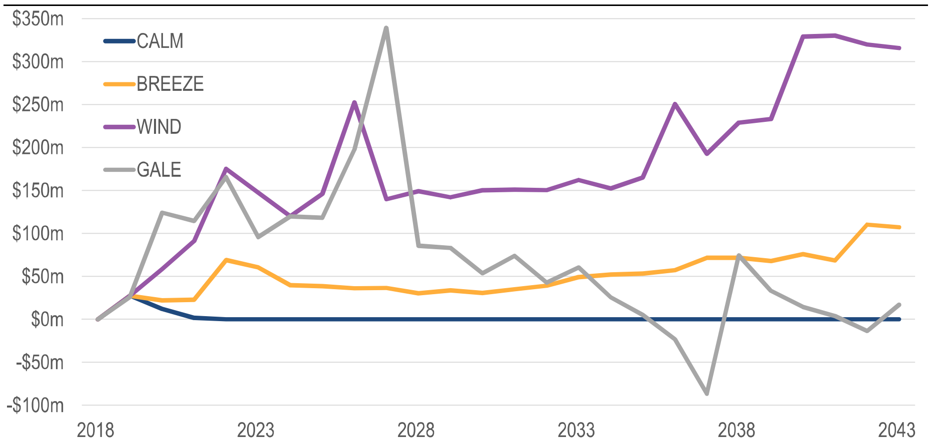
FIGURE ES 5 REAL TAXATION, NORTHERN TERRITORY GOVERNMENT, A$ MILLION, REAL TERMS, BY SCENARIO



SOURCE: ACIL ALLEN CONSULTING

ACIL Allen estimates the Commonwealth Government could expect to raise between $1.3 billion (BREEZE), $4.6 billion (WIND), and $5.5 billion (GALE) in income and profits based taxation over the forecast period, or $50.2 million, $176.2 million and $210.4 million per annum (Figure ES 6).

FIGURE ES 6 REAL TAXATION, COMMONWEALTH GOVERNMENT, A$ MILLION, REAL TERMS, BY SCENARIO



SOURCE: ACIL ALLEN CONSULTING

Project development probability matrix, and key development assumptions

As discussed in Section 4, the shale gas industry in the Northern Territory is at such an early stage that the modelling conducted in this engagement is subject to more than the usual uncertainty. Below, ACIL Allen has presented a subjective probability matrix to represent the qualitative likelihood of each scale of development occurring (Figure ES 7).

On the basis of the financial modelling undertaken on the each development scenario, ACIL Allen has assessed the probability of a shale gas industry developing in the Northern Territory in each case. This is based on the outcomes of the financial modelling, the uncertainty regarding the size of the Northern Territory's commercial reserves, and the challenges associated with producing gas at a price which the market will accept. As the development scales up, these challenges will become greater, leading to a reduced likelihood that any given scale of development can be realised.

ACIL Allen has also formed a view that the probability of a shale gas industry developing in the Northern Territory will improve the greater the potential area for exploration and appraisal. This is in line with international experience, which shows that it is often developments which occur following an initial discovery and development that prove to be the most commercial.

For example, under the GALE scenario, ACIL Allen has assessed, on current information, the likelihood of a shale gas industry that will begin to scale to 1000 terajoules per day (TJ/day) of gas production at an average price of $4.01 per gigajoule (GJ) within the next five years as low, assuming the moratorium is lifted in full across the Northern Territory. If there is only a partial lift in the moratorium, this becomes a very low probability, because there is less of an ability for a potential shale gas industry to find the most commercial shale gas deposits.

In the context of the probability matrix, ACIL Allen notes that it has made a critical assumption that the shale gas developments modelled in this report are a "dry gas play". That is, the hydrocarbons produced in a development do not include higher value liquid hydrocarbons such as ethane, propane, butane or crude oil. A "liquids rich" shale gas play results in a very small increase in operating costs (associated with increased processing to separate the higher value hydrocarbons from the lower value hydrocarbons), and a very large increase in potential production revenue. This improves the commercial viability of a shale gas development, to the point where a larger development may have a higher probability of occurring versus a dry gas play.

For further information on the development scenarios, refer to Section 4.

To be clear, this matrix is not an assessment of the commercial prospects of a shale gas industry in the Northern Territory, as ACIL Allen has not been engaged to assess this, and it is too early in the industry's development to make such a determination.

FIGURE ES 7 ACIL ALLEN DEVELOPMENT SCENARIO PROBABILITY MATRIX

			POLICY SCENARIO PROBABILITY MATRIX		
INDUSTRY DEVELOPMENT SCENARIO	**Production Profile**	**Production Cost Regime**	**PERMANENT MORATORIUM**	**PARTIAL LIFT**	**FULL LIFT**
BASELINE	Nil Shale Production	N/A	CERTAIN	MODERATE	LOW
SHALE CALM	Exploration occurs Failure to commercialise	N/A	ZERO	VERY HIGH	VERY HIGH
SHALE BREEZE	**Scenario 1** Target production: 36PJ per annum	High cost	ZERO	MODERATE	HIGH
SHALE WIND	**Scenario 2** Target production: 150PJ per annum	Moderate cost	ZERO	LOW	MODERATE
SHALE GALE	**Scenario 3** Target production: 365PJ per annum	Low cost	ZERO	VERY LOW	LOW

SOURCE: ACIL ALLEN CONSULTING

1 REPORT STRUCTURE AND KEY TERMS

Structure of this report

As this is a complex engagement, ACIL Allen has structured its report in a logical fashion, with overarching Chapters and a series of Sections underneath. The contents of each remaining Chapter and Section is briefly outlined below (excluding this introductory chapter).

Chapter I: Preliminary Information

Section 2: Economic context. This section provides relevant contextual information regarding the structure and recent performance of the Northern Territory economy, the Australian economy, Australia's gas and electricity markets (including a brief discussion of recent policy initiatives) and the Northern Territory's energy markets.

Section 3: Unconventional gas and hydraulic fracturing. This section provides relevant contextual information regarding unconventional gas and hydraulic fracturing techniques, a brief overview of unconventional gas extraction in Australia, and the recent experience of hydraulic fracturing for shale gas in the Northern Territory prior to the moratorium.

Chapter II: Shale Gas Industry Development Scenarios

Section 4: Project Assumptions and Development Scenarios. This section outlines the process used to derive the industry development scenarios discussed above, including a full explanation of the target and realised gas sales and prices, single average type curve assumptions and production and supporting infrastructure requirements. This includes the timing of development under each scenario.

Section 5: Project Cash Flow Modelling. This section outlines the ProjectCo and PipelineCo financial models, including all assumptions relating to the cost of development and overall financial position of ProjectCo under each set of assumptions outlined in Section 4.

Chapter III: Economic Impact Assessment

Section 6 through 11: Economic Impact Assessment Results. This section outlines the economic forecasting results of the baseline scenario, before articulating the economic impact assessment results of the four scenarios under the criteria established.

Section 12: Economic Impact Assessment Summary. This section briefly outlines the results of the economic impact assessment chapter of the report in a brief, easy to understand format centred on the highest level economic outputs and a narrative style description of the exercise.

Chapter IV: Economic Policy Considerations

Section 13: Shale Gas Economics Literature Review. This section contains a thorough review of contemporary academic literature regarding the benefits and costs of shale gas industry development, and measures that can be taken to ensure sustainable economic development.

Section 14: Perspectives on Policy. This section uses domestic and international case studies and feedback from stakeholder consultation to articulate some of the key policy issues likely to emerge should a shale gas industry successfully develop in the Northern Territory. This section does not include ACIL Allen's perspective on measures the Northern Territory Government should adopt, as this is outside of our scope of works.

Appendices

Appendices Part One: Information relevant to the engagement that has not been included in the body of the report but which ACIL Allen believes is important to ensure transparency.

Appendices Part Two: Information regarding the structure and processes of ACIL Allen's economic and gas market models.

Glossary of terms and abbreviations

Throughout this report, ACIL Allen has used a number of technical terms related to both the economic and energy market modelling tasks it has completed. These terms are outlined below.

Term	Definition
"Fracking"	In this report, ACIL Allen will specifically define "fracking" as the process of hydraulically fracturing shale formations for the purposes of targeting hydrocarbons.
Employment	The number of full time equivalent job years created as a result of a project or expenditure in the economy, which includes direct and indirect (flow-on) employment.
Exchange rate	The exchange rate is expressed as the AUD/USD exchange rate unless otherwise stated and is denoted as A$ throughout the document.
Exports	The value of goods exported and amounts receivable from non-residents for the provision of services by residents.
Gross product or real economic output	*A measure of the size of an economy* Gross product is a measure of the output generated by an economy over a period of time (typically a year). It represents the total dollar value of all finalised goods and services produced over a specific time period and is considered as a measure of the size of the economy. At a national level, it is referred to as Gross Domestic Product (GDP); at the state level, Gross State Product (GSP); while at a regional level, Gross Regional Product (GRP).
Gross value added	*A measure of the value of goods and services produced in an industry or sector of an economy.* Gross Value Added (GVA) is the output of an industry or sector minus intermediate consumption. GVA therefore represents the value of all goods and services produced, minus the cost of all inputs and raw materials used to produce that good or service. Unlike Gross Product, GVA does not include the value of taxes minus subsidies.
Imports	The value of goods imported to a region and amounts payable to non-residents for the provision of services to residents.

Term	Definition
Job years	Real employment is measured in job years. A job year is employment of one full time equivalent (FTE) person for one year. Alternatively in can be expressed as one 0.5 FTE person for two years.
Millions, billions and trillions of standard cubic feet	In this report, ACIL Allen Consulting will make use of units of measurement for hydrocarbons in millions, billions and trillions of cubic feet (mmscf, BCF and TCF). These units of measurement are an order of magnitude apart: 1,000mmscf = 1 BCF 1,000BCF = 1 TCF These units of measurement are the industry standard for measurement of gas produced at the wellhead of a development. ACIL Allen Consulting will refer to "BCF" produced per well.
Net Real Income, Net Gross Territory Product and other "Net" Prefixes	The economic modelling outputs in this report are presented in "net" terms, unless otherwise stated. This is a representation of the aggregated economic impact on the particular variable, being the gross benefit of an investment less the crowding out effect on other sectors.
Net present value (NPV)	The value of a future stream of income (or expenses) converted into current terms by an assumed annual discount rate. The underlying premise is that receiving, say, $100 in 10 years is not 'worth' the same (i.e. is less desirable) than receiving $100 today. For the purposes of this study, NPV calculations have been made based on a discount rate of 10 per cent. The discount rate has been selected as a balance between a typical commercial financial discount rate (12-15 per cent) and a typical social discount rate (seven per cent).
Real and nominal dollars	Nominal dollars are dollars that are expressed in the actual dollars that are spent or earned in each year, including inflation effects. Real dollars have been adjusted to exclude any inflationary effects and therefore allow better comparison of economic impacts in different years. Over time, price inflation erodes the purchasing power of a dollar thereby making the comparison of a dollar of income in 2063 with a dollar of income in 2016 invalid. Adjusting nominal dollars into real dollars overcomes this problem. All values are expressed in real dollar terms with a base year of 2016, unless otherwise stated.
Real income	*A measure of the welfare of residents in an economy through their ability to purchase goods and services and to accumulate wealth* Although changes in real economic output are useful measures for estimating how much the output of the economy may change due to the Project, changes in real income are also important as they provide an indication of the change in economic welfare of the residents of a region through their ability to purchase goods and services. Real income measures the income available for final consumption and saving after adjusting for inflation. An increase in real income means that there has been a rise in the capacity for consumption as well as a rise in the ability to accumulate wealth in the form of financial and other assets. The change in real income from a development is a measure of the change in the economic welfare of residents within an economy.
State final demand	*A measure of the value of goods and services in an economy*

Term	Definition
	The aggregate obtained by summing government final consumption expenditure, household final consumption expenditure, private gross fixed capital formation and the gross fixed capital formation of public corporations and general government. It is conceptually equivalent to the Australia level aggregate domestic final demand.
Terajoules and petajoules	Terajoules and petajoules are a standardised unit of energy measurement, used in the energy and pipeline sectors. In this report, ACIL Allen will refer to energy production in terms of terajoules per day (TJ/day) and petajoules per annum (PJ/annum). One terajoule (TJ) = ~0.001 petajoules (PJ)
Working age population	All usual residents of Australia aged 15 years and over except members of the permanent defence forces, certain diplomatic personnel of overseas governments customarily excluded from census and estimated population counts, overseas residents in Australia, and members of non-Australian defence forces (and their dependants) stationed in Australia.

LIST OF ACRONYMS

Abbreviation	Full name
ABS	Australian Bureau of Statistics
AUD/ A$ or $	Australian dollars
BCF	Billions of cubic feet of gas
Billion	Billion measured by $1x10^9$ (or 1,000 million) as per the US convention
CAPEX	Capital expenditure
CGE	Computable general equilibrium (model)
CPI	Consumer Price Index
FIFO	Fly in-fly out work practice
FTE	Full time equivalent
GDP	Gross Domestic Product
GSP	Gross State Product
GST	Goods and services tax
GTP	Gross Territory Product
GVA	Gross Value Added
LNG	Liquefied natural gas
Million	Million measured by $1x10^6$ (or 1,000 thousand) as per the US convention
mmscf	Millions of cubic feet
NPV	Net present value
OPEX	Operational expenditure
PJ	Petajoules
PJ/day	Petajoules per day
PRRT	Petroleum Resources Rent Tax
TCF	Trillion cubic feet
TJ	Terajoules
TJ/day	Terajoules per day

Abbreviation	Full name
USD or US$	United States dollars
WPI	Wage Price Index

Stakeholder consultation

While our own independent research has helped form much of the inputs into our methodology, ACIL Allen also conducted an extensive program of stakeholder consultation in the first month of the engagement. ACIL Allen met with the following groups as part of its structured program of stakeholder consultation, and held follow up meetings with a range of stakeholders to gather additional information as the engagement progressed. Stakeholders were provided with a Consultation Guide prepared by ACIL Allen, and comprehensive verbatim notes of the consultation sessions were taken by ACIL Allen. A copy of the Consultation Guide has been included in Appendix B.

Stakeholders have been presented in alphabetical order.

TABLE 1.1 ACIL ALLEN STAKEHOLDER CONSULTATION

Stakeholder Organisation	Method of Meeting	Stakeholder Group
Australian Petroleum Production & Exploration Association	Face to face	Non-Government Organisation
Central Land Council	Teleconference	Traditional Owner representative
Lock the Gate Alliance & The Australia Institute	Face to face (Lock the Gate) and teleconference (The Australia Institute)	Non-Government Organisation
MS Contracting	Teleconference	Industry operators
Northern Land Council	Face to face	Traditional Owner representative
NT Cattlemen's Association	Face to face	Non-Government Organisation
NT Department of Business, Trade and Innovation	Face to face	Government
NT Department of Primary Industry and Resources	Face to face	Government
NT Department of Primary Industry and Resources (follow up)	Teleconference	Government
NT Farmers	Face to face	Non-Government Organisation
NT Treasury	Face to face	Government
NT Treasury (follow up)	Teleconference	Government
NT Treasury (second follow up)	Teleconference	Government
Origin Energy	Face to face and teleconference	Industry operators
Origin Energy (follow up)	Face to face	Industry operators
Pangaea Pty Ltd	Teleconference	Industry operators
Pangaea Pty Ltd (follow up)	Teleconference	Industry operators
Santos	Face to face	Industry operators
Santos (follow up)	Teleconference	Industry operators

In addition to the consultation sessions above, ACIL Allen received a variety of material from all stakeholders throughout the engagement, and drew on submissions made to the Inquiry by the full range of stakeholders.

I

PRELIMINARY INFORMATION

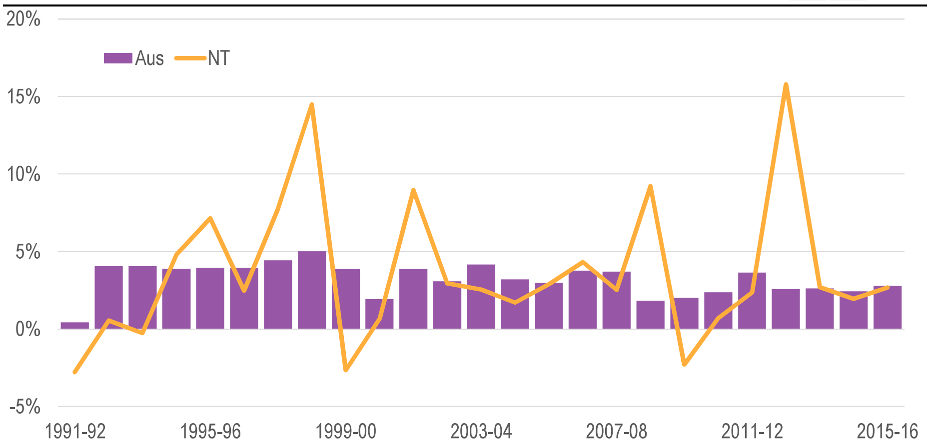
2 ECONOMIC CONTEXT

2.1 Economic trends

The Northern Territory economy is a regional economy, which generated $23 billion in Gross State Product (GSP) in 2015-16, accounting for 1.4 per cent of Australia's Gross Domestic Product (A$1.6 trillion). Northern Territory is an emerging economic centre, with average annual rates of growth in the economy exceeding five per cent per annum over the past five years (around double the rates of growth recorded in the national economy over the same period).

Economic growth in the Northern Territory is fairly volatile due to its small size and narrow economic base. As a result, major investments can have a disproportionately large impact on overall growth. The development of the Ichthys LNG Project has had a substantial impact on the Northern Territory economy, driving growth (as measured by Gross Territory Product) to a high of 15.8 per cent in 2012-13 as investment activity accelerated. While investment activity levels have remained at historically high levels, as the pace of growth in investment has slowed this has had a corresponding impact on the broader measures of growth in the Northern Territory.

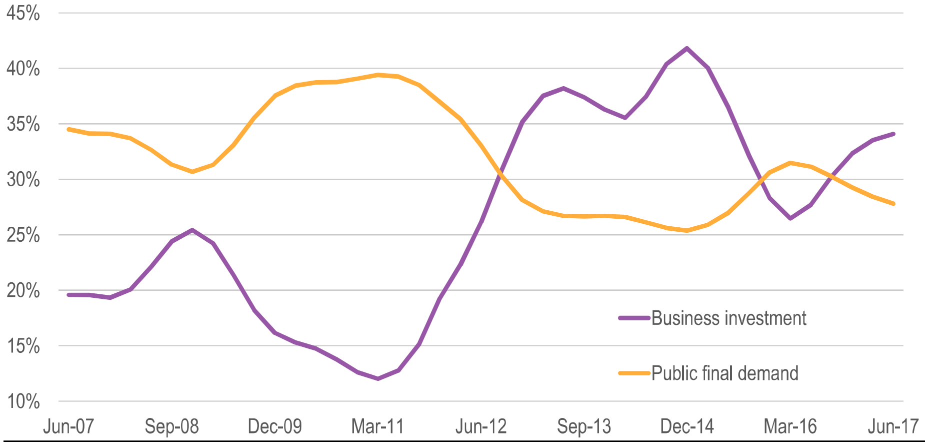
FIGURE 2.1 REAL ECONOMIC GROWTH, NORTHERN TERRITORY AND AUSTRALIA, ANNUAL PERCENTAGE CHANGE



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 5220.0

Business investment has driven overall levels of growth in the Northern Territory economy in recent years, due to the impact of the development of the Ichthys LNG Project. Business investment has averaged 31 per cent per annum on average since the commencement of the Project, and has accounted for 34 per cent of all domestic economic activity, as measured by State Final Demand. This has seen business investment overtake government spending and investment activity in the Territory (as measured by Public Final Demand) as the key driver of domestic economic growth (see Figure 2.2 below).

FIGURE 2.2 NT BUSINESS INVESTMENT AND PUBLIC FINAL DEMAND AS A SHARE OF TOTAL FINAL DEMAND



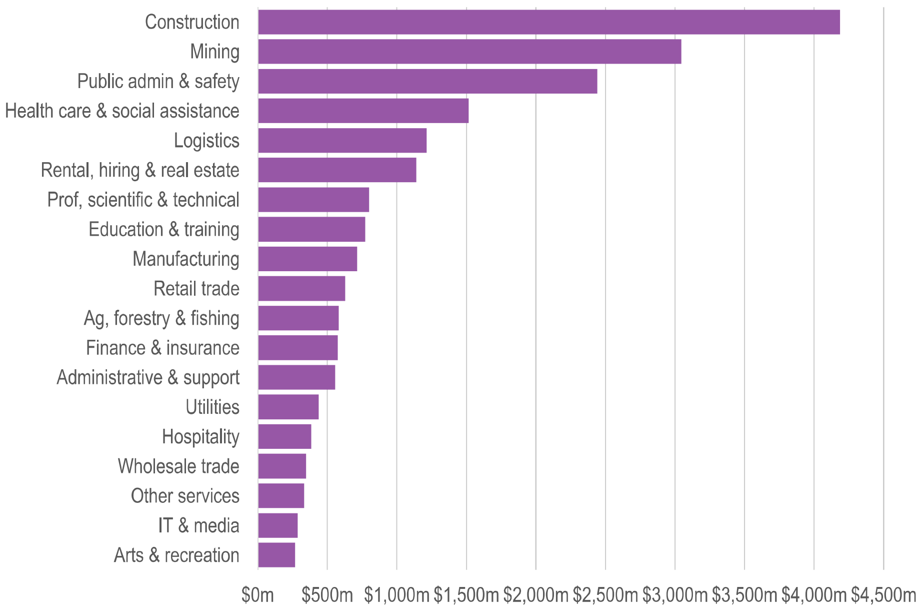
SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 5242.0

Historically, it has been government that has been the dominant sector of the Northern Territory economy, due in large part to the Commonwealth's large defence presence. However, in recent years significant development in the resources sector has seen it overtake the public sector as the driver of the Territory's economy. The substantial developments in the resources sector has in turn stimulated construction activity, which became the largest contributor to the Territory economy in 2015-16.

By value add, the largest industries in the Northern Territory in 2015-16 were Construction ($4.2 billion or 21 per cent of the economy), Mining ($3 billion or 15 per cent of the economy), and Public Administration and Safety ($2.4 billion or 12 per cent of the economy) (refer to Figure 2.3).

However, ACIL Allen estimates that as the Ichthys LNG Project transition from construction to production, this will see the Mining industry overtake the Construction industry to become the largest industry in the Northern Territory.

FIGURE 2.3 NT OUTPUT BY INDUSTRY, 2015-16, A$ MILLION

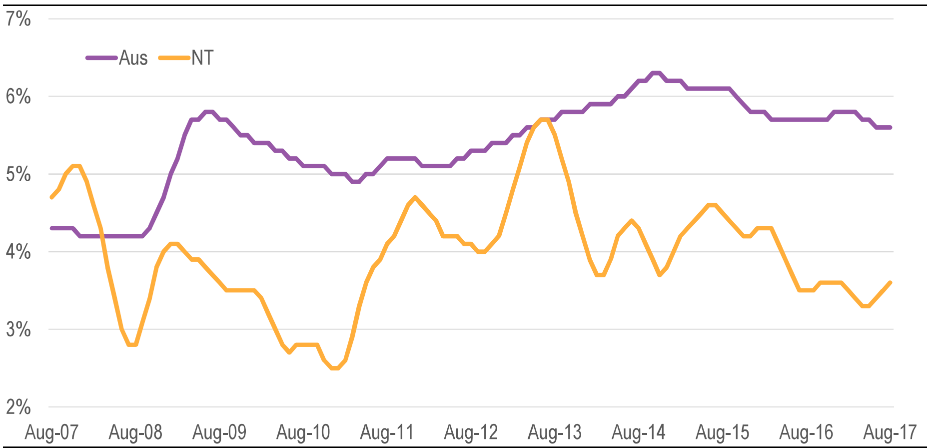


SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 5220.0

2.2 Labour market trends

The Northern Territory historically has had high levels of labour force utilisation. Overall levels of labour force participation have averaged 74 per cent over the past decade, which is well above the national average of 65 per cent. Employment opportunities have in turn meant that the average rates of unemployment are well below those recorded in another other part of Australia (refer to Figure 2.4 below).

FIGURE 2.4 UNEMPLOYMENT RATE, PERCENTAGE OF WORKFORCE UNEMPLOYED

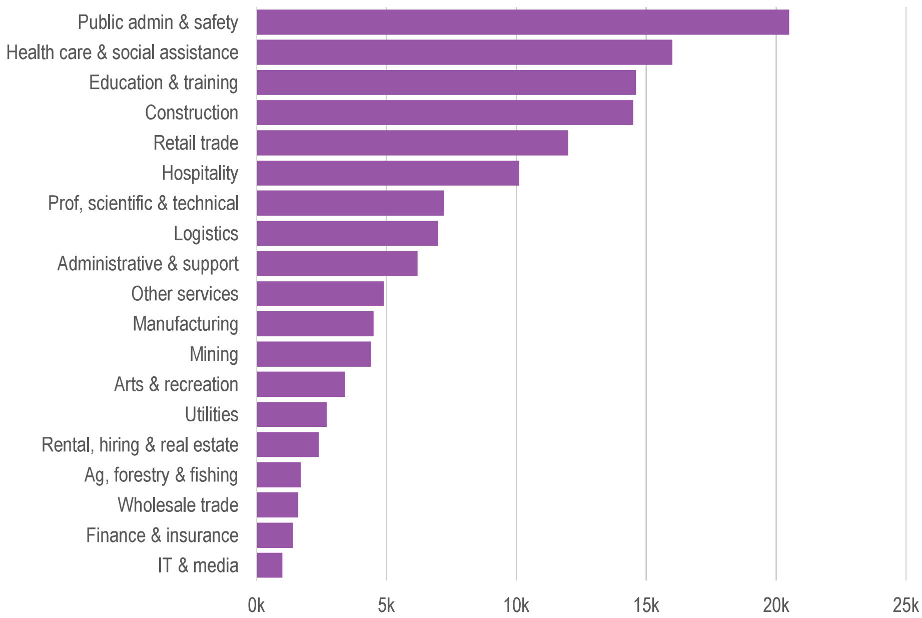


SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 6202.0

Total employment in the Northern Territory was 132,200 in August 2017, which was just below the record high of 139,900 in February 2017. Over the five years to August 2017, total employment has increased by 5,600 or 4.4 per cent.

Employment trends in the Northern Territory have been largely driven jobs growth in government and in construction, which has increased its capacity in line with developments in the resources sector. Over the past five years, there has 5,100 new jobs created in government, with a further 2,900 new jobs created in construction. Against these trends, the largest decreases in employment have been seen in agriculture (4,700) and wholesale trade (1,700).

FIGURE 2.5 NT EMPLOYMENT BY INDUSTRY, JUNE 2017, THOUSANDS



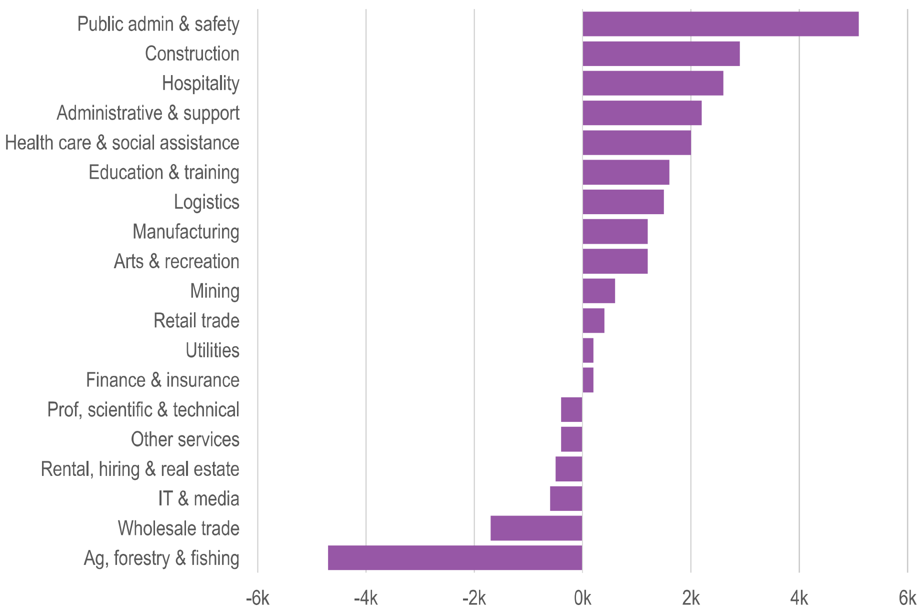
SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 6202.0

Wage trends in the Northern Territory have typically followed broader wage trends across the national economy in recent years. Despite robust labour market conditions in the Territory, wages growth (as measured by the Wage Price Index (WPI)) has trended lower in recent years, due to the combination of the unwinding of the resources boom, structural factors such as lower levels of productivity, and the low inflation environment.

Over the year to June 2017, wages growth in the Territory averaged 2.1 per cent, which is well down on the most recent high of 4.2 per cent in December 2011 during the height of the resources boom. Across the public and private sectors, significant variances emerge, with public sector wages growing by three per cent over the year to June 2017, compared to just 1.7 per cent in the private sector.

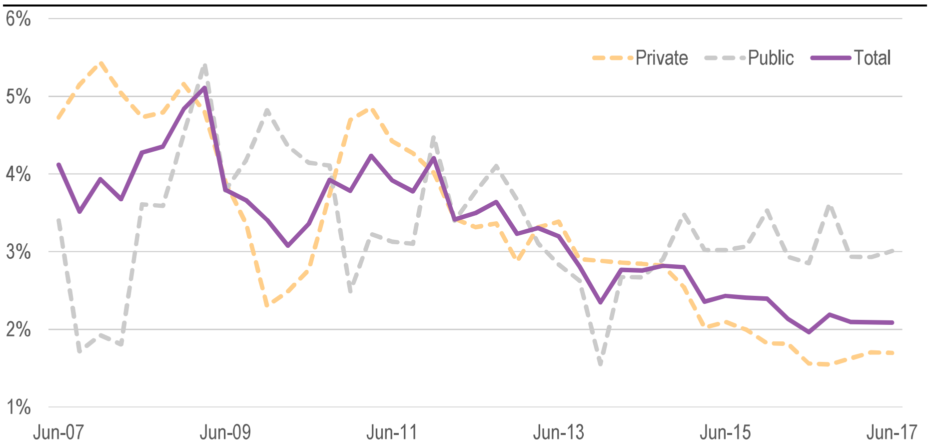
These trends are broadly consistent with the trends across the national economy, where the WPI rose by 1.9 per cent over the year to June 2017.

FIGURE 2.6 NT EMPLOYMENT BY INDUSTRY, CHANGE BETWEEN JUNE 2012 & JUNE 2017, THOUSANDS



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 6202.0

FIGURE 2.7 NT WAGE PRICE INDEX, PUBLIC SECTOR, PRIVATE SECTOR AND TOTAL, ANNUAL PERCENTAGE CHANGE



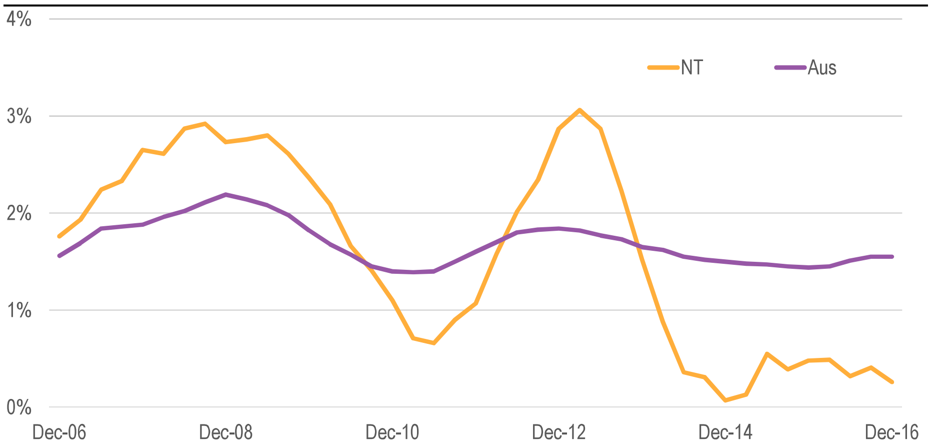
SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 6345.0

2.3 Population trends

In recent years, population growth in the Northern Territory has slowed significantly relative to the demographic trends in other parts of Australia. Over the 12 months to December 2016, the population of the Northern Territory grew by just 0.3 per cent, which was the slowest rate of growth of any state or territory in Australia, and well down on the most recent high of 3.1 per cent in March 2013.

By contrast, population trends across Australia have been relatively stable, with the estimated resident population in Australia increasing by an annual rate 1.6 per cent by the end of 2016. The constancy of Australia's population trends reflects the relatively stronger rates of population in the larger states of New South Wales (annual growth 1.5 per cent by the end of 2016) and Victoria (annual growth of 2.4 per cent), offsetting the slowing rates of population growth in the resources states like Western Australia (annual growth of 0.7 per cent by the end of 2016), Queensland (1.5 per cent) and the Northern Territory.

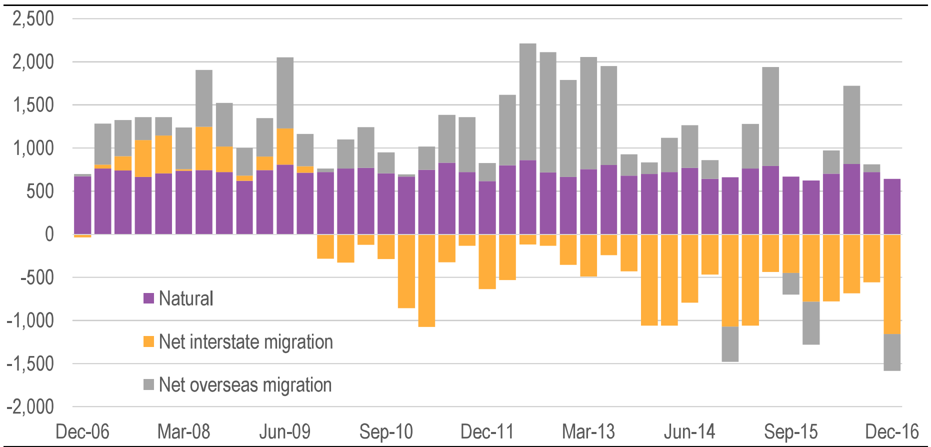
FIGURE 2.8 POPULATION GROWTH, ANNUAL PERCENTAGE CHANGE



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 3101.0

The end of the resources boom has had a pronounced impact on the population trends in the predominately mining states and territories in Australia. For the Northern Territory, this has seen the levels of overseas migration fall significantly (see Figure 2.9), as potential overseas migrants seek to settle in other parts of Australia where their job prospects are stronger.

FIGURE 2.9 COMPOSITION OF NT POPULATION GROWTH



SOURCE: ACIL ALLEN CONSULTING, ABS CAT. 3101.0

2.4 Northern Territory Government finances

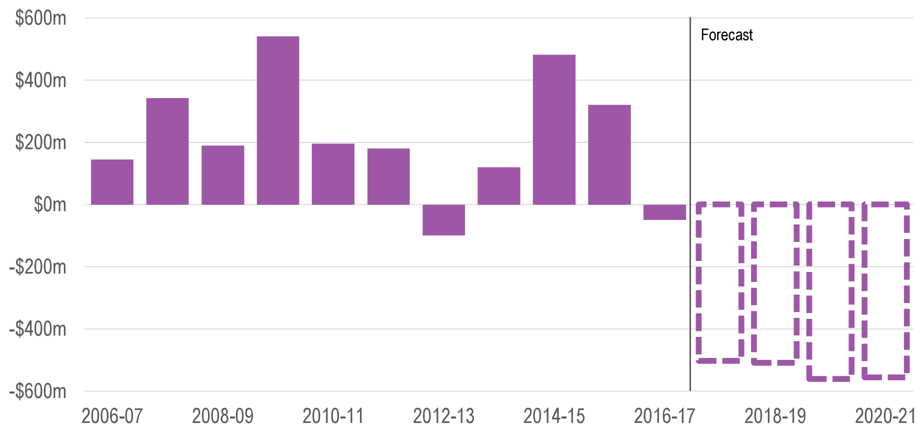
The Northern Territory's 2017-18 Budget, released on in May 2017, projects five consecutive net operating deficits for the Territory's General Government sector (the arm of government that provides most services to the community), with net debt rising from $2.4 billion to $5.5 billion between 2016-17 and 2020-21. The Northern Territory non-financial public sector raised $1.9 billion in revenue from its own sources in 2016-17, and recorded total operating expenditure of $6.5 billion.

The Goods and Services Tax, including redistribution effects, is the Northern Territory Government's largest source of revenue, accounting for 49 per cent of the Territory's revenue in 2016-17 (the last year of actual data). With a large land mass and low population density, the delivery of government services is a challenge in the Northern Territory. The Commonwealth Grants Commission's formula for distributing the GST assessed the Northern Territory Government requires between four and five times the hypothetical equal per capita distribution of GST revenue.[1]

Expenditure challenges are writ large across all elements of Northern Territory public finances. The high share of the Northern Territory's population that is Aboriginal or Torres Strait Islander, remoteness and regional costs, higher wage costs, and lack of administrative scale all result in the Commonwealth Grants Commission assessing the Territory as requiring significant assistance from the GST to help in the provision of services, vis-à-vis the other States and Territories. The Northern Territory has been a significant recipient State in the GST distribution system since its inception.

However, the Northern Territory's broader public finance challenges are a relatively recent phenomenon. This is because as a result of the release of the 2016 Census the Australian Bureau of Statistics believes the population of the Northern Territory is smaller than previously thought, while the Commonwealth Grants Commission believes the Northern Territory requires less GST per capita than previously thought to compensate it for structural spending challenges.[2] NT Treasury considers this is a structural shock to the Territory's finances.

FIGURE 2.10 NT GOVERNMENT NET OPERATING BALANCE, ACTUAL & FORECAST, $M



SOURCE: AUSTRALIAN BUREAU OF STATISTICS, CONSECUTIVE NT BUDGETS

2.5 Recent Australian energy market developments

Over time, the individual energy markets across Australia's eastern states have become joined up through a series of policy changes and asset investments. The system is referred to as the "National Electricity Market", or NEM for short. Broadly speaking, it encompasses the full supply chain from the extraction of

[1] Commonwealth Grants Commission. 2017. *2017-18 Update Report*. Accessed online at http://www.cgc.gov.au
[2] NT Treasury. 2017. *2017-18 State Budget, Northern Territory*. Accessed online at http://www.budget.nt.gov.au

hydrocarbons and other fossil fuels through to the consumption of electricity, gas and other fuels by domestic consumers and processing for export.

A series of significant developments in Australia's energy market have emerged in recent years, driven by rapid technological change, the pressing need for action to address climate change, and the development of new onshore and offshore hydrocarbon industries targeting both domestic and international sales of petroleum products.

Broadly speaking, these issues have manifested in significant uncertainty regarding the future direction of energy policy in Australia; higher wholesale gas prices, which feed through the entire NEM supply chain; and pressures to rapidly adjust to low emissions energy technologies.

The principal short term issue is an elevated level gas market uncertainty in eastern Australia. The long-anticipated transition of the east coast domestic gas market as a result of the development of six large export LNG trains at Gladstone has reached a critical point, with the last three trains having been commissioned between December 2015 and September 2016. The full extent of the dislocation in the domestic gas market caused by the LNG projects is now being felt as production ramps up and the market moves to a new equilibrium state.

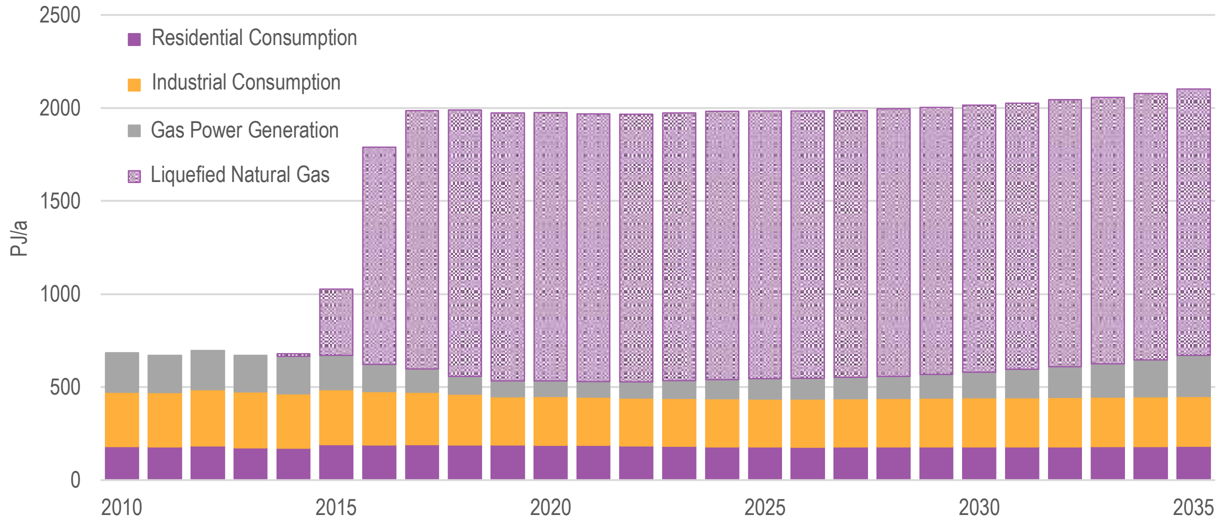
A number of other risk factors have become more prominent in recent times. A relatively severe winter in 2016 combined with constraints on the electricity interconnector between Victoria and South Australia resulted in high electricity and gas prices which caused distress for large industrial users and brought a renewed political focus on the idea of an electricity interconnector between South Australia and New South Wales.

2.5.1 Eastern Australia gas demand and the LNG export transformation

Over the past six years there has been an unprecedented transformation of the eastern Australia gas market, driven by large-scale export LNG developments and associated upstream coal seam gas (CSG) field production facilities in Queensland. Three separate LNG export projects, with a combined production capacity in excess of 25 million tonnes per year of LNG, were commissioned between late 2014 and late 2016. These facilities have a combined gross gas requirement of around 1,500 PJ/a—more than double the amount of gas currently used in the entire eastern Australia domestic gas market.

The Australian Energy Market Operator (AEMO) released its 2016 National Gas Forecasting Report (NGFR) in December 2016. Figure 2.11 shows historical and forecast levels of gas demand in eastern Australia (Queensland, New South Wales, Victoria, Tasmania and South Australia; the NGFR does not include Northern Territory) under AEMO's Neutral scenario. This shows a tripling of total gas demand in eastern Australia, driven by the rapid expansion of LNG production from the six LNG trains now operational at Gladstone in central Queensland.

FIGURE 2.11 HISTORICAL AND FORECAST GAS DEMAND IN EASTERN AUSTRALIA



SOURCE: ACIL ALLEN ANALYSIS OF DATA PRESENTED IN THE AEMO 2016 NATIONAL GAS FORECASTING REPORT, DECEMBER 2016

These LNG projects have had impacted on the domestic gas market by reducing the availability of gas to supply domestic markets; affected the price of domestic gas and the ways in which gas prices are determined; and affected levels of domestic gas consumption, particularly in the power generation sector.

Gas for power generation was, for a number of years, expected to be a driver of strong growth in demand for gas in eastern Australia. Gas-fired power generation was commonly seen as offering a cleaner energy transition pathway to a lower emissions future. However, in practice, the role of gas-fired generation in the eastern Australian market has evolved very differently.

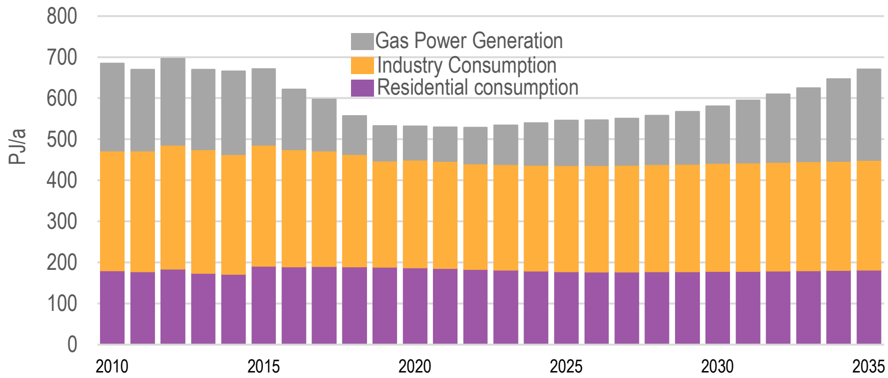
With large amounts of large-scale renewable energy (mostly wind) being added to the system to meet mandated renewable energy targets, and strong uptake of subsidised rooftop solar photovoltaic systems, the demand for centrally-generated electricity in the National Electricity Market has fallen and average wholesale electricity prices have been suppressed. In these circumstances, and with tight gas supply and rising gas prices, a number of large gas-fired generators have been mothballed or de-rated. This has allowed them to profit by using their contractual gas entitlements to sell gas to LNG and/or other domestic gas buyers, rather than using it to generate electricity. The Tamar Valley (Tasmania)[3] and Swanbank E (Queensland) combined cycle gas turbine (CCGT) generators have been mothballed, and the Pelican Point CCGT in Adelaide has cut back its operations and on-sold much of its gas entitlements[4].

The overall result has been to drive a significant reduction in recent and projected gas demand in the eastern Australian domestic market. This is shown in Figure 2.12. Overall domestic demand is expected to decline from 700 PJ per annum in 2012 to around 530 PJ per annum by 2019. Most of the decline will occur in the gas-fired power generation sector, with gas use by large industrial consumers also expected to fall. In the retail residential and commercial sectors consumption is expected to remain relatively flat, with increasing customer numbers (driven by demographic growth) offset by declining average consumption per customer (as a result of improved appliance efficiency, better building standards and increased penetration of electric reverse-cycle air-conditioning).

[3] Tamar Valley was temporarily returned to service in 2016 in response to an extended outage on the Basslink electricity interconnector between Victoria and Tasmania.
[4] In March 2017, the owner of Pelican Point (Engie) announced that it would recommission its second turbine by July 2017, returning the station to full capacity. This decision followed a deal in which Origin Energy agreed to provide gas to Pelican Point and to enter into an offtake agreement covering 240 MW of capacity from the station. The deal follows critical power shortages and blackouts in South Australia in late 2016 and early 2017, and is designed to improve the security of the grid in South Australia following closure of coal-powered generation at Port Augusta.

The steep decline in gas-fired power generation reflects a number of factors: abnormally high levels of gas-fired generation in the recent past (particularly in 2013 and 2014) driven by readily-available and low cost gas from the ramp-up of coal seam gas (CSG) production in Queensland; rising gas prices resulting in lower levels of economic dispatch of gas-fired generators; and increased penetration of renewable generation sources displacing marginal gas-fired generation.

FIGURE 2.12 HISTORICAL AND FORECAST DOMESTIC GAS DEMAND IN EASTERN AUSTRALIA



SOURCE: ACIL ALLEN ANALYSIS OF DATA PRESENTED IN THE AEMO 2016 NATIONAL GAS FORECASTING REPORT, DECEMBER 2016

Implications for eastern Australia gas supply

The structural transformation of the eastern Australia gas market brought about by the establishment of the Queensland LNG industry has seen a large increase in the demand for east coast natural gas with a consequent tightening of supply to domestic gas buyers. At the same time, the LNG developments have seen the rapid expansion of gas production from CSG fields in Queensland. The LNG export developments have been the primary driver for this increased production, although some of this gas has been (and continues to be) supplied to the domestic gas market.

It is nevertheless the case that a large part of the gas production capacity in eastern Australia has been committed, on a long-term basis, to support LNG production activities. The affected production sources include not only the Queensland CSG projects controlled by the LNG proponents who have prioritised delivery to the LNG facilities over domestic market sales. It has also seen the commitment of large volumes of third-party gas supply, under long-term contract arrangements, to supply additional gas to the LNG projects. There is anecdotal evidence that, for at least some of the Queensland CSG fields intended to support LNG production, production performance has been below design expectations and the costs of production higher than anticipated. As a result, LNG project proponents have turned to third-party producers—traditionally suppliers to the domestic market—to seek incremental gas supply.

While the LNG projects have increased demand for gas in eastern Australia, they have also led to development of large tracts of gas, and has increased the number of potential suppliers to the domestic gas market. These newly developed sources of gas could, depending on market conditions, supply the domestic gas market. Indeed, data published by AEMO on the Natural Gas Services Bulletin Board confirms that, during the severe southern winter in July 2016, QCLNG diverted some gas supply from its Gladstone operations into the southern states domestic market.

2.5.2 Northern Gas Pipeline

Jemena is currently constructing the Northern Gas Pipeline (NGP) between Tennant Creek in the Northern Territory and Mount Isa in north-west Queensland. The NGP is designed to allow gas from the Northern Territory to be delivered into the Eastern Australian market from late 2018. To the extent that the project succeeds in allowing substantial quantities of competitively priced gas from the Northern Territory to enter the East Coast market, the project represents a competitive threat to other sources of gas supply in eastern Australia.

Jemena took delivery of the first batch of pipe for the NGP in October 2016 and has commenced construction. However the size of the project has been scaled back, reflecting a lack of customer commitment. The diameter of the pipeline has been reduced to 12" (from the 14" diameter pipe originally planned), with a corresponding reduction in throughput capacity from 120 TJ/d to 90 TJ/d.

Given the current scarcity of gas available for commitment into new long-term contracts in the east coast market, this lack of customer support strongly suggests that the issue facing the NGP project relates to a lack of proven gas reserves available to support firm gas sales agreements, rather than a lack of demand from end-user customers. Apart from the gas being sold into the project by the Northern Territory government from its Blacktip entitlements, no other gas supply has yet been committed to the project. The Blacktip gas has effectively been committed to the Mount Isa market in Queensland (which has an annual gas requirement comparable to the annualised throughput capacity of the NGP in its current configuration).

Under current policy settings, NGP does not appear likely to deliver large quantities of competitively priced gas into the east coast market.

2.5.3 Australian Domestic Gas Security Mechanism

In response to the current tight gas supply situation, sharply rising prices and forecasts of potential supply shortages, the Australian Government has moved to bolster domestic gas supply by introducing the Australian Domestic Gas Security Mechanism (ADGSM) which will rely on the Australian Government's constitutional powers in relation to export controls. The ADGSM has been described by the government as a 'targeted, temporary measure … to repair markets and allow Australian users to compete on a level playing field'. The objective of the policy is to ensure that there is a secure supply of gas to meet the forecast needs of Australian gas consumers by requiring, if necessary, LNG producers that are drawing gas from the domestic market to limit their exports or to find offsetting sources of new gas.

The ADGSM came into effect on 1 July 2017. Operational details are set out in Guidelines dated 30 June 2017. In summary the ADGSM will operate as follows:

1. Export controls may be triggered on an annual basis if the Minister determines that there is likely to be shortage of domestic gas supply in the next year, and that LNG exports are likely to contribute to that shortfall.
2. If such a trigger occurs, LNG exporters would provide information to determine if they are 'net-deficit' projects that are withdrawing more gas from the domestic market than they are contributing to it. LNG exporters assessed as being 'no effect' or 'net suppliers to the domestic market' will not face any export restrictions.
3. The extent of any export restrictions will depend on the 'Total Market Security Obligation' (TMSO) determined by the Minister and the proportion of the gas shortfall attributable to net-deficit LNG projects.
4. 'Net deficit' exporters will be required to contribute to the achievement of the TMSO on a pro-rata basis according to the extent of their market deficits. This will be done by restricting Export Permissions for these exporters.
5. Each 'net deficit' exporter will be required to meet its individual Exporter Market Security Obligation either by restricting exports, or by increasing domestic production.

The Guidelines restrict the scope of 'domestic suppliers' by excluding suppliers that developed gas for the primary purpose of export. The tests also involve the concept of 'own gas', with a source of gas to the LNG plants being considered 'own gas' rather than gas obtained from domestic suppliers if it is owned by an LNG joint venture, or by one of the joint venture partners who developed and contracted the gas for LNG export sale. These provisions will reduce significantly the amount of gas deemed to be diverted from domestic markets by the LNG project.

Assessment

On the basis of what is set out in the Guidelines it appears that the only party likely to be caught under the ADGSM arrangements is the Santos-operated Gladstone LNG project, which is heavily reliant on third party gas. However, depending on how the definitions of 'third party gas' and 'own gas' are interpreted, even GLNG's obligations may be relatively limited. We are aware of several 'third party' sales contracts under which GLNG has access to gas supply totalling between 475 and 635 TJ/day. However, a number of these contracts are likely to meet the test for 'own gas' and/or 'export compatible third party gas'.

GLNG is likely to be the only liable party, and its net deficit is likely to be relatively small for the reasons mentioned above. Even if the Minister declares a domestic shortage and imposes an Export Market Security Obligation on GLNG, questions remain regarding the price at which that gas would be offered to the market, how it would be sold, and what would happen to any gas offered for sale but not taken up. The Guidelines are largely silent on the matter of the price or terms upon which any gas withheld from export under the ADGSM would be offered for sale to domestic consumers.

On balance, we think that the ADGSM is unlikely to result in any large quantities of additional gas being supplied into the domestic market, nor is it likely to result in significant downward pressure on domestic gas prices.

2.5.4 Regulatory reform: the Vertigan Inquiry

In June 2017 the Gas Market Reform Group, chaired by Dr Michael Vertigan AC, published a final design recommendation for a 'Gas Pipeline Information Disclosure and Arbitration Framework'.

The overarching objective of the new information disclosure and arbitration framework is to facilitate access on reasonable terms to services provided by 'non-scheme' (that is, currently unregulated) pipelines, including SEA Gas.

The information disclosure requirements and arbitration processes proposed by Vertigan are set out in changes to the *National Gas Law* that recently passing through the South Australian parliament.

The arbitration process covers disputes on any matter (including price or other terms and conditions). It may be triggered by either the prospective shipper or the pipeline operator. While the arbitration mechanism is a key element of the new framework, it is intended that commercial negotiation will continue as the principal means by which access terms and conditions are determined and that the arbitration mechanism will rarely be triggered. That is, it is intended that the threat of arbitration will be sufficient to encourage the parties to reach a commercial agreement.

The arbitration design involves a three stage process:

Stage 1: Shipper considers whether to seek access having regard to basic information published by pipeline operator

Stage 2: Shipper requests access and enters into commercial negotiations with pipeline operator. Negotiations informed by further information exchanges

Stage 3: If negotiations fail, either party may seek arbitration. Arbitrator to make decision having regard to the arbitration principles

Under the new framework, existing and prospective new shippers may be less inclined to agree to commercially negotiated terms for pipeline services and more inclined to have recourse to arbitration. This is because, while the arbitration process is said to be 'binding', the shipper is not in fact bound to enter into a gas transport services agreement on the terms set out in the arbitrator's decision. The shipper can elect (within 30 days) not to proceed in which case it is still able to continue to negotiate for transport. Under this scenario, the only downside from the shipper's perspective is that it foregoes the right to trigger a new arbitration process (for a similar service) for 12 months. In effect, the prospective shipper has a free option to see if it can get a better outcome under arbitration than it would achieve by accepting commercially negotiated terms.

2.5.5 The Finkel Review

The Independent Review into the Future Security of the National Electricity Market (the 'Finkel Review', named after the Review's Chair Dr Alan Finkel) was commissioned by the Council of Australian Governments (COAG), in order to address the security and reliability challenges faced by the National Electricity Market in the context of transitioning policy imperatives and emerging and evolving technologies.

The report primarily addresses key issues in the National Electricity Market – such as the balance of security and reliability, affordability and reduced emissions, as well as new technology integration and rising gas prices rendering stations unviable – and provides guidance on measures to address current and future challenges.

Finkel believed energy policy in Australia should be calibrated to deliver four central objectives:

— increased security
— future reliability
— rewarding consumers, and
— lower emissions

The principal recommendation of the review is that technological change is occurring rapidly in the energy sector, and the way forward is to provide certainty to both the energy sector and Australians more broadly as to how Australia will meet its international emissions reduction commitments. In this respect, security references the National Electricity Market's ability to respond to disturbances, which with the inclusion of variable renewable energy generation will require more attention than with more traditional, fossil fuel methods of electricity generation.

Underpinning these are three pillars promoting an "orderly transition" to the future energy mix, better system planning and stronger governance. An orderly transition is upheld by the recommendation of a Clean Energy Target, and the recommendation for a mandatory three years' notice prior to closure of a generator. Improved system planning seeks a system wide grid plan that informs investment decisions and improved reporting and analysis in regards to reliability and security. Stronger governance is recommended to be delivered through a new energy security board, and strengthened market bodies.

The Finkel Review outlines a blueprint of recommendations for the transition that makes special mention of the increased requirement for flexible, gas-fired generation to support the variable renewable energy generation. Finkel also noted that in the short to medium term tightening gas supply, and therefore rising prices, threaten the economics of such generators.

Despite the clear findings and roadmap provided by the Finkel Review, there remains significant uncertainty regarding the direction of energy policy in Australia.

2.6 The Northern Territory's gas industry and energy markets

The Department of Industry, Science and Innovation suggest the Northern Territory consumed 46.2PJ of natural gas in 2014-15, making it the largest source of energy for the Territory.[5] This gas is used to produce electricity and to fuel industry, as well as being used in the processing of Liquefied Natural Gas (LNG) that is exported through the Darwin LNG Plant (which does not show up in the Department's statistics as it is not consumed in the NT).

The majority of the Territory's gas is provided by three fields: ENI's Blacktip Gas Field, in the Bonaparte Basin off the north west coast of the Northern Territory[6] (predominantly for domestic consumption), ConocoPhillips' Bayu-Undan field in the Australia-Timor-Leste Joint Petroleum Development Area[7] (predominantly for LNG exports) and from fields in the Amadeus Basin to the east of Alice Springs, with the Mereenie Oil and Gas Field the major producing play[8]. The Ichthys LNG project, owned and operated by Japanese energy company INPEX, produces LNG at a facility in the Port of Darwin, but extracts gas from the Browse Basin off the north west coast of Western Australia.

The major players in the Northern Territory energy market are NT Power and Water Corporation ('PowerWater'), the State-owned transmission and network company, and Territory Generation, the wholesale provider of electricity. The two entities were formerly one vertically integrated entity but were structurally separated in 2014 as part of a broader program of electricity market reform.[9] PowerWater and Territory Generation represent a significant share of the residential and small scale commercial/industrial

[5] Department of Industry, Science and Innovation, 2016. *Australian Energy Statistics 2016, Table D*. Accessed online at http://www.industry.gov.au
[6] ENI Australia. 2016. *ENI in Australia*. Accessed online at http://www.eni.com/
[7] ConocoPhillips. 2017. *Our Business Activities – Bayu-Undan*. Accessed online at http://www.conocophilips.com.au/
[8] Central Petroleum. 2017. *Mereenie Oil and Gas Field*. Accessed online at http://www.centralpetroleum.com.au/
[9] Territory Generation. 2017. *Territory Generation: About Us*. Accessed online at http://www.territorygeneration.com.au

energy markets in the Territory. The Territory has a contestable market for residential and small scale commercial users.

3 UNCONVENTIONAL GAS AND HYDRAULIC FRACTURING

3.1 What is Hydraulic Fracturing?

There are two broad types of gas reserves: conventional and unconventional. Conventional gas reserves accumulate in confined areas with well-connected pore spaces in a sedimentary basin. This allows for effective drainage of reserves with well-placed vertical wells. By contrast, unconventional gas reserves accumulate in a larger area amongst more tightly bound and less porous sedimentary basins, which are typically lower in the ground. A visual representation of conventional and unconventional gas accumulations and some of the extraction techniques is provided in Figure 3.1 (overleaf).

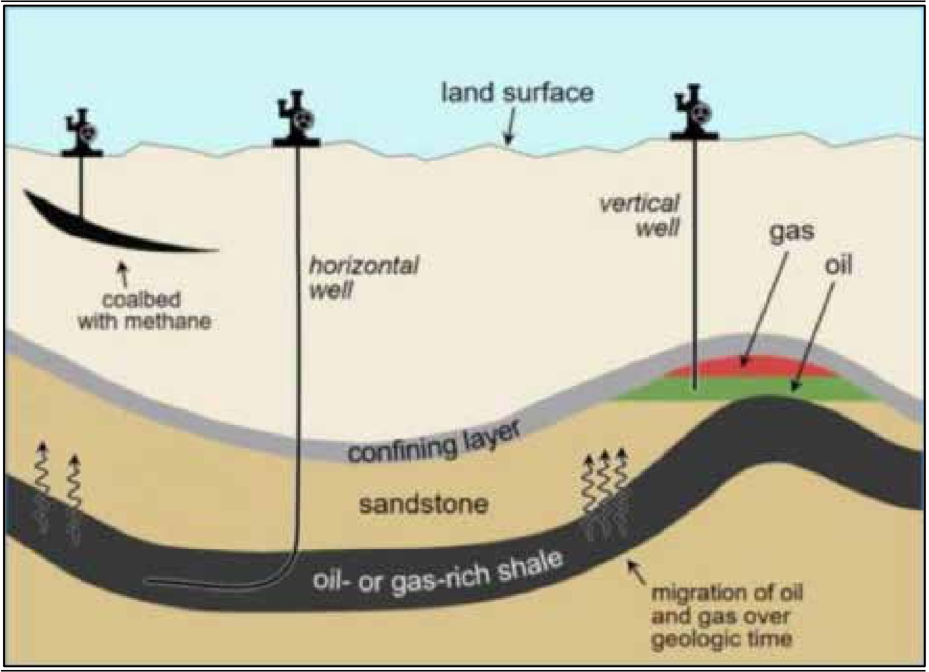
Artificial stimulation is typically required to make the gas in unconventional reservoirs flow through a well. One commonly used technique to achieve this is called hydraulic fracturing, commonly known as 'fracking'. Fracking basically involves pumping a mixture of water, sand and chemical additives ('fracking fluid') into the production well, under pressure, so that the rocks containing the gas resources crack. This allows the gas contained in the tight reservoir to flow more freely.

3.1.1 Shale gas versus coal seam gas (CSG)

Fracking is used to extract both coal seam gas (CSG) and shale gas. The two types of resources differ significantly.

- CSG is typically extracted from wells that are much closer to the land surface (300m – 1,000m) than shale wells (1,500m – 4,000m)
- CSG is typically much closer to the surface, and therefore closer to potable water sources such as aquifers. Shale gas is not typically located near aquifers
- CSG is most often extracted using vertical wells, while shale gas is extracted using a combination of vertical and horizontal drilling techniques
- CSG wells are typically low productivity and require a larger number of wells, where shale gas wells produce more energy per well. However, shale wells use more water per well, and operate across a larger underground footprint.
- The land surface area of CSG wells and shale gas wells is largely the same.

FIGURE 3.1 DIFFERENT TYPES OF PETROLEUM ACCUMULATIONS AND DEVELOPMENT



SOURCE: THE INQUIRY, VIA U.S. ENVIRONMENTAL PROTECTION AGENCY.

3.1.2 The fracking process

Shale gas is mainly methane (often with associated liquid hydrocarbons) that is trapped within clay-rich sedimentary rock at depths greater than 1,500 metres. The low permeability of the rock means that gas, either absorbed or in a free state, in the pores of the rock, is unable to flow easily.

To extract shale gas, wells are drilled anywhere from 1,500 – 4,000 metres deep through various layers of rock to access the shale. The wells are lined with various steel casings, which are cemented using fit-for-purpose cement designed to protect groundwater from contamination.

To maximise shale gas recovery a technique called horizontal drilling is used. This technique typically involves the well changing from a vertical to a horizontal direction deep underground.

Before gas can be extracted from the shale gas reservoir, hydraulic fracturing must occur. Hydraulic fracturing is a technique used to enhance the production of the gas. Hydraulic fracturing refers to the injection of fluid (comprising approximately 99.5% water and proppant (sand) and approximately 0.5% chemical additives) at high pressure into targeted sections of the layers of gas-bearing rocks. This creates localised networks of fractures that unlock gas and allow it to flow into the well and up to the surface. An average of 20 to 30 megalitres (ML) of water is used per fracked horizontal well over the life of the well.

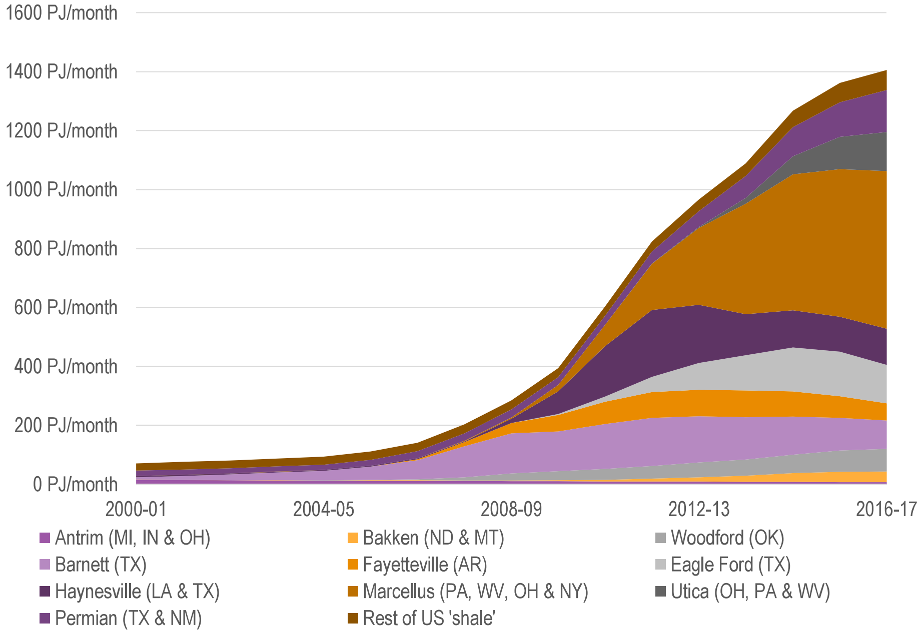
After fracturing, the hydraulic pressure is released and most of the 'frack fluid' is pumped back out of the well. Typically gas production from the well builds up over a period of days or weeks as the frack fluid is recovered (a process known as 'well clean-up'). Much of the sand remains in the well, propping open the cracks so that gas flow is maintained (hence 'proppant').

3.2 The "Shale Revolution"

Fracking is not a particularly new or novel technique for accessing petroleum deposits. However, rapid technological improvements and a period of very high natural gas prices in the United States led to a significant wave of exploration and investment targeting shale gas with horizontal drilling techniques. The result has been a so-called “shale revolution”, which has put significant downward pressure on energy prices in the United States and across the world.[10]

Production of petroleum products from US shales has grown exponentially between 2007 and 2017, and the shale gas industry deepens and continues to learn the most economic ways to target and extract oil and gas from shales. According to the US Energy Information Administration, the volume of dry shale gas produced in the United States has increased 15-fold between 2005-06 and 2016-17, from an average of 110.8 PJ per month to 1405.3 PJ per month (Figure 3.2).[11]

FIGURE 3.2 DRY SHALE GAS PRODUCTION, UNITED STATES, BY MAJOR PLAY, PJ/MONTH (12 MONTH AVERAGE)



SOURCE: ACIL ALLEN CONSULTING, US EIA

US producers have been able to extract more gas per well each year for the past 10 years, as technology advancements like longer horizontal drilling, improved fracturing techniques, and increased knowledge of the geology of formations have led to surging productivity. These conspire to reduce the average cost of establishing a single petroleum well, which is the single largest influence on the wellhead cost of gas produced.[12] More than anything though, there is a strong negative relationship between the total number of wells drilled in a shale gas play and the overall average cost per well drilled in said play (that is, the more wells drilled the lower the marginal cost of establishing a well).

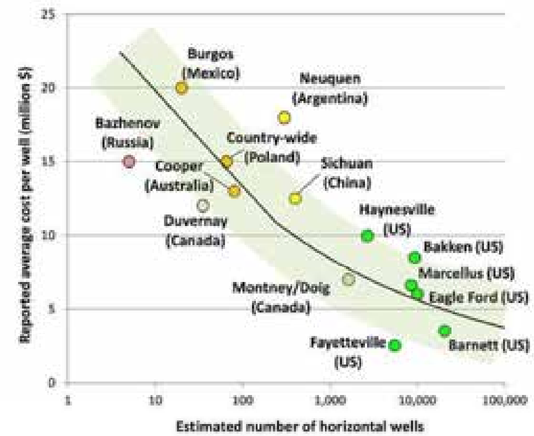
This “learning effect”, where the incremental cost of delivering a unit of gas has been shown to fall substantially over time, has been the catalyst behind the shale revolution, and the ability for the shale industry in the United States to deliver gas at increasingly lower prices (Figure 3.3).

[10] European Commission. 2017. *Shale gas production costs: historical developments and outlook*. Accessed online at http://www.insightenergy.org/

[11] US Energy Information Administration. 2017. *US dry shale gas production, monthly data*. Accessed online at http://www.eia.gov

[12] ACOLA. 2013. *Engineering Energy: Unconventional Gas Production in Australia, A study of shale gas in Australia*. Accessed online at http://www.acola.org.au/

FIGURE 3.3 THE INTERNATIONAL SHALE LEARNING CURVE



SOURCE: US EIA

3.3 Shale gas in the Northern Territory

Given the significant uncertainty regarding the shale gas potential of the Northern Territory, ACIL Allen Consulting has prepared this brief summation based on information presented by the Inquiry in its Interim Report, released in July 2017.

There are a range of estimates available regarding the shale gas potential of the Northern Territory. Geoscience Australia believes there is 257,276 PJ of potential gas resource trapped in shale formations across the Territory – the vast majority of this concentrated in the Beetaloo Sub-Basin of the McArthur Basin, in northern central Northern Territory. The US Energy Information Administration's 2015 *Technically Recoverable Shale Oil and Shale Gas Resources* report for Australia estimated approximately 262 TCF of shale gas was in situ in the Northern Territory's two most explored basins, Beetaloo and Georgina.[13]

Additional resource is thought to exist to the south (the Amadeus Basin, which is currently subject to conventional gas production), north west (an onshore portion of the predominately offshore Bonaparte Basin), south east (the Georgina Basin) and south-south east (the Pedrika Basin). However, the majority of the effort of potential industry operators has been spent better understanding the geology and petroleum potential of the Beetaloo Sub-Basin.

A map of the Northern Territory's known and approximated source rocks for hydrocarbons is presented in Figure 3.4 (page 27).

According to the Department of Primary Industry and Resources,[14] there have been eight hydraulically fractured wells targeting unconventional shale gas in the Northern Territory. Four such wells have been drilled in the Georgina Basin, and four in the Beetaloo Sub-Basin.

The most significant well drilled to date is Origin Energy's ('Origin') Amungee NW-1H well, which completed a 57 day production test prior to the moratorium taking effect.[15] The well was a 1,100m long horizontal fracture stimulated well with 11 fracture stages, targeting the so-called "Velkerri B shale" layer within the basin. Origin reported a positive production test, and in conjunction with additional geological data gathered over its exploration program to date lodged a notice with the Petroleum Resource Management System (PRMS) that identified a "Contingent Resource" of 6.6 TCF of technically

[13] US EIA. 2015. *Technically Recoverable Shale Oil and Shale Gas Resources: Australia.*
[14] Scientific Inquiry. 2017. *Scientific Inquiry into Hydraulic Fracturing in the Northern Territory: Interim Report, July 2017*. Accessed online at http://www.frackinginquiry.nt.gov.au/
[15] Origin Energy. 2017. *Notice to market: Beetaloo Basin drilling results indicate material gas resource, 15 February 2017.* Accessed online at http://www.asx.com.au/

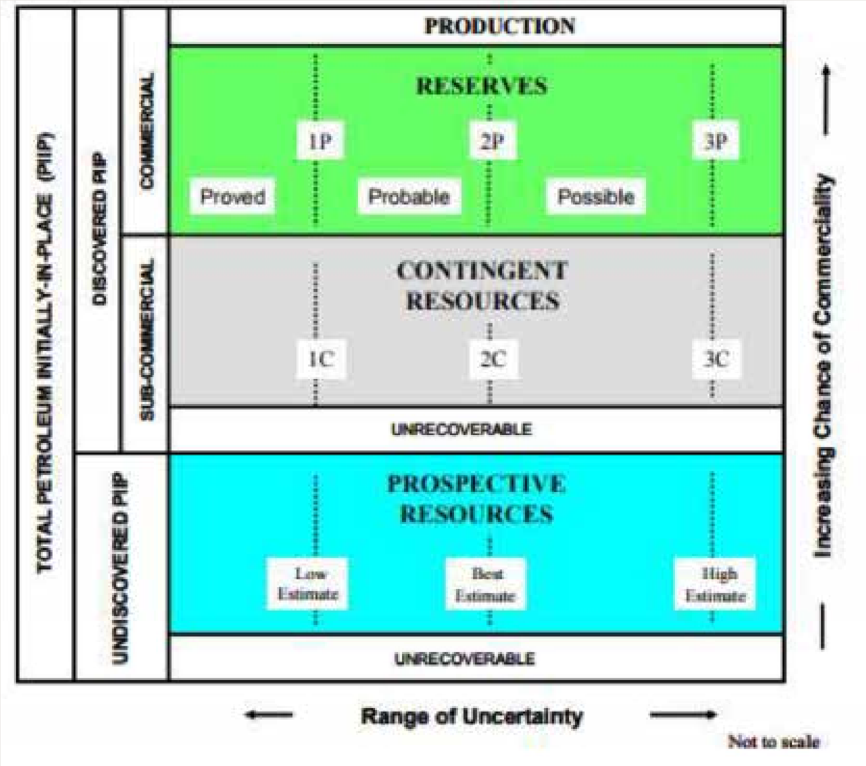
recoverable gas (the PRMS system is outlined briefly in Box 3.1). A 6.6 TCF discovery is significant; it is 50 per cent larger than the “Pluto” onshore LNG project in Western Australia, which cost an estimated $15 billion to develop (including liquefaction facilities).

BOX 3.1 THE PETROLEUM RESOURCE MANAGEMENT SYSTEM

The Petroleum Resource Management System is the system used to classify the commerciality of conventional and unconventional hydrocarbon discoveries in a clear, consistent and transparent manner as it relates to companies listed on the Australian Stock Exchange. All publicly listed Australian companies are required to report on the outcomes of their exploration activities using this framework.

It is a framework that allows companies to determine the quantity of petroleum thought to be in place in a particular area using probabilistic modelling and an assessment of commerciality contingent on the ability to deliver the petroleum to market.

Petroleum deposits effectively move through a codified lifecycle, starting out as prospective resources, progressing to contingent resources – which are deposits with confirmed petroleum in place, but with questions over the commerciality of the deposit – and finally to commercial reserves and eventual production. This framework, prepared by the Society of Petroleum Engineers, is reproduced below.

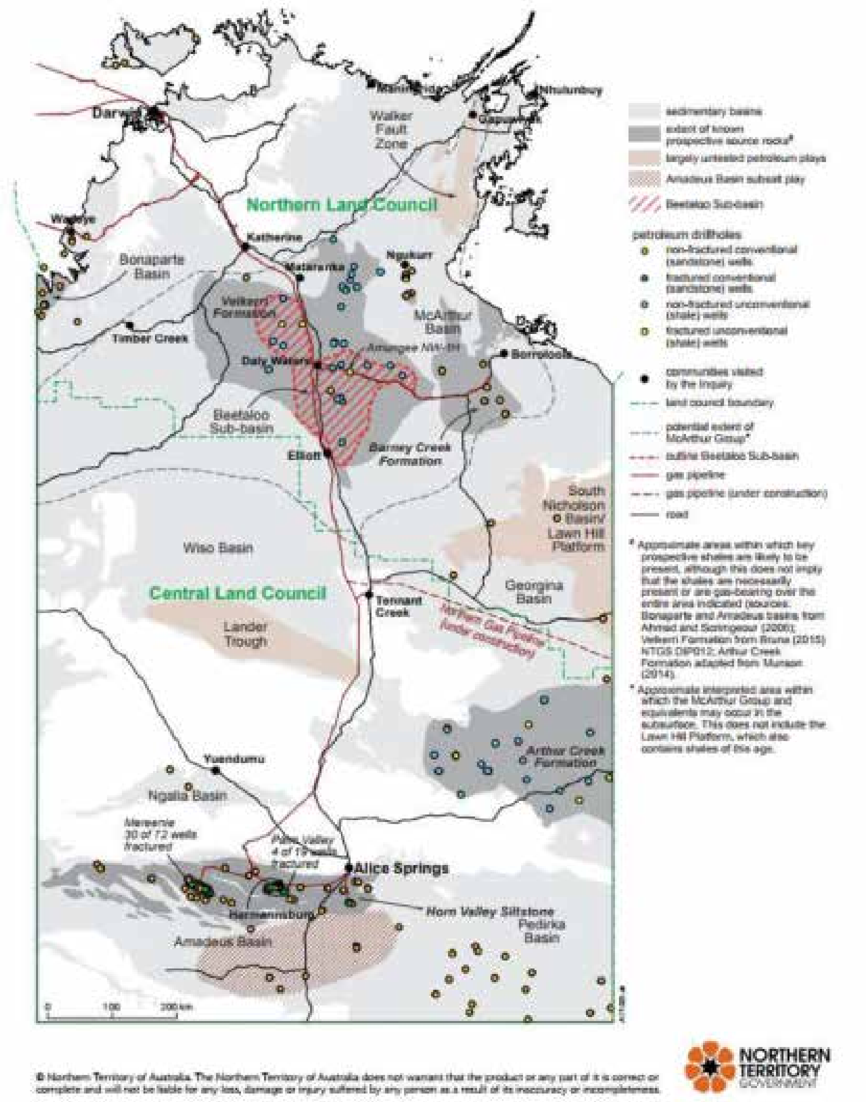


SOURCE:SOCIETY OF PETROLEUM ENGINEERS PETROLEUM RESOURCE MANAGEMENT SYSTEM

Origin Energy’s discovery in the Beetaloo Sub-Basin has been assessed by Origin as a 2C grade contingent resource. In lay terms, this means Origin is fairly certain there is commercial scale petroleum in place, but requires further testing to confirm this, and still has significant commercial hurdles to overcome to progress to determination of a commercial reserve.

Origin’s contingent resource is the only material discovery made so far. While the Northern Territory is thought to have significant shale gas, it is a mostly unknown proposition and requires significant further exploration, testing and appraisal to ascertain a more defined estimate of its potential. There are three lead industry proponents seeking to undertake exploration and appraisal of shale gas deposits in the Beetaloo Sub-Basin and beyond. These are Origin Energy Ltd (an ASX-listed energy company), Pangaea Resources Pty Ltd (a privately held exploration company) and Santos Ltd (an ASX-listed energy company). These three companies are the lead operators in the region, with a range of other companies holding shares in exploration and appraisal projects. There are also a raft of companies which hold exploration permits covering mostly unexplored regions of the Northern Territory.

FIGURE 3.4 POSSIBLE SHALE GAS DEPOSITS, NORTHERN TERRITORY



SOURCE: SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING

II

SHALE GAS INDUSTRY DEVELOPMENT SCENARIOS

4 PROJECT ASSUMPTIONS AND DEVELOPMENT SCENARIOS

4.1 Introduction

The shale gas industry in the Northern Territory is in a pre-embryonic stage of development. To date, there has been one fracked well which has progressed to a 57 day production test. In the Marcellus Basin in the United States State of Pennsylvania, more than 2,000 wells are drilled every year. Information on the potential of the industry, and how it may develop in Northern Territory, is scant.

The results of our modelling are subject to higher than usual uncertainty and should be treated as what they are – an estimate of the impacts of a hypothetical development – and not for what they are not – a prediction of what will actually happen in the future. As a result of this lack of defined information, ACIL Allen sought approval from the Scientific Inquiry to modify its scope of works slightly.

ACIL Allen's original scope of works was to complete economic modelling under three scenarios:

1. The moratorium on fracking remained in place in perpetuity ('Baseline')
2. The moratorium on fracking is lifted for the entire Northern Territory ('full lift')
3. The moratorium on fracking is lifted in the Beetaloo Sub-Basin only ('Beetaloo only')

This was the premise with which ACIL Allen conducted its program of stakeholder consultation in the Northern Territory. This implication of these scenarios is that it was possible to develop a model of what *would* happen should the moratorium be lifted at some point in the future.

However, as we began to gather more information from government agencies, industry operators, and conducted our own research, it became clear that there was no way of knowing what *would* happen, as was the original intent of our scope of works.

With the endorsement of the Scientific Inquiry, ACIL Allen has modified the initial scope of works to instead complete economic modelling on five scenarios. These scenarios make a broad assumption that the quantity of shale gas in the Northern Territory is not a constraint, but instead the constraint on the size of a potential development is on the demand side and contingent on the development of a quantity of gas that can meet certain price points in the market. These are discussed below.

In addition to the uncertainty regarding the scale of commercial quality shale gas reserves, ACIL Allen was confronted with a significant challenge to develop a set of underlying assumptions that would allow it to "build" a shale gas industry in the Northern Territory. Typically, economic modelling is conducted using a project or industry-level financial model; the development of a shale gas industry in the Northern Territory is so early stage that such information was scant and largely held in commercial confidence by potential industry operators.

ACIL Allen has sought to be as transparent as possible in this process. This section details every assumption made in regards to the development of an industry financial model, including a rationale for the assumption and a source where one is available. We have not been able to independently source evidence for every assumption required to build the financial model; some assumptions regarding the cost of particular elements of a hypothetical development have by necessity been sourced as "industry operators".

The sum total of this scope variation is ACIL Allen now completing its economic modelling task using information that is our assessment of what a successful shale gas industry *could* look like in the Northern Territory. The Scientific Inquiry agrees that this fulfils the overall objectives of the economic advisory services we have been asked to provide, which is to articulate for Territorians the potential economic impacts, benefits and risks to them should an industry develop in the future.

The chapter of our report outlines:

1. The five industry development scenarios (baseline, exploration only, and three production scenarios)
2. The process of determining the inputs and outputs of the industry development scenarios
3. The overlaying assumptions used to determine gas prices, sales and production volumes in each of the production scenarios
4. The underlying assumptions used to build the financial models of an industry
5. The financial models of gas industry development in the three production scenarios
6. The financial models of gas pipeline development in the three production scenarios

4.2 Modelling process

ACIL Allen has undertaken a comprehensive exercise to build the assumptions set and associated inputs and outputs used to facilitate the cash flow and economic modelling required to complete our scope of works. The modelling occurred in four sequential phases, outlined below.

1. **Gas Market Modelling:** Understanding the supply and demand for gas from a Northern Territory shale gas industry under each scenario, to determine the volume of gas that could be placed in the market at market prices each year of the study. This was completed using ACIL Allen's *GasMark* gas market model. A description of the manner in which ACIL Allen's *GasMark* deals with new sources of supply is provided in Box 4.1, and a full outline of *GasMark's* underlying system and processes is provided in F.

   The task of gas market modelling was different to a normal modelling task, as ACIL Allen typically knows the quantity, target sales price and underlying cost structure of a new gas development prior to attempting to place it into the market in *GasMark*. Due to the early stage of development, there is no information regarding the underlying cost structure of the gas present in the Northern Territory, even a very limited understanding of the quantity and quality of the gas itself. To make up for this information gap, in this engagement, ACIL Allen first had to determine how much gas could be sold to the market, to then understand the infrastructure required to facilitate the extraction of gas, and ultimate cost structure of the gas.

   At first, ACIL Allen developed target levels of gas production under the three scenarios: 100. These target production levels were input into *GasMark* iteratively, with $0.25 incremental price increase (starting at $2.00/GJ) per iteration. *GasMark* then determined how much gas could be placed in the market at each price point in each year of the study (through 2035). ACIL Allen then conducted a simple NPV calculation using a 10 per cent discount rate to determine the price and volume quantities that should be adopted for ProjectCo to maximise its revenue. These price and volume calculations were adopted as the actual values for modelling.

2. **Project Development Modelling:** Understand the production and infrastructure requirements to meet the volume of gas to be placed in the market, using a bespoke shale well production schedule model.

   This model required two major inputs: an assumed single average type curve of a hypothetical shale well (different for each scenario) and a series of assumptions regarding the infrastructure required to enable production to occur (wells, pads, gathering pipes, roads, water, camps, labour). This occurred in two streams:

   a) "ProjectCo": the hypothetical development company responsible for exploring, appraising and developing the shale gas industry in the Northern Territory.

BOX 4.1 ACIL ALLEN'S GASMARK MODEL AND NEW DEVELOPMENTS

ACIL Allen's *GasMark* model is built from the bottom up using both real world supply and demand sources and pipelines which link supply to demand. When considering the right size of new sources of supply and transport, ACIL Allen considers:

— Current and projected future pipeline capacities across the national gas grid, and transport costs based on actual tariffs (for regulated pipelines) or estimated tariffs (for unregulated pipelines)
— Current and projected future supply from currently producing and committed sources of gas, as well as yet-to-be-discovered gas, by taking publicly available information on reserve size, depletion rate and estimated production costs
— Current and projected future demand from households, industry, electricity generation and LNG export facilities, based on publicly available information and internally generated projections, cross-checked against forecasts prepared by the Australian Energy Market Operator (National Gas Forecasting Report).

The model takes this information and attempts to clear the market in the most efficient manner possible, taking into account effective final prices (ex-field, processing and transport inclusive).

When considering a new production project, ACIL Allen will typically incorporate assumptions about the volume of new gas supply that will be made available to the market. ACIL Allen instructs the model to offer the new gas into the market at a particular price point or in accordance with a specified supply cost curve, and the market finds a new equilibrium – which may include reducing the production of existing fields or stopping the development of planned fields if they are made uncompetitive versus the new supply. The model will only dispatch the new gas offered into the market to the extent that it is able to competitively meet demand at the price offered.

As discussed above (Page 22), this engagement requires a somewhat different approach because, given the early stage of shale gas exploration in the Northern Territory, there is a lack of reliable information regarding the size of the gas resource and its costs of production. We assume the existence of a significant shale gas resource in the Northern Territory and to use the gas model to determine the hypothetical cost of production (and consequently, the minimum ex-field selling prices) needed in order to achieve market penetration at the levels implied by the three staged market development scenarios.

SOURCE: ACIL ALLEN CONSULTING

b) "PipelineCo": the hypothetical builder, owner and operator of new pipeline infrastructure required to facilitate the sale of ProjectCo shale gas to market.

ProjectCo and PipelineCo are separate entities, but interact via tariffs paid by ProjectCo to PipelineCo for the provision of pipelines to transport gas to market.

3. **Project Cash Flow Modelling:** Understanding the financial implications of the development using assumptions regarding the cost of development of ProjectCo and PipelineCo, and volume and price data derived from *GasMark.*

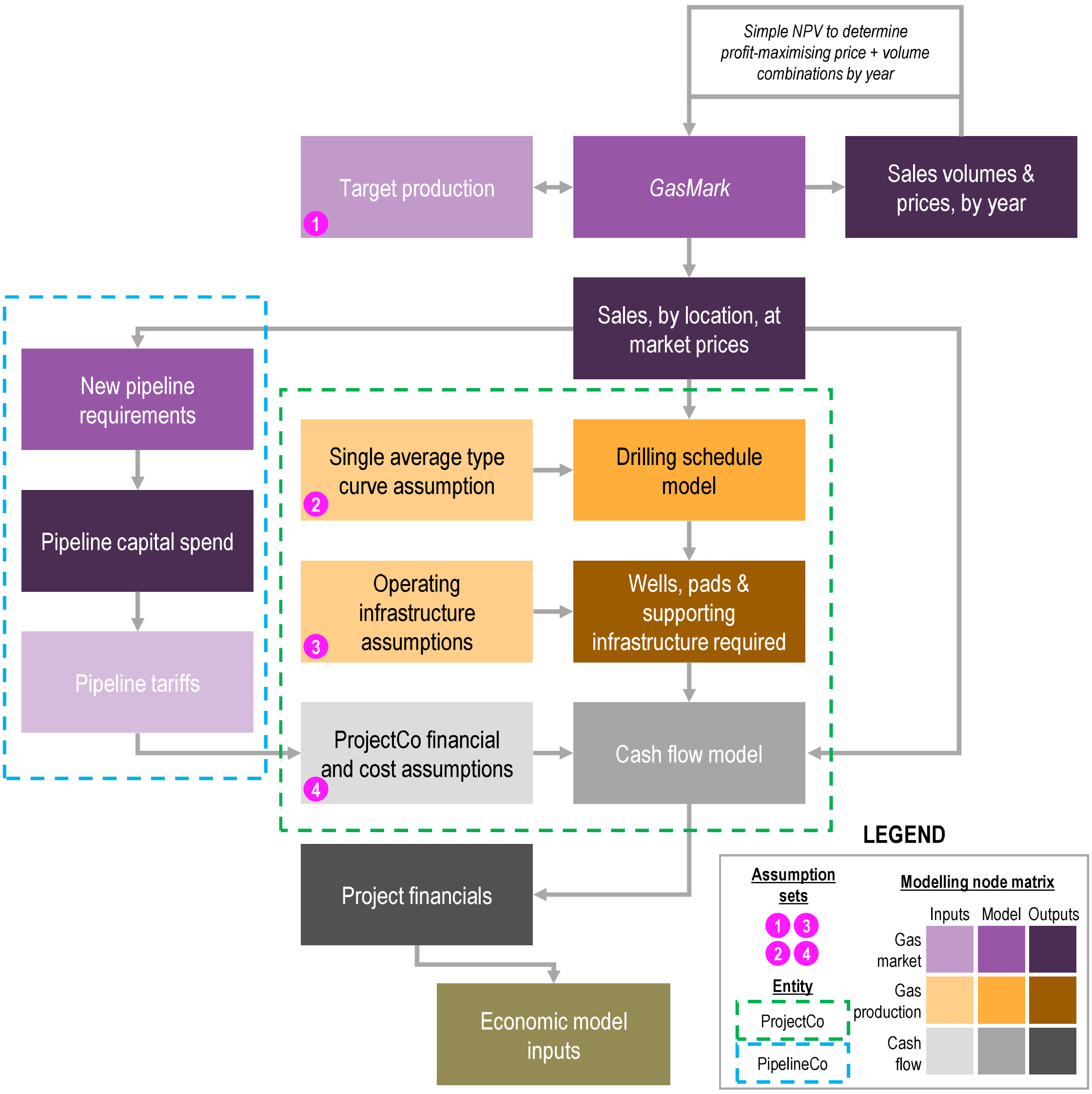
   ACIL Allen has built a bespoke discounted cash flow model that takes into account all features of ProjectCo's finances, including estimates of taxation. PipelineCo is built as a simple discounted cash flow model with capital investment, ProjectCo tariffs revenue and operating expenditure.

4. **Economic Impact Assessment Modelling:** The summary inputs and outputs of the ProjectCo and PipelineCo cash flow modelling are converted to a national accounting framework and processed through ACIL Allen's *TasmanGlobal* computable-general equilibrium (CGE) model. The four development scenarios are compared to the baseline assessment of the future growth of the Northern Territory economy to produce estimates of the potential economic impacts of each development scenario as a discrete set of outputs.

   Outputs are presented at the Northern Territory and Australia level, under the Australian Bureau of Statistics National Accounting framework for income, expenditure and output – including at ANZSIC major industry level. This ensures a comprehensive understanding of both positive and negative impacts of an industry.

This is a complex and iterative process. The process is outlined in the flow chart below (Figure 4.1). Specific details regarding the models and modelling techniques described above can be found the appendix of this report. The remainder of this chapter outlines the process of modelling, the assumptions used, and the outputs of each phase of modelling.

FIGURE 4.1 ACIL ALLEN MODELLING FLOW CHART



SOURCE: ACIL ALLEN CONSULTING

4.3 Shale gas industry development scenarios

ACIL Allen's three onshore gas industry development scenarios

1. **BREEZE Scenario:** Target production of 100 TJ/day of gas into existing pipeline infrastructure, the net effect being an increase in the amount of Northern Territory gas flowing through the Northern Gas Pipeline (NGP) into the East Coast market. This was selected as the "small" scale development following consultation with industry stakeholders and a review of their submissions to the Inquiry.
2. **WIND Scenario:** Target production of 400 TJ/day into newly constructed pipeline infrastructure, to fill short term gap in East Coast industrial and power generation, and penetrate the Northern Territory market (post-Blacktip) thereafter. This was selected as the "medium" scale development following consultation with industry stakeholders and a review of their submissions to the Inquiry.
3. **GALE Scenario:** Target provision of 1000 TJ/day into the existing Darwin LNG facility and additional East Coast supply (for power generation and LNG), replacing the Bayu-Undan feed stock as it depletes in the middle of the next decade. This was selected as the "large" scale development as a development of such scale would allow for scale economies to embed significantly into the project, and allow ProjectCo to provide the scale of gas feed into LNG production.

The rationale and supporting evidence for each scale of development is outlined below. As discussed above, at this stage these volumes of gas production are only "target" rates which have been fed into ACIL Allen's *GasMark* model for the purposes of determining what can be realistically sold into the market at particular price points. A second stage of modelling is conducted to determine how much gas ProjectCo will provide to the market in order to maximise its revenue generating capacity.

Critical assumption: A dry gas development

One critical and overarching assumption in ACIL Allen's development scenarios is the play that is developed is a 100 per cent "dry gas" play. That is, there are no higher value hydrocarbons, such as butane, ethane, propane or crude oil targeted for extraction, nor extracted, by ProjectCo. A "liquids rich" shale gas play results in a very small increase in operating costs (associated with increased processing to separate the higher value hydrocarbons from the lower value hydrocarbons), and a very large increase in potential production revenue. As a result, the net effect of a liquids rich development is to significantly improve total project economics.

ACIL Allen has assumed a dry gas play for two reasons. As discussed in Section 3.2, Origin Energy's Amungee NW-1H well produced dry gas from the Velkerri B shale, the shale which has been the target play of operators that have explored in the Beetaloo Sub-Basin. While operators are of the view there is likely to be a liquids rich shale in the sub-basin, it is too early to estimate the types or quantities of liquids available for extraction. Given this uncertainty, ACIL Allen has not sought to model any liquids.

In addition, ACIL Allen's scope of works requires a conservative assessment of the potential. Given the significant boost to project economics associated with a liquids rich development, ACIL Allen is more comfortable excluding the potential from its modelling. We can confidently state however that should a liquids rich development occur, the overall project economics will be significantly more positive, and the value of the shale gas industry to the Northern Territory would be significantly larger.

4.3.2 BREEZE Scenario: Target 100TJ/day scale

Based on ACIL Allen's assessment of the Northern Territory gas market in Section 2.6, there is currently a surplus of gas in the Northern Territory for the purposes of domestic consumption. This, and the potential for future on and offshore gas developments in the Northern Territory, has spurred the development of a gas pipeline linking Tennant Creek and Mt Isa in Queensland to the East Coast Gas Market – the Northern Gas Pipeline.

In 2006, Northern Territory Power and Water, the Territory's State-owned utility provider, entered into a 25 year off take agreement with ENI to take between 23 PJ/year and 37 PJ/year of gas from an onshore processing facility on the Territory coast.[16] However, it appears the current agreement results in the provision of more gas than is required by the Territory, with NT Power and Water effectively underwriting

[16] Ibid

the initial development of the NGP through the on-sale of Blacktip gas to a major industrial user in Queensland.[17]

The current 12-inch diameter specification of the NGP allows for the provision of up to 90 terajoules per day (TJ/day) of gas to the East Coast market.[18] As it stands, there is likely to be significant unutilised capacity on the pipeline upon commissioning, with the on-sale of Blacktip gas referred to above utilising only about one-third of the available capacity.

The Blacktip gas field has an estimated remaining life of 18 years, based on current reserves and assuming a flat production profile of 87.4 TJ/day (about 32 PJ/year). Under current estimates of NT domestic demand, there is unlikely to be a need for a major new source of gas for NT domestic consumption over the forecasting period of *GasMark* (2017 – 2035). However, the entry of NT Power and Water into the national gas market via the Northern Gas Pipeline affords it an opportunity to become a larger player in the provision of gas to East Coast markets.

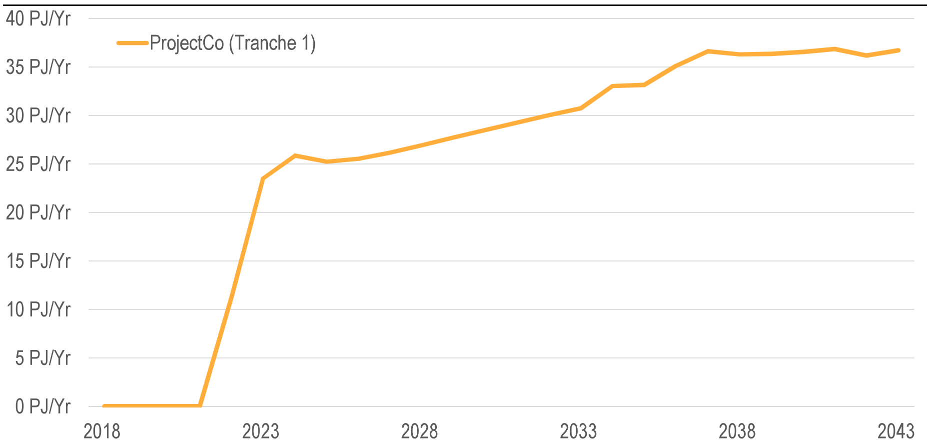
Our preliminary analysis using ACIL Allen's *GasMark* model shows that on the basis of growth in NT demand and potential to supply the East Coast market through the current specification of the NGP, there is room for between 24 and 34 PJ/year of new gas to enter the market at current prices between 2018 and 2035. It is assumed that ProjectCo will meet this demand.

Under the first scenario, it is assumed ProjectCo begins to produce shale gas in FY2022, with the current moratorium on activities lifting at the end of FY2018 and the exploration/appraisal phase of development occurring in FY2019, FY2020 and FY2021. At the tail end of FY2021, ProjectCo begins to build the facilities required to tie into the Amadeus Gas Pipeline, which at that time will be linked to the East Coast market via the NGP. ProjectCo produces gas at an initial rate of 33.4 TJ/day in 2022, ramping up to 90 TJ/day in 2034 as the Blacktip field begins to wind down production.

The model assumes the price of gas from ProjectCo is set at a level that allows for competitive supply into the East Coast market without displacing production of Blacktip gas that is contractually committed to NT Power and Water. Initially, all of the gas produced by ProjectCo flows to the East Coast gas market. After 2030 some ProjectCo gas starts to be delivered to the Northern Territory market, backfilling the decline in production from Blacktip. However, as *GasMark* is only able to produce estimates to 2035, ACIL Allen has assumed production remains constant from 2036 to 2043.

The profile of gas production by ProjectCo in BREEZE is below (Figure 4.2).

FIGURE 4.2 PROJECTCO GAS PRODUCTION, BREEZE SCENARIO, PJ/ANNUM



SOURCE: ACIL ALLEN CONSULTING

[17] NT Power and Water. 2017. *Power and Water positioned to enter the Australian gas market*. Accessed online at http://www.powerandwater.com.au/
[18] Australian Energy Market Operator. 2017. *Gas Statement of Opportunities, March 2017*. Accessed online at http:///www.aemo.com.au/

4.3.3 WIND Scenario: Target 400TJ/day scale

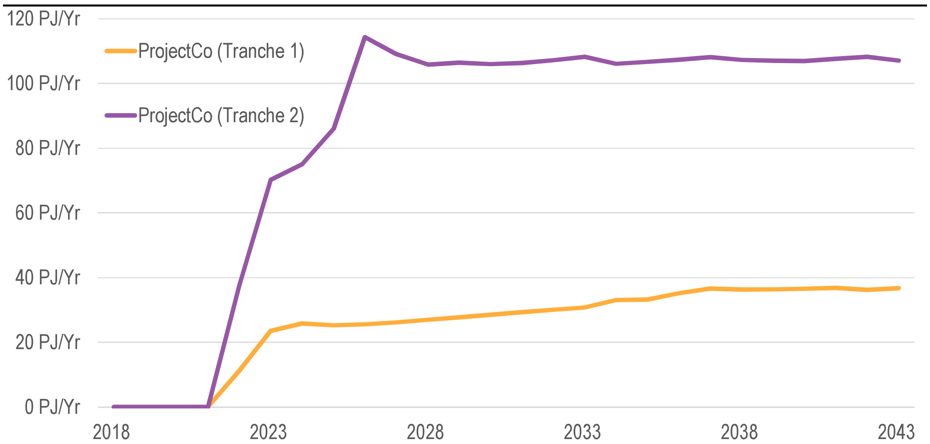
The WIND scenario assumes ProjectCo is further able to deliver commercial gas into the NGP and East Coast market. After a successful initial development, ProjectCo seeks to build its market share on the East Coast via production efficiencies to take advantage of push and pull factors in East Coast gas markets associated with the development of higher cost coal seam gas (CSG) production and the backfill requirements of existing LNG facilities in Queensland.

ProjectCo's target production rate for this scenario is 400TJ/day – or an additional 300TJ/day over the BREEZE scenario. Modelling indicates that under the optimal price/volume strategy adopted, the maximum amount of gas that could flow to the East Coast market under current market assumptions is an incremental 244 TJ/day peak in 2026 (total gas produced 315 TJ/day), with a long term equilibrium of 210 TJ/day by 2035 (total gas produced 300 TJ/day).

The majority of this gas is placed into the East Coast market, requiring additional pipeline infrastructure be developed as the capacity of the existing NGP is 100 per cent subscribed by ProjectCo. Pipeline-related assumptions are outlined in Section 4.5.1.

The production profile of ProjectCo in the WIND scenario is presented in Figure 4.3.

FIGURE 4.3 PROJECTCO GAS PRODUCTION, WIND SCENARIO, PJ/ANNUM



SOURCE: ACIL ALLEN CONSULTING

4.3.4 GALE Scenario: Target 1000TJ/day scale

The Darwin LNG plant (DLNG) is currently supplied feed gas from the Bayu-Undan gas project in off the coast of the Northern Territory in the Australia Timor-Leste Joint Petroleum Development Area. DLNG has a single production train[19], producing up to 3.7 million tonnes of LNG per annum for sales to Japan[20]. To produce 3.7 million tonnes of LNG, the plant requires approximately 225 PJ/year of feed gas.

As it stands, Bayu-Undan provides 100 per cent of the feed in gas to the plant. The field is set to reach maturity in 2022-23, and will progressively reduce its production. Unless replacement gas is found DLNG will cease production some time towards the end of the next decade. Acknowledging this, the owners of the Bayu-Undan joint venture have begun independently investigating new sources of gas for the plant, at this stage focussed on a new large scale offshore development off the coast of the Northern Territory.[21]

ACIL Allen assumes ProjectCo is able to build to a scale that would allow it to progressively replace the Bayu-Undan gas field as the feed in gas for DLNG, allowing the existing train to continue production

[19] ConocoPhillips. 2017. *Our Business Activities – DLNG*. Accessed online at http://www.conocophilips.com.au/
[20] Santos. 2017. *Bayu-Undan/Darwin LNG Joint Venture*. Accessed online at http://www.santos.com/
[21] Energy News Bulletin. 2017. *Barossa development begins*. Accessed online at http://www.energynewsbulletin.net/

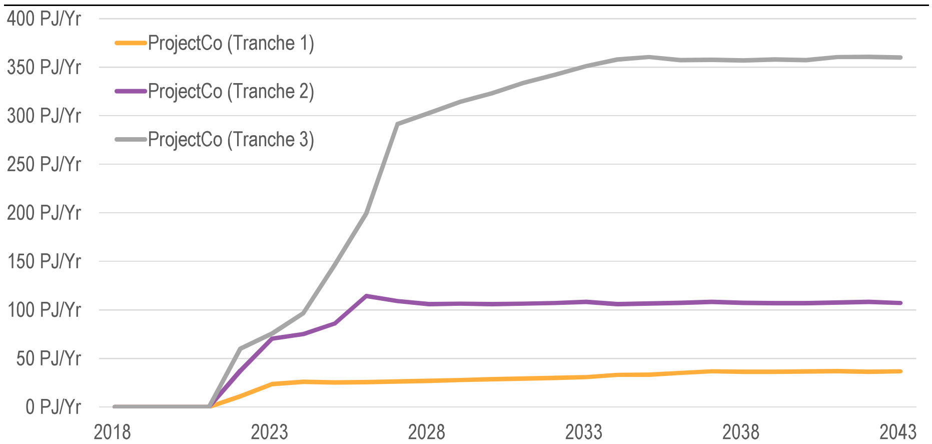
beyond 2022-23 at current rates. This necessitates investment to expand the Amadeus Gas Pipeline to allow more gas to flow north to DLNG.

For the purposes of economic modelling, it is assumed that DLNG will continue to produce LNG at its current rate with or without ProjectCo gas. In the base case, it is assumed one of the new offshore developments discussed above comes to pass and this gas backfills DLNG. This is a critical assumption, as it means there is no incremental value associated with LNG production attributable to ProjectCo gas – the incremental value is any change to the production profile, profitability and local content of gas required to backfill DLNG in an onshore scenario versus an offshore scenario. This is discussed further in Section 6.

It is also assumed that due to ProjectCo's increasing scale economies, its cost of production falls below the rate of the WIND scenario, allowing for further gas sales into the East Coast gas market – potentially including partial backfill of an LNG train at Gladstone. In any event, the cascading effect of ProjectCo's gas results in a reduction in the wholesale price of gas in the East Coast market, with the "ripple" effect of injection of more gas flowing west to east leading to less gas produced in Queensland fields moving south. Similarly to DLNG, there is no incremental value associated with LNG backfill.

As such, this necessitates further investment in the NGP and Carpentaria Gas Pipeline over and above the investment assumed to be required to meet WIND East Coast exports. As a result, ProjectCo is able to fulfil its full target production of 1000 TJ/day by 2035. Economies of scale in production allowing it to increase its penetration of the East Coast market over the WIND scenario. The production profile of ProjectCo under these assumptions is shown below (Figure 4.4).

FIGURE 4.4 PROJECTCO GAS PRODUCTION, PJ/ANNUM, GALE SCENARIO



SOURCE: ACIL ALLEN CONSULTING

4.3.5 Final volumes and prices

The final volumes and selling prices for ProjectCo gas under each scenario are presented below, in real 2017 terms, inclusive of transport costs. Details on the stratified sales of gas by market (domestic NT, East Coast and DLNG) are presented in Appendix C.

TABLE 4.1 PROJECTCO FINAL GAS VOLUMES AND PRICES, BY SCENARIO, $/GJ & PJ/ANNUM

	BREEZE		WIND		GALE	
	Volume	Price	Volume	Price	Volume	Price
Year	PJ/annum	$/GJ	PJ/annum	$/GJ	PJ/annum	$/GJ
2018	-	-	-	-	-	-
2019	-	-	-	-	-	-
2020	-	-	-	-	-	-

	BREEZE		WIND		GALE	
	Volume	Price	Volume	Price	Volume	Price
Year	PJ/annum	$/GJ	PJ/annum	$/GJ	PJ/annum	$/GJ
2021	-	-	-	-	-	-
2022	11.3	7.37	37.7	5.65	60.1	6.12
2023	23.5	7.64	70.2	6.07	75.6	6.12
2024	25.9	7.64	75.0	6.09	96.5	6.12
2025	25.2	7.69	85.9	6.12	146.6	5.96
2026	25.5	8.16	114.3	6.19	199.3	5.88
2027	26.2	8.37	109.1	6.79	291.5	5.88
2028	26.9	8.48	105.9	7.33	302.8	5.82
2029	27.7	8.94	106.5	7.74	314.4	5.77
2030	28.5	9.04	106.0	7.97	323.2	5.73
2031	29.3	9.24	106.3	8.19	333.7	5.70
2032	30.0	9.32	107.2	8.43	342.2	5.67
2033	30.7	9.89	108.2	8.55	351.3	5.65
2034	33.0	9.81	106.1	8.80	357.9	5.63
2035	33.2	9.84	106.6	9.05	360.4	5.61
2036	35.1	9.84	107.3	9.05	357.5	5.55
2037	36.6	9.84	108.1	9.05	357.7	5.48
2038	36.3	9.84	107.3	9.05	357.0	5.42
2039	36.4	9.84	107.0	9.05	358.0	5.35
2040	36.6	9.84	107.0	9.05	357.4	5.28
2041	36.9	9.84	107.6	9.05	360.6	5.28
2042	36.2	9.84	108.3	9.05	360.7	5.28
2043	36.7	9.84	107.1	9.05	360.0	5.28

SOURCE: ACIL ALLEN CONSULTING

4.4 Adopting single average type curves

To progress from the volume of gas to be sold to the cost of production, ACIL Allen has formulated a series of assumptions regarding the quality of the gas reserve available to ProjectCo in each of the scenarios. The manifestation of this is what is known as a “type curve”, which shows how much gas is produced from a single well at any one point in time (in this case per annum).

ACIL Allen has developed its own type curves, rather than using estimated type curves for gas fields in the Northern Territory. This is because there has been one successful horizontally drilled shale gas well for production testing in the Northern Territory: Origin Energy’s Amungee NW-1H. The results of this test were positive, but cannot be used for our type curve assumption for three reasons:

— The well only involved 11 “frack” stages (number of fracture stimulation points from the well). A typical horizontal well will have at least 20 frack stages, and in most cases many more.

— The well’s production profile was atypical, with a very low initial production rate and an almost perfectly flat production curve.[22] A typical shale gas well has a high initial production in the first year or two relative to the average production over the well life, and lower than average production over the well life thereafter.

[22] Origin Energy. 2017. Submission to the Inquiry, #272. *Accessed online at http://www.frackinginquiry.nt.gov.au*

Nonetheless, ACIL Allen has attempted to adopt the “flatter” characteristic of the Amungee NW-1H well in its type curve

— The well underwent production testing for 57 days. This is less than two months, making development of an estimated type curve problematic

ACIL Allen has adopted a “single average type curve” for the purposes of modelling. In reality, every well will produce a different type curve, relating to the location the well is drilled, the specific geology of the formation, and the particular techniques used. However, ACIL Allen considered it impractical to develop multiple type curves, and considers that the ultimate production in a given development can be summarised by a single average type curve regardless.

A typical shale gas type curve is a hyperbolic decline function, where the production of a well in the first period (typically reported in months) is very high relative to the average monthly production over the life of the well. A well’s production declines rapidly from this initial production rate, and continues to produce for a long period of time at very low levels.

There are four key pieces of information required to develop a type curve:

— Initial production rate (IP): the volume of gas produced in the first month of the well’s life
— Decline rate (in two parts: exponent and rate): the speed in which the well’s production declines per month
— Estimated Ultimate Recovery (EUR): the ultimate volume of gas that will be extracted from the well over its useful life, measured in petajoules (PJ)
— Well life (an exogenous figure): the useful production life of each well

ACIL Allen has developed a single average type curve for each of the three shale gas development scenarios in the Northern Territory. We have built our type curves using a variety of sources – on the advice of potential shale gas operators and the Northern Territory Government – and used the operators’ collective assumption that a shale gas well in the Northern Territory would have a useful life of 20 years.

Much of the information used is related to the Marcellus Basin shale gas play, in the United States of America State of Pennsylvania. The rationale for the Marcellus analogue is that both Marcellus and Beetaloo basin plays are thought exhibit similar geological characteristics: assumed to be a mostly dry gas play, similar shale formation, similar depths and similar geology.[23]

The parameters of ACIL Allen’s development type curve assumptions are below Table 4.2.

TABLE 4.2 ACIL ALLEN TYPE CURVE ASSUMPTIONS

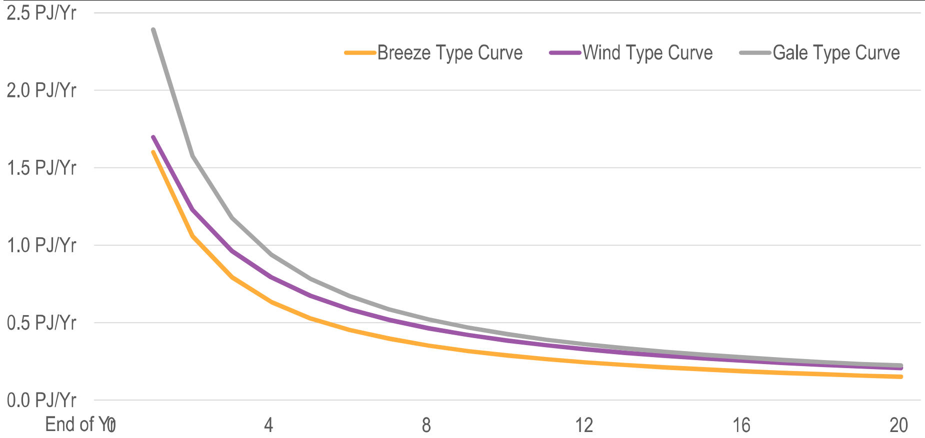
Scenario	Initial Production (mmscf/month)	Decline exponent	Decline rate (% per month)	EUR (Petajoules per well)	Well life (years)
BREEZE	160	1.0	5.3%	8.4	20
WIND	160	1.0	3.8%	10.6	20
GALE	240	1.0	5.4%	12.7	20

SOURCE: ACIL ALLEN CONSULTING, DERIVED USING VARIOUS SOURCES BELOW

ACIL Allen’s type curves are presented below, in annual production terms. The type curves essentially “graduate” in each scenario (each curve produces more gas at every point in time), as a proxy measure for the fact that better project economics are required for ProjectCo to progress from one scenario to the next.

[23] Consensus view sourced from Origin Energy, Santos and Department of Primary Industry and Resources submissions to the Scientific Inquiry into Hydraulic Fracturing Issues Paper.

FIGURE 4.5 PROJECTCO SINGLE AVERAGE TYPE CURVES, BY SCENARIO, ANNUAL PRODUCTION (PJ)



SOURCE: ACIL ALLEN CONSULTING

The type curve is a critical assumption, as it governs the number of wells required to meet target production rates, which flows through to capital and operating costs as well as the economic impact (as this is fundamentally driven by total expenditure). The rationale for ACIL Allen's type curve assumptions are below.

4.4.1 Initial Production Rate (IP)

ACIL Allen initially developed its type curve assumption from a report prepared by petroleum engineer Gary Swindell, titled *Marcellus Shale in Pennsylvania: A 3,800 Well Study of Estimated Ultimate Recovery (EUR)*. The table in this report has been reproduced below (Figure 4.6).

FIGURE 4.6 SWINDELL REPORT DATA

The increase in initial production rate during the early years of the Marcellus development may be related to an increase in the horizontal length during the same period. For a subset of 2,168 wells where an estimate of the horizontal length was able to be made, the average horizontal section increased from 2,280 ft in 2008; 2,890 ft. in 2009; 3,800 ft in 2010; 4,100 ft. in 2011; 4,500 ft. in 2012 and 4,751 in the 2013 vintage wells.

Average decline profiles for the whole state, vintaged by the year of first production are summarized in **Table 1**.

Vintage	Average initial production Mcf/month	Average initial decline rate - %	Hyp b factor	Average EUR Statewide - Bcfe
2008	43,263	43.87	0.65	2,032.69
2009	71,768	43.21	0.55	3,327.25
2010	121,248	48.52	0.65	4,873.21
2011	121,339	49.02	0.66	4,531.52
2012	129,302	48.38	0.51	4,201.77
2013	172,787	46.22	0.39	5,397.40

Table 1. Average decline profiles for the Pennsylvania Marcellus.

SOURCE: SWINDELL, G. 2016. MARCELLUS SHALE IN PENNSYLVANIA: A 3,800 WELL STUDY OF ESTIMATED ULTIMATE RECOVERY (EUR)

As the target of the Swindell study is estimating average EUR, his study does not include contemporary information regarding initial production rates. The study used data from the Pennsylvania Department of Environmental Protection, which mandates that producers in the State must report monthly production figures for all shale wells drilled in the Marcellus shale.

This is a regulatory requirement to assist the Department manage the industry and its impact on the environment. However, the Department also publishes all of this data on the internet, allowing for precise analysis of shale gas production from wells drilled in the Marcellus Basin. ACIL Allen initially sought out this data to verify the findings of this report, but after understanding the depth of data available instead used the data to determine an appropriate initial production rate for its type curves.

ACIL Allen extracted well level production data from 2012 to 2016. Data for 2012 to 2014 was reported on a six-monthly basis, while 2015 and 2016 was monthly data. Initially, ACIL Allen converted production data to monthly mmscf by dividing total production in the period by the number of days in the period, multiplying this by 365.25 days (a standard year) and divided this by 12.

ACIL Allen then filtered out well data that was not dry gas and was not a horizontally drilled well. This resulted in 171,611 individual data points over 7,925 wells for analysis.

ACIL Allen then determined the time which each well initially came online by applying a formula that looked up the first time a Well ID Number appeared in the database. If this was in the first six months of 2012, this data was ignored as it was the first time Well ID Numbers appears for many wells which may have been producing for some time. Applying this filter allowed ACIL Allen to determine the average IP rate for wells drilled in particular years. These are presented in a table below.

TABLE 4.3 INITIAL PRODUCTION RATES OF SHALE GAS WELLS DRILLED IN MARCELLUS BASIN BY YEAR

Period	Initial Production (TJ/month)	# of Wells in Sample
2012 (2H2012 only)	134.7	746
2013	177.3	1402
2014	209.6	1217
2015	184.6	1004
2016	233.3	672

SOURCE: ACIL ALLEN CONSULTING, PA DEPARTMENT OF ENVIRONMENTAL REGULATION

This data suggests the IP rate of horizontal dry shale gas wells drilled in the Marcellus Basin has increased over time, from 127.7 mmscf/month (134.7 TJ/month) in the second half of 2012 to 221.1 mmscf/month (233.3 TJ/month) in 2016. The increase has not been linear, with a decline in 2015.

ACIL Allen adopted an IP rate of 160 mmscf/month (168.8 TJ/month) for its BREEZE and WIND scenarios, and an IP rate of 240 mmscf/month (253.2 TJ/month) in its GALE scenario. ACIL Allen has adopted these as conservative estimates, noting:

— technological progress in the shale gas industry is rapid, so adopting IP rates that are two to five years behind the analogue shale is conservative
— the anticipated geology of the most prospective areas of the Northern Territory is conducive to the development of long horizontal wells, which tend to have higher IP rates.

It is noted that this IP rate is higher than the Amungee NW-1H well (33.5 mmscf/month or 35.3TJ/month), and higher than the most comprehensive previous study of the economics of shale gas developments in Australia, the Australian Council of Learned Academics report *Unconventional Gas Production: A study of shale gas in Australia* (the 'ACOLA report'), of 446Mscf per day (13.6 mmscf/month or 14.3TJ/month). ACIL Allen has not adopted the well profile of NW-1H for the reasons identified above. ACIL Allen has not adopted the well profile of the hypothetical shale gas development presented in the ACOLA report as we are of the view it is now out of date, given it is based on the findings of a 2012 US Energy Information Agency report, which itself was based on data that is two years older again, and is not certain that it represents the experience of the Marcellus shale given the significant discrepancy between it and data prepared by the Government of Pennsylvania.

4.4.2 EUR and Well Life

Determining the EUR of a well is a difficult exercise, even when information is fully available. It can only be known once a well has reached the end of its useful life, which in the case of the current shale gas industry in the United States is not possible. It is possible to determine probabilistic measurements of well EUR, but ACIL Allen does not have access to the requisite information to do so.

The EUR is a central assumption, as it is the variable in the type curve that provides the most sensitivity to the number of wells required to facilitate the volume of production under each scenario, and the expenditure on supporting infrastructure. ACIL Allen was unable to source adequate analogue data to adopt like for like for a modelling assumption, and so was left to piece together evidence for credible EUR assumptions from a range of sources. These are discussed below.

EUR is a function of the quality of the geology of the shale, the length of the horizontal section of the well being drilled, the precision of the drilling activity taking place, and the number of fracking stages per unit of lateral length. Research presented to the Inquiry and ACIL Allen by industry operators shows that shale gas operators in the United States are drilling increasingly long horizontal wells with the aim of increasing the EUR per well and thus lowering their development costs.[24]

There is some conjecture regarding the relationship between lateral drilling length and the volume of gas extracted per well, to the extent that EUR per 1,000 feet of lateral drilling (the industry definition of well productivity) increases as the horizontal well length increases. A recent paper by Yuan et al, published in the Society of Petroleum Engineers, found there was no additive effect of gas recovery per 1,000 foot of horizontal drilling in the Barnett Basin (in Texas), but that there was a clear relationship between the length of drilling and early production.[25] In addition to the above factors, EUR is thought to be partially a function of initial production rates per well, to the extent it reflects the quality of the shale targeted and the ultimate productivity of the well drilled. Therefore, EUR per well is likely to exhibit a positive relationship with the length of the horizontal section of a well.

This is reinforced by academic literature, such as in the Swindell report referenced in Section 4.4.1. The Swindell report found the mean EUR per well across the study period (wells spudded between 2008 and 2013) was 5.0PJ per well, with approximately 80 per cent of wells exhibiting an EUR per well of 6.3 PJ or less.[26] The Swindell data suggests the average lateral length of wells drilled in the Marcellus Basin has increased from 2,280 feet (694 metres) in 2008 to 4,751 feet (1,448 metres) in 2013 – more than doubling over this time.[27] The Swindell report does show average EUR per well by year of well spudding has increased over time, from 2.1 PJ in 2008 to 4.7 PJ in 2011, and to 5.7 PJ in 2013. Assuming a steady compound annual growth rate from 2011 to 2013 (9.5 per cent per annum), the PJ per well in the Marcellus Basin could have increased to 8.2 PJ per well on average in 2017.

The latest report on US shale gas industry performance prepared by the US Energy Information Administration, which ACIL Allen has relied upon for other assumptions in this report, found EUR in the Marcellus Basin had increased from 4.6PJ per well in 2010 to 6.8 PJ per well in 2014.[28] Assuming a steady compound annual growth rate (11.9 per cent per annum), the PJ per well in the Marcellus Basin could have increased to 9.5 PJ per well on average in 2017.

A second piece of research prepared by the US EIA suggested the average EUR of wells spudded in the Marcellus Basin has increased from 0.4 PJ in 2008 to 5.4 PJ in 2010, and 6.8 PJ in 2013.[29] Assuming a steady compound annual growth rate from 2010 to 2013 (7.5 per cent), the PJ per well in the Marcellus Basin could have increased to 9.0 PJ per well on average in 2017.

While useful, these estimates are based wholly on the continuation of historic growth rates in PJ per well, without assuming any technological progress which has occurred in the United States in recent years. This also illustrates the inherent difficulty in assessing EUR, as even in one of the most widely studied basins there is significant uncertainty.

Outside of these two papers, ACIL Allen was unable to source academic literature that was able to strike a balance between rigorous academic analysis and the contemporary experience of the shale gas industry in the United States. The published data produced above contained data for wells that was at least three

[24] See Origin (2017), Santos (2017) and Pangaea (2017).
[25] Yuan, G. et al. 2017.
[26] Swindell, G. 2016. *Marcellus Shale in Pennsylvania: A 3,800 well study of estimated Ultimate Recovery (EUR).* Accessed online at http://www.gswindell.com/
[27] Contemporary industry information suggests the average horizontal drilling length in the Marcellus Basin has increased to 7,000 feet (2,133 metres) in 2016.
[28] US EIA. 2016. *Trends in US Oil and Natural Gas Upstream Costs*. Accessed online at http://www.eia.gov/
[29] Staub, J. 2015. *The growth of US natural gas: An uncertain outlook for US and world supply*. Accessed online at http://www.eia.gov/

years old, and given the rapid productivity increases of the industry (see Section 3.2), is considered the best available conservative estimate of contemporary shale gas industry practices.

To compensate for this, ACIL Allen accessed a series of reports prepared by US shale gas industry operators for the Securities and Exchange Commission.[30] These reports indicated a strong trend of increasing EUR in the Marcellus Basin over time, and projections of further increases into the future. These reports were supportive of EURs in excess of 21.1 PJ per well at the leading edge of developments in the Marcellus Basin.

Operators provided a very large range of EUR per well that could be expected in the Northern Territory, of 4.2 - 21.1 PJ per well. For instance, Santos, in a submission to the Inquiry, indicated it was expecting an EUR of 12.2 PJ to 21.5 PJ of raw gas per well (raw gas suggesting it includes components which would be stripped out following extraction such as carbon dioxide).[31] Origin provided a range of between 5.2 PJ and 15.8 PJ per well in one of its submissions to the Inquiry.[32] Pangaea did not provide a range of expected EUR in its exploration areas, but it did cite evidence of 21.1+ PJ per well EUR outcomes in the United States.[33]

As a conservative assumption, ACIL Allen has adopted a graduated EUR for each scenario, starting with an 8.4 PJ per well in the BREEZE scenario in line with ACIL Allen's simple extrapolation analysis presented above. EUR rates of 10.6 PJ per well and 12.7 PJ per well are adopted for WIND and GALE scenarios, reflecting that to progress to increasingly large development ProjectCo would be required embed technological improvements or the quality of the shale would have to improve. This strikes the balance between ACIL Allen's requirement to take conservative assumptions, consider the most relevant contextual information of contemporary practice in the shale gas industry, and deliver economic modelling results on the economic impact of the industry (as opposed to delivering an assessment of the economics of the shale itself). This assumption also reflects the relationship between longer lateral lengths and PJ per well observed in the literature.

Operators suggested an average well life of 20 years, which ACIL Allen understands is in line with international experience. ACIL Allen has adopted this across the three scenarios.

4.4.3 Decline rates

ACIL Allen has assumed a decline rate and decline exponent that allows for the delivery of the target EUR of gas in each scenario over a 20 year well life, assuming the IP rate of either 160 mmscf/month (168.8 TJ/month) or 240 mmscf/month (253.2 TJ/month). ACIL Allen has adopted a decline exponent of 1.0, given there is no compelling reason to adopt a decline exponent of greater than or less than 1.0 – the exponent varies significantly across plays. Therefore in effect, the decline rates adopted are a residual calculation based on assumed IP, EUR and well life.

As discussed in Section 4.4, ACIL Allen has sought to qualitatively reflect the relatively low decline rate experienced in the NW-1H well drilled and spudded by Origin. This can be seen below, with the BREEZE type curve versus a hypothetical average decline curve developed from the data presented in Swindell report and the ACOLA report.

The assumed single average type curves for each scenario are applied to the production volumes modelled in Section 0 to determine the scale of the development required. The process of combining these two outputs, and the assumptions used to determine the scale of the development, are discussed in the next section.

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30 ACIL Allen accessed material prepared by US shale companies Cabot, Antero, Eclipse Resources, EQT, Gulfport Resources, Rice Energy, Southwestern Energy, and Tourmaline Corp, which were mostly in the form of SEC-compliant investor presentations. These reports contain the historic and projected future productivity of wells drilled in the Marcellus Basin. While these reports are not prepared according to the scientific method of academic research, they represent a body of evidence that is contemporary and based on the current experience of independent operators in the United States.

31 Santos. 2017. *Submission to the Scientific Inquiry into Hydraulic Fracturing, Submission #232*. Accessed online at http://www.frackinginquiry.nt.gov.au

32 Origin. 2017. *Submission to the Scientific Inquiry into Hydraulic Fracturing, Submission #272*. Accessed online at http://www.frackinginquiry.nt.gov.au

33 Pangaea. 2017. *Submission to the Scientific Inquiry into Hydraulic Fracturing, Submission #427*. Accessed online at http://www.frackinginquiry.nt.gov.au

4.5 ProjectCo drilling schedule and supporting infrastructure

This section details how ACIL Allen estimated the number of wells required to meet the production profile of each production scenario presented in Section 0. The estimation of the number of wells under each production scenario enabled ACIL Allen to estimate the supporting infrastructure requirements, including:

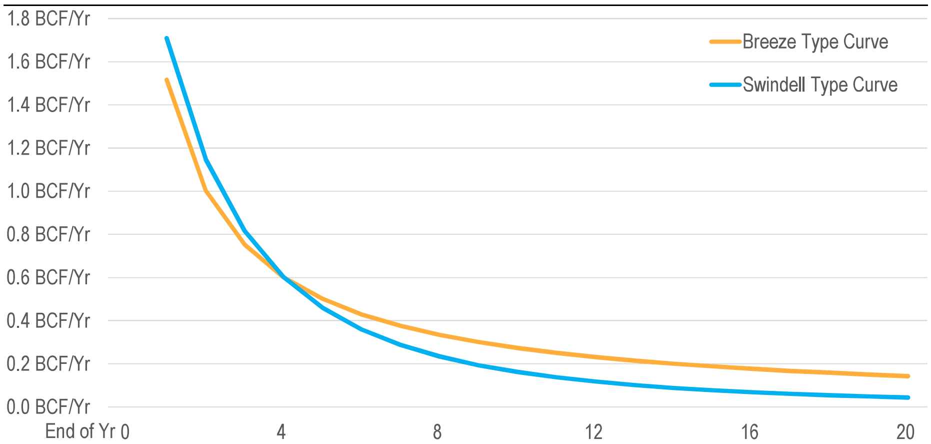
— number of pads;

— required length of connecting roads; and

— required length of gathering pipes.

The process used by ACIL Allen to estimate the required number of wells and these infrastructure requirements is detailed below.

FIGURE 4.7 HYPOTHETICAL DECLINE RATE, OBSERVED IN MARCELLUS BASIN VS ACIL ALLEN TYPE CURVE ASSUMPTION



SOURCE: PA DEPARTMENT OF ENVIRONMENTAL REGULATION, ACIL ALLEN CONSULTING

4.5.1 Number of wells required

To estimate the required number of wells to meet each development scenario's production profile, ACIL Allen required estimates of:

— sales volumes (as estimated by *GasMark* and presented in Section 0); and

— single average type curve assumptions (presented in Section 4.4).

Combining these two inputs allowed ACIL Allen to estimate the number of new wells required over time to meet the production profile estimated by *GasMark*. This is a two-step process, involving new wells and existing wells.

Existing wells are wells which have been constructed in previous periods, and which are still producing gas. Each year, there are a number of new wells commissioned, which decline in production on an annual basis in line with ACIL Allen's assumed single average type curve. New wells are wells which are required to be built in a given year to make up for a gap between required production and existing well production. The number of new wells required is calculated by subtracting required production from existing production, and dividing by the annual initial production rate of a new well. This excludes Year One of production, as there is no existing production, and 100 per cent of required production must be met by new wells.

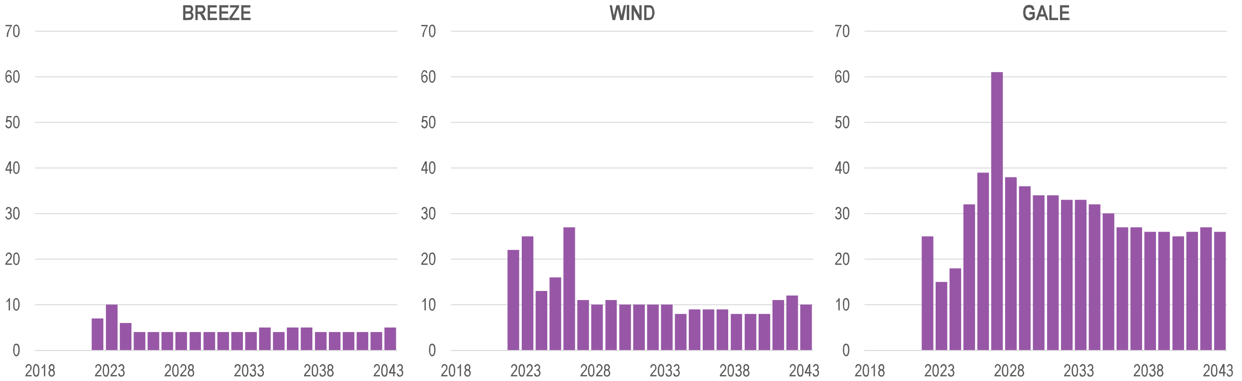
Figure 4.8 highlights the number of new wells required to be drilled per annum to meet the production profile in each development scenario.

Over the study period, ACIL Allen has estimated that a total of; 103 wells will be drilled (at an average of four wells drilled per annum) under the BREEZE development scenario, 167 new wells under the WIND development scenario (at an average of 10.3 wells drilled per annum) and 670 new wells under the GALE development scenario (at an average of 25.8 wells drilled per annum); to meet each scenario's production profile.

Figure 4.9 presents the total number of wells that are operating per annum by development scenario. Towards the end of the study period, the number of wells that are operating under each development scenario begins to level off as production profile of each development scenario hits its target level of production.

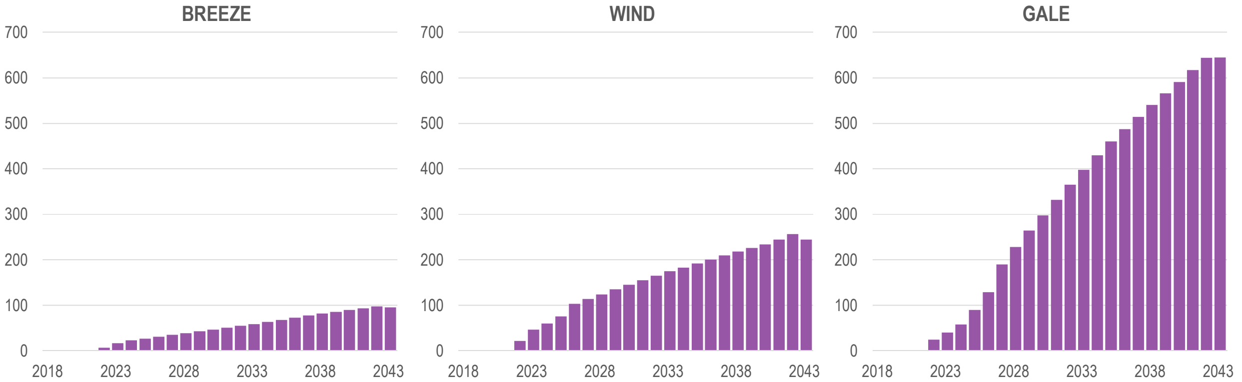
Through the study period, the number of wells in operation peaks at 98 in 2042 under the BREEZE development scenario, and 257 in the WIND development scenario. The number of wells in operation peaks one year later at 645 for the GALE development scenario.

FIGURE 4.8 DRILLING SCHEDULE, NUMBER OF WELLS DRILLED PER ANNUM, BY DEVELOPMENT SCENARIO



SOURCE: ACIL ALLEN CONSULTING

FIGURE 4.9 NUMBER OF OPERATING WELLS PER ANNUM, BY DEVELOPMENT SCENARIO



SOURCE: ACIL ALLEN CONSULTING

4.5.2 Supporting infrastructure

In addition to the number of wells, there is a range of supporting infrastructure required to enable gas to be extracted, processed, and sent to market. ACIL Allen has developed a simplified supporting infrastructure regime using a series of ratios, presented in Table 4.4. Supporting infrastructure requirements are a function of the number of wells built in a given year.

TABLE 4.4 SUPPORTING INFRASTRUCTURE REQUIREMENTS

Supporting Infrastructure	Assumption	Source
Pads	Every eight wells drilled requires one new pad. If nine wells are drilled, two pads are required, and a new pad is not required until the number of new wells drilled exceeds 16.	ACIL Allen estimate based on industry consultation
Roads	For every one pad, 1.7km of roads are required for connection purposes.	ACIL Allen estimate based on industry consultation
Gathering pipes	For every one pad, 1km of 5 inch piping is required for gathering purposes.	ACIL Allen estimate based on industry consultation

These values for supporting infrastructure are fed into ProjectCo's financial model, and are costed in line with assumptions presented in Section 5.1.

4.6 Development prospect matrix

The above development scenarios are hypothetical, based on what a development could look like should ProjectCo discover a commercial quality shale gas reserve in the Northern Territory. This is subject to significant uncertainty, because there has been such little exploration activity that it is not possible to determine the extent to which a development is likely to occur.

With this in mind, ACIL Allen has developed a qualitative matrix to represent the prospect of each development occurring (Figure 4.10). On the basis of the financial modelling undertaken on the each development scenario, ACIL Allen has assessed the probability of a shale gas industry developing in the Northern Territory in each case. This is based on the outcomes of the financial modelling, the uncertainty regarding the size of the Northern Territory's commercial reserves, and the challenges associated with producing gas at a price which the market will accept. As the development scales up, these challenges will become greater, leading to a reduced likelihood that any given scale of development can be realised.

ACIL Allen has also formed a view that the probability of a shale gas industry developing in the Northern Territory will improves the greater the potential area for exploration and appraisal. As discussed in Section 3.2, international experience suggests that the ability to deliver large scale commercial quantities of petroleum products from prospective shale gas resources is a function of the volume of exploration and activity which has occurred, and the area available for exploration and activity to occur. This is driven by institutional learning, the ability to find better quality reserves over time, and economies of scale and scope.

For example, under the GALE scenario, ACIL Allen has assessed, on current information, the likelihood of a shale gas industry that will begin to scale to 1000 terajoules per day (TJ/day) of gas production at an average price of $4.01 per gigajoule (GJ) within the next five years as low, assuming the moratorium is lifted in full across the Northern Territory. If there is only a partial lift in the moratorium, this becomes a very low probability, because there is less of an ability for a potential shale gas industry to find the most commercial shale gas deposits.

In the context of the probability matrix, ACIL Allen notes that it has made a critical assumption that the shale gas developments modelled in this report are a "dry gas play". That is, the hydrocarbons produced in a development do not include higher value liquid hydrocarbons such as ethane, propane, butane or crude oil. A "liquids rich" shale gas play results in a very small increase in operating costs (associated with increased processing to separate the higher value hydrocarbons from the lower value hydrocarbons), and a very large increase in potential production revenue. This improves the commercial viability of a shale gas development, to the point where a larger development may have a higher probability of occurring versus a dry gas play.

FIGURE 4.10 ACIL ALLEN POLICY SCENARIO PROBABILITY MATRIX

			POLICY SCENARIO PROBABILITY MATRIX		
INDUSTRY DEVELOPMENT SCENARIO	Production Profile	Production Cost Regime	PERMANENT MORATORIUM	PARTIAL LIFT	FULL LIFT
BASELINE	Nil Shale Production	N/A	CERTAIN	MODERATE	LOW
SHALE CALM	Exploration occurs Failure to commercialise	N/A	ZERO	VERY HIGH	VERY HIGH
SHALE BREEZE	**Scenario 1** Target production: 36PJ per annum	High cost	ZERO	MODERATE	HIGH
SHALE WIND	**Scenario 2** Target production: 150PJ per annum	Moderate cost	ZERO	LOW	MODERATE
SHALE GALE	**Scenario 3** Target production: 365PJ per annum	Low cost	ZERO	VERY LOW	LOW

SOURCE: ACIL ALLEN CONSULTING

4.7 PipelineCo development assumptions

To get ProjectCo's gas to market, it will need to be transmitted on a series of major gas transmission pipelines. As discussed in Section 0, there is limited capacity available on existing gas transmission pipelines. As a result, new pipelines must be developed.

PipelineCo is the builder, owner and operator of new major transmission pipeline infrastructure required to facilitate the development of ProjectCo's gas fields in each of the three scenarios. The development of PipelineCo is significantly simpler than ProjectCo, as PipelineCo simply builds pipelines of the requisite size to convey ProjectCo's gas to market over the life of the modelling period. PipelineCo is modelled as a typical pipeline owner-operator, with a relatively low required rate of return on its investments reflecting the relative safety of investment in pipeline infrastructure.

The key assumptions used to develop PipelineCo are presented below.

— PipelineCo builds all of its pipelines in the two years prior to the first flow of ProjectCo gas, to a specification that will allow it to carry the peak load of ProjectCo gas in the modelling period.

— PipelineCo has a 40 year investment horizon, and sets tariffs at a level that allow it to generate a six per cent pre-tax internal rate of return in a simple DCF model.

— PipelineCo's operating costs are set at 1.25 per cent of its total up front capital costs, and begin accruing from one year post the commencement of construction.

— Finally, part of PipelineCo's capital investment is stratified into initial investment in pipelines, which can carry a certain volume of uncompressed gas, and ongoing smaller capital investments required to build compression stations on the pipeline network as transmission requirements increase.

There are five distinct pipelines that are required to be built or duplicated over the three development scenarios, with the diameter of the pipe changing in each scenario depending on the volume of gas requiring transmission. The below matrix outlines the diameter of each pipe on PipelineCo's network in each scenario.

TABLE 4.5 PIPELINECO PIPELINE SPECIFICATIONS

Pipeline (length)	Breeze diameter	Wind diameter	Gale diameter
Tie into Amadeus pipeline (50km)	12 inch	19 inch	22 inch
Amadeus duplication (300km)	10 inch	18 inch	22 inch

Pipeline (length)	Breeze diameter	Wind diameter	Gale diameter
Northern Gas Pipeline (NGP) duplication (622km)	N/A	16 inch	21 inch
Carpentaria Gas Pipeline (CGP) duplication (841 km)	N/A	15 inch	21 inch
DLNG Feed Pipeline (new pipeline) (550km)	N/A	N/A	20 inch

Note: For simplicity, ACIL Allen assumed the processing facility built by ProjectCo is approximately 50 kilometres away from the Amadeus pipeline, and 550km away from the DLNG facility. Outside of this, ACIL Allen has not assumed a location for the development

SOURCE: ACIL ALLEN CONSULTING

ACIL Allen has not considered the mooted Moomba-Alice Springs gas pipeline in this analysis for two reasons. First, it is simpler to assume that existing pipeline routes are expanded or duplicated rather than developing an entirely new pipeline from scratch, as existing pipeline lengths, routes and cost estimates are available. Second, the Moomba-Alice Springs pipeline has been discussed for some time, and is yet to progress beyond the pre-feasibility study stage, albeit the Federal Government committed to fund a more detailed feasibility study earlier this year.[34] At face value, the Moomba-Alice Springs gas pipeline would represent a viable route to market for gas produced by a Northern Territory shale gas development.

[34] NT News. 2017. *Federal Government to investigate feasibility of north-south gas pipeline, 2 April 2017*. Accessed online at http://www.ntnews.com.au/

5 PROJECT DEVELOPMENT FINANCIAL MODEL

After shaping the development, using a series of modelling tasks, ACIL Allen has converted ProjectCo and PipelineCo's development plans in each scenario into three separate financial models. The financial models for ProjectCo are prepared as discounted cash flow ('DCF') model as if ProjectCo was a standalone corporate entity with a relatively simple financial structure. This requires a series of assumptions, which are outlined in Section 5.1. The outcome of the DCF modelling for ProjectCo is presented in Section 5.2. Recognising the role that assumptions can play in the results of DCF modelling, ACIL Allen has presented a series of sensitivity analysis on key inputs under each scenario. The results of this are presented in Section 5.3. Finally, the simple financial model for PipelineCo is outlined in Section 5.4.

5.1 ProjectCo financial inputs and assumptions

This section details the remaining key inputs and assumptions used to populate the cash flow model for each development scenario.

5.1.1 Overall inputs and assumptions

The inputs and assumptions used to populate the framework of the cash flow model are presented in the table below.

Input or Assumption	Value	Source
Reporting year	Financial year	ACIL Allen
Cash flow model start date	2018	ACIL Allen
Discount rate start date	2018	ACIL Allen
Discount rate	10 per cent	ACIL Allen

5.1.2 Financial inputs and assumptions

The inputs and assumptions used to estimate ProjectCo's non capital, operating and taxation expenses are presented in the table below.

Input or Assumption	Value	Source
Share of capital funded by debt	66.7 per cent	ACIL Allen estimate based on industry standards
Share of capital funded by equity	33.3 per cent	ACIL Allen estimate based on industry standards

Input or Assumption	Value	Source
Term length of debt	20 years	ACIL Allen estimate based on industry standards
Amortisation of debt	Yes	ACIL Allen based on industry standards
Native Title payments, exploration	3 per cent of proponent exploration cost	Stakeholder consultation
Native Title payments, operations	10 per cent of royalty payments	Stakeholder consultation
Pastoralist payments, operations	$250,000 per pad	Stakeholder consultation
Exploration permit	$4,927 per permit	NT Government[35]
Exploration permit renewal	$1,642 per permit	NT Government*
Production permit	$18,000 per block	NT Government*
Production permit renewal	$1,642 per permit	NT Government*
Environmental bond	Estimated cost of abandonment	Stakeholder consultation

5.1.3 Capital inputs and assumptions

The inputs and assumptions used to estimate ProjectCo's capital expenditure are presented in the table below.

Input or Assumption	Value	Source
Cost, drilling construction *(well-related civil work, surface hole preparation, drilling, fracture stimulation, completion, connection. This includes implicit costs of water extraction and sand acquisition for proppant)* *(also include implicit capital cost of a processing facility as a cost per 8.4-10.6-12.7PJ of gas. ACIL Allen could not determine the cost of a standalone processing facility)*	$18 million per well	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation.
Costs, pad construction	$3.7 million per pad	ACIL Allen estimate based on industry consultation
Number of wells drilled per pad	8 wells per pad	ACIL Allen estimate based on industry expectations
Costs, gathering pipes construction	$350,000 per km	ACIL Allen estimate based on industry consultation assuming a 5 inch diameter pipe at $70,000 per inch kilometre
Costs, road construction	$450,000 per 1.7km	Cummings Economics, *Submission to Infrastructure Australia*, 2012
Costs, camp construction	$8 million per camp	ACIL Allen, based on: – Estimated cost per bed of INPEX Icthys camp, when applied to 150 bed camp structure = $11.1m.[36] – Stakeholder consultation

[35] https://nt.gov.au/industry/mining-and-petroleum/petroleum-titles/petroleum-titles-fees-and-rents
[36] INPEX. 2013. *ICHTHYS LNG PROJECT'S MANIGURR-MA VILLAGE OPEN FOR BUSINESS*. Accessed online at http://www.inpex.com/

Input or Assumption	Value	Source
Useful life, drilling	20 years	ACIL Allen based on standard ATO practice
Useful life, pad	20 years	ACIL Allen based on standard ATO practice
Useful life, gathering pipes	20 years	ACIL Allen based on standard ATO practice
Useful life, road	20 years	ACIL Allen based on standard ATO practice
Useful life, camp	20 years	ACIL Allen based on standard ATO practice
Abandonment, well	$250,000 per well	ACIL Allen based on industry consultation
Abandonment, pad	$100,000 per pad	ACIL Allen based on industry consultation

5.1.4 Operating inputs and assumptions

The inputs and assumptions used to estimate the operating cost of ProjectCo are presented in the table below.

Input or Assumption	Value	Source
All-in costs *(downhole maintenance and monitoring, extraction processing, labour, overheads, compliance, insurance)*	$1.50 per GJ	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; and – industry consultation.
Gathering and compression costs *(operations and maintenance for gathering pipelines, processing for sale)*	$0.75 per GJ	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; and – industry consultation.
Avoided cost of fuel *(included in 'all-in' costs and gathering and compression costs which reduces operating cost per GJ. Cost saving is mostly associated with diesel fuel hauling and storage costs)*	$0.90 per GJ	Industry consultation
Camp operating cost	$10 million per camp per annum	Industry consultation

5.1.5 Learnings inputs and assumptions

The inputs and assumptions used to estimate the learnings the ProjectCo will achieve over its economic life are presented in the table below.

Input or Assumption	Value	Source
Drilling construction costs	15 per cent, cap at 40 per cent per annum	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation.
Pad construction costs	15 per cent, cap at 40 per cent per annum	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation.
All-in operating costs	7.5 per cent, cap at 20 per cent per annum	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation.
Gathering and compression operating costs	7.5 per cent, cap at 20 per cent per annum	ACIL Allen estimate based on: – US Department of Energy, *Trends in US Oil and Natural Gas Upstream Costs*, March 2016; – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation.

5.1.6 Labour inputs and assumptions

The inputs and assumptions used to estimate the labour component of ProjectCo are presented in the table below.

Input or Assumption	Value	Source
Average construction salary	$150,000 per FTE	ACIL Allen
Average operations salary	$150,000 per FTE	ACIL Allen
Field construction	35 FTEs per pad	Industry consultation
Camp construction	15 FTEs per camp	Industry consultation
Field operations	8 FTEs per pad	Industry consultation
Field abandonment	10 FTEs per pad	Industry consultation
Camp operations	20 FTEs per camp	Industry consultation

5.1.7 Pipeline tariffs

ACIL Allen anticipates ProjectCo will be able to utilise some latent capacity on existing gas transmission pipelines. The assumed tariffs for these are below. ACIL Allen has taken a conservative assumption and bought capacity at the quoted spot rate by pipeline owners, noting that realised tariffs are likely to be lower. Tariffs for new pipelines developed by PipelineCo are presented in Section 0.

Input or Assumption	Value	Source
Amadeus Gas Pipeline	$0.58 per GJ	APA Group
Northern Gas Pipeline (NGP)	$1.45 per GJ	Jemena Group
Carpentaria Gas Pipeline (CGP)	$1.56 per GJ	APA Group

5.1.8 Water inputs and assumptions

The inputs and assumptions used to estimate ProjectCo's total water requirements are presented in the table below.

Input or Assumption	Value	Source
Water requirements	41ML per frack	ACIL Allen estimate based on: – ACOLA, *Engineering Energy: Unconventional Gas Production, A study of Shale Gas in Australia, Final Report*, June 2013; and – industry consultation. As a conservative estimate, ACIL Allen has doubled its expected water use projection.
Water recycle rate	0 per cent recycled	ACIL Allen estimate
Number of fracking stages	20 fracks and 1 hydraulic fracture stimulation program per well	ACIL Allen estimate based on industry consultation
Water charges	$0/ML	NT Government, there is currently no policy to charge users of groundwater for the use of groundwater resources. The cost of extracting ground water is implicit in ACIL Allen's well cost assumption

5.1.9 Macroeconomic inputs and assumptions

The macroeconomic inputs and assumptions that impact on ProjectCo's net cash flows are presented in the table below.

Input or Assumption	Value	Source
Long-term bond rate	3.5 per cent	ACIL Allen
Interest rate	6 per cent	ACIL Allen
Inflation	Real terms	ACIL Allen

5.1.10 Taxation inputs and assumptions

The taxation inputs and assumptions used in this cash flow assessment of ProjectCo are presented in the table below.

Input or Assumption	Value	Source
Payroll tax rate, Northern Territory	5.5 per cent	NT Department of Treasury and Finance http://www.treasury.nt.gov.au/TaxesRoyaltiesAndGrants/PayrollTax/Pages/Payroll-Tax-Rates-and-Thresholds.aspx
Payroll tax threshold, Northern Territory	$1.5 million	NT Department of Treasury and Finance http://www.treasury.nt.gov.au/TaxesRoyaltiesAndGrants/PayrollTax/Pages/Payroll-Tax-Rates-and-Thresholds.aspx
Company tax rate	30 per cent	ATO
Quarantine losses	Yes	ACIL Allen based on standard ATO practice
PRRT rate	40 per cent	ATO
PRRT general expenditure growth rate	4 per cent	ACIL Allen
Oil and gas royalty rate, Northern Territory	10 per cent of well head value	NT Department of Treasury and Finance

5.2 ProjectCo cash flow modelling results

Based on the set of inputs and assumptions detailed in the previous sections, the estimated net cash flows of ProjectCo for each development stage is presented below.

ACIL Allen estimated the net cash flows of each development scenario using a bottom-up approach. This involved estimating costs for capital, operations, other operating costs and direct taxation payments made by ProjectCo and the resulting margin under each development scenario (refer to Table 5.1 and Figure 5.1 overleaf).

TABLE 5.1 AVERAGE COST BETWEEN 2022 AND 2043 OF EACH PROJECTCO DEVELOPMENT SCENARIO, FINANCIAL YEAR, REAL TERMS, A$ PER GJ

Cost	BREEZE	WIND	GALE
CAPEX	$2.20/GJ	$1.74/GJ	$1.45/GJ
Interest	$1.20/GJ	$0.86/GJ	$0.55/GJ
OPEX	$1.77/GJ	$1.59/GJ	$1.46/GJ
Taxation	$0.75/GJ	$0.71/GJ	$0.45/GJ
Other costs	$0.16/GJ	$0.13/GJ	$0.09/GJ
Total costs (ex-field)	**$6.07/GJ**	**$5.03/GJ**	**$4.01/GJ**
Market price (ex-transport tariff)	**$6.84/GJ**	**$5.11/GJ**	**$3.75/GJ**
Margin	**$0.77/GJ**	**$0.09/GJ**	**-$0.26/GJ**

Note: Market prices presented are ex-transport tariff.

SOURCE: ACIL ALLEN CONSULTING

The largest components of ProjectCo's cost structure are the costs associated with capital expenditure. For example, under the BREEZE development scenario, the cost of capital averages $2.20 per GJ, with the resulting average interest costs associated with financing capital expenditure of $1.20 per GJ. The costs of capital and interest reduce in the subsequent WIND and GALE development scenarios due to improved learnings and the economies of scale achieved under a larger production scenario.

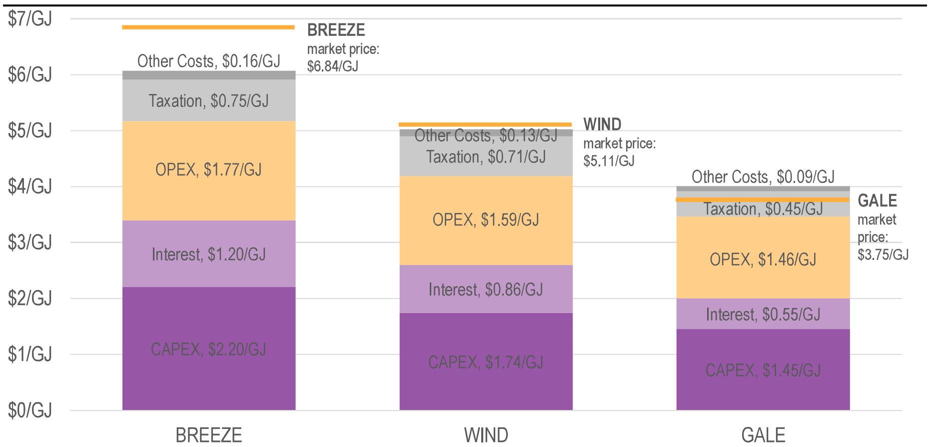
Ex-field costs associated with ProjectCo's production phase are the next biggest share of its total cost structure. For example, under the BREEZE development stage, operating costs average $1.78 per GJ, reducing to an average of $0.55 per GJ under the GALE development scenario as a result of the improved learnings and economies of scale benefits.

Taxation payments made by ProjectCo are dependent on the economics of each development stage. Based on the margins generated under each development scenario, the tax payments are expected to range from $0.74 per GJ under the BREEZE development scenario to $0.45 per GJ under the GALE development scenario.

Based on the 20 year study period, this does not allow enough time for ProjectCo to return a substantial dividend on its capital expenditure. However, beyond the study period and over the economic life of the Project, the dividends increase and the Project's taxation payment increase.

Ex-field all other costs include costs for abandonment, payments to native title owners and pastoralists, and licensing. On average, other costs make up a very small proportion of ProjectCo's cost structure under each development scenario.

FIGURE 5.1 AVERAGE COST BETWEEN 2022 AND 2043 OF EACH PROJECTCO DEVELOPMENT STAGE, FINANCIAL YEAR, REAL TERMS, A$ PER GJ



Note: Market prices presented are ex-transport tariff.

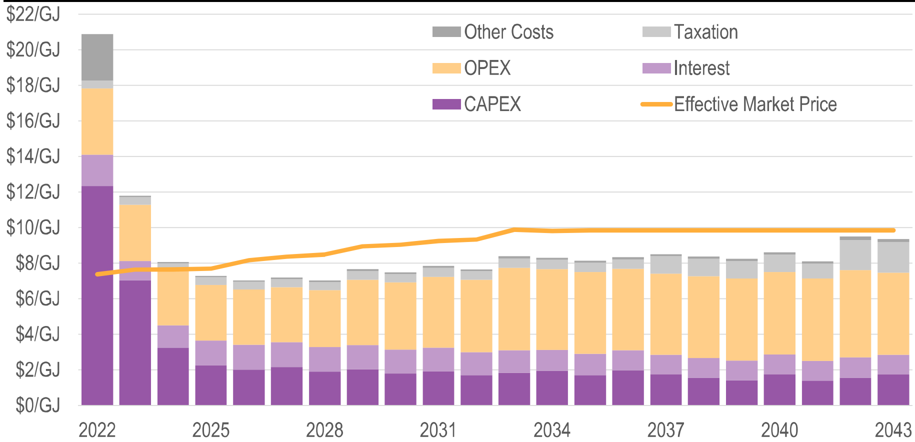
SOURCE: ACIL ALLEN CONSULTING

The figures presented in Figure 5.1 represent averages over the period between 2022 and 2043, and therefore do not necessarily represent the operating position of each development scenario at any one time. It is for this reason in Figure 5.1 that the GALE development scenario shows an operating loss over the study period.

Figure 5.3 below presents the operating position of the BREEZE development scenario each year over the study period. At the start of the development, the capital requirements of ProjectCo are significant, but as ProjectCo reaches a steady state of production, the level capital required to maintain steady state production significantly falls. This results in ProjectCo operating at a loss in the early years of the development (when capital costs are high), with a positive margin being generated once steady state production is reached (due to lower capital requirements).

This is consistent across all development scenarios.

FIGURE 5.2 AVERAGE COST BETWEEN 2022 AND 2043 OF BREEZE DEVELOPMENT SCENARIO, FINANCIAL YEAR, REAL TERMS, A$ PER GJ



Note: Market prices presented are ex-transport tariff.

SOURCE: ACIL ALLEN CONSULTING

5.2.1 CALM

The CALM scenario is the scenario that sees ProjectCo undertake a three year program of exploration and appraisal, but fail to progress beyond this due to an inability to find a commercial quality shale gas reserve. The CALM scenario is also the basis for the first four years (in Year 0, nothing occurs as the moratorium is lifted) of the production scenarios discussed below, but instead of an assumption that no commercial quality shale gas is discovered, the assumption is a requisite scale commercial shale gas reserve is discovered.

ACIL Allen has assumed in the first year of the exploration and appraisal program, ProjectCo builds eight production wells, and the associated infrastructure to support the program. This is valued at $315.9 million. In Year two of the exploration and appraisal program, testing, commercial analysis and other services are purchased to allow ProjectCo to understand the shale it is testing. This is valued at $166.9 million. In Year three, residual exploration expenditure occurs, as ProjectCo decommissions its exploration and appraisal program due to a failure to find a commercial shale gas reserve. This is valued at $4.2 million.

In the CALM scenario, this is the extent of ProjectCo's financial model. The total cost of the exploration and appraisal program is $500 million. It is assumed ProjectCo does not earn any revenue from its operations, meaning the discounted net cash flows of ProjectCo are estimated to total -$440 million over the study period (refer to Figure 5.3 overleaf).

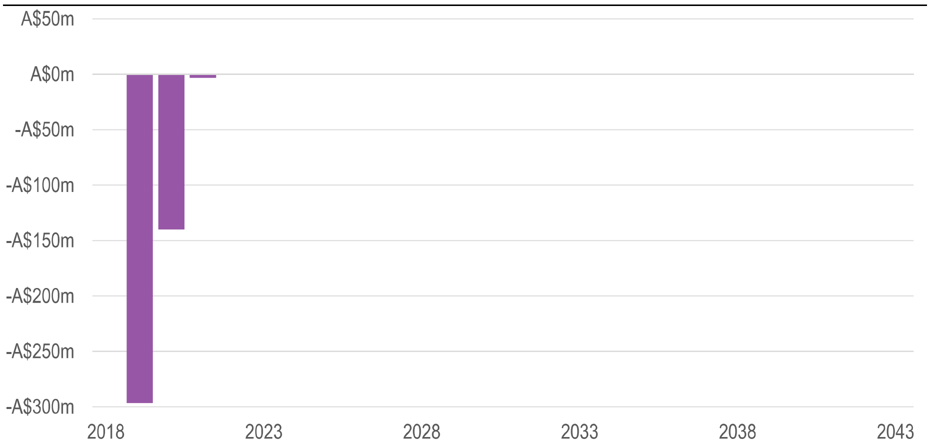
In the BREEZE, WIND and GALE scenarios, the expenditure associated with CALM is the starting point of the cash flow model, and is recovered progressively over the modelling period as ProjectCo moves into production and begins to generate positive cash flows.

5.2.2 BREEZE

Based on the production profile and the associated drilling schedule developed by ACIL Allen, it is estimated the capital requirements of ProjectCo under the BREEZE development scenario over the study period would total $2 billion, at an average of $76 million per annum.

The cost of drilling and associated pad costs are estimated to total $1.5 billion over the study period, making them the largest component of total capital expenditure. The remainder of the capital expenditure consists of supporting infrastructure, such as gathering pipes, roads and camp construction costs.

FIGURE 5.3 CALM NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



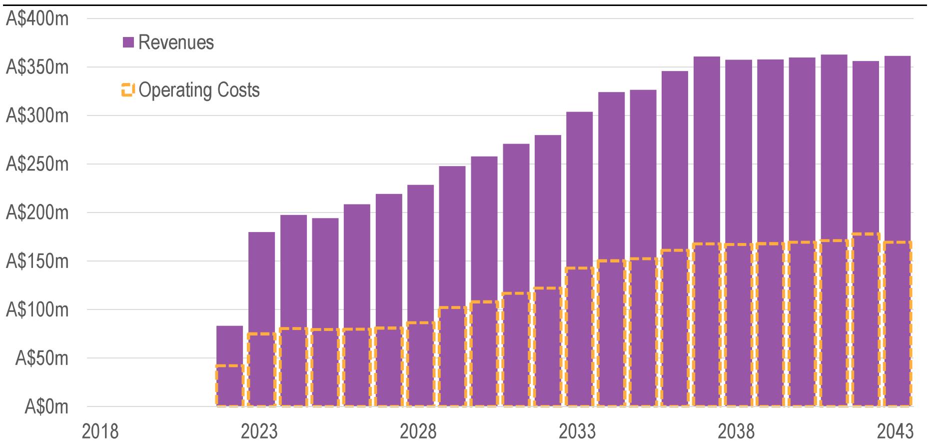
SOURCE: ACIL ALLEN CONSULTING

The operating costs of ProjectCo reach a steady state of around $170 million per annum in 2037 (refer to Figure 5.4 overleaf). Over the study period, operating costs total $2.8 billion at an average of $107 million per annum. Transport costs total $1.6 billion over the study period, and are the largest component of ProjectCo's total operating cost structure.

The capital expenditure and operating costs generate a steady state of revenue of around $350 million per annum by 2037. Over the study period, the revenues are estimated to total $6.2 billion at an average of $238 million per annum.

Once ProjectCo becomes liable for PRRT payments, PRRT payments overtake company taxation payments as the major profits based tax.

FIGURE 5.4 BREEZE OPERATING POSITION, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

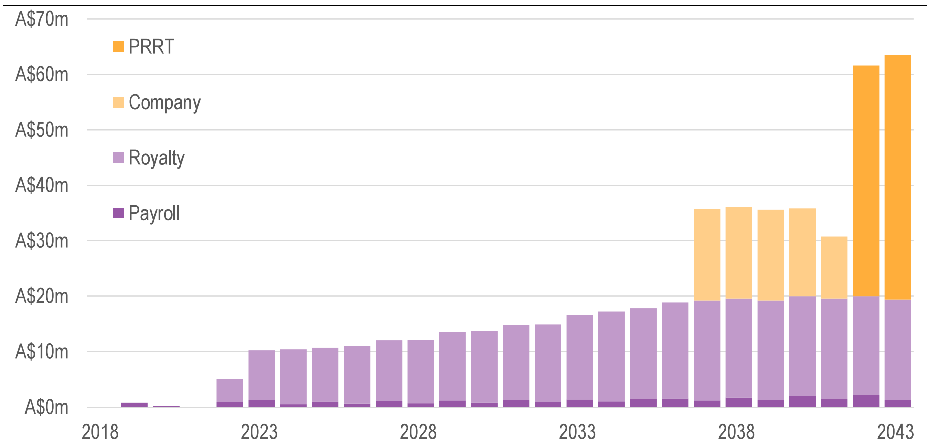
Figure 5.4 presents the major heads of taxation ProjectCo is liable to pay over the study period. Under the BREEZE development scenario, it is estimated that ProjectCo becomes liable for profit based taxation payments from 2037.

Company taxation payments to the Commonwealth are estimated to be first payable in 2037 and total $76.5 million at an average of $2.9 million per annum over the study period. As the taxable income of ProjectCo increases over time and the Project's PRRT credits are fully consumed, ProjectCo becomes liable for PRRT payments in 2042, and total $85.8 million over the study period.

Over the study period, the Northern Territory Government will be the primary beneficiary of taxation payments made by ProjectCo. This will largely occur through the form of royalty payments, which are estimated to total $309 million over the study period or $11.9 million per annum.

The Northern Territory Government will also receive payroll taxation payments from ProjectCo, which are estimated to total $27.2 million over the study period, or on average $1.1 million per annum.

FIGURE 5.5 BREEZE DIRECT TAXATION PAYMENTS, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

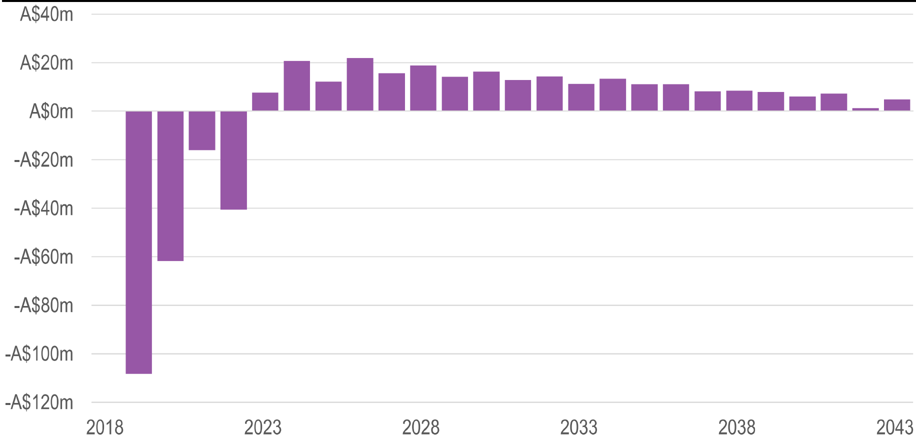
The level of taxation receipts collected by both Commonwealth and Territory governments are dependent on the magnitude of net cash flows generated by ProjectCo, which are of course highly sensitive to the inputs and assumptions that underpin the cash flow model.

Over the study period, the discounted net cash flows of ProjectCo are estimated to total $19.4 million, at an average of $0.8 million per annum. Under the set of inputs and assumptions presented above, interest payments on the debt required to fund ProjectCo's capital expenditure, and the cost of PRRT payments first being realised in 2042, are major determinants of the Project's overall economic viability from a discounted cash flow prospective.

This is because the cash flow model has been developed to fund capital expenditure via debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo in the early years reduce the level of debt the Project is required to take on, which reduces interest payments and further increases the Project's net cash flows.

However, as taxation expenses increase when ProjectCo's taxable income increases towards the end of the study period, positive net cash flows are reduced, resulting in ProjectCo's financing more of its capital expenditure by debt, which increases interest payments and further reduces net cash flows.

FIGURE 5.6 BREEZE NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



Note: Discount rate of 10 per cent per annum.

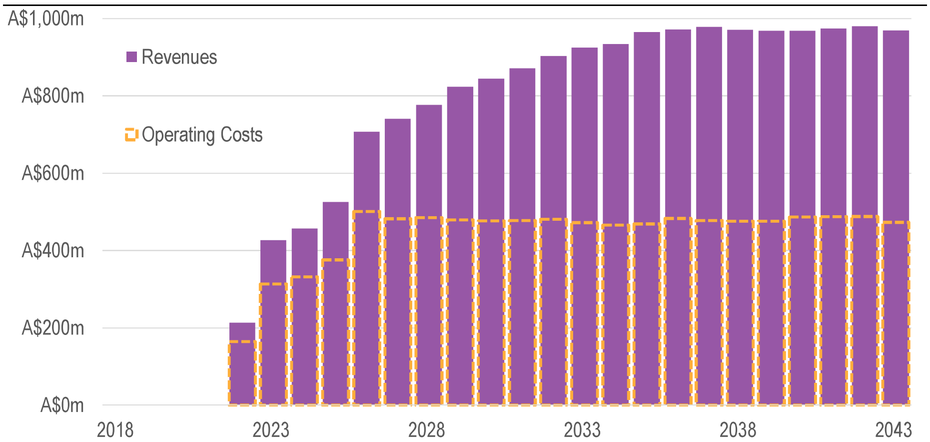
SOURCE: ACIL ALLEN CONSULTING

5.2.3 WIND

Based on the production profile and the associated drilling schedule developed by ACIL Allen, it is estimated the capital requirements of ProjectCo under the WIND development scenario over the study period would total $4.3 billion, at an average of $167 million per annum. The cost of drilling and associated pad costs are estimated to total $3.5 billion over the study period, making them the largest component of total capital expenditure. The remainder of the capital expenditure consists of supporting infrastructure, such as gathering pipes, roads and camp construction costs.

The operating costs of ProjectCo reach a steady state of around $480 million per annum in 2027 (refer to Figure 5.7). Over the study period, operating costs total $9.8 billion at an average of $379 million per annum. Transport costs total $6.3 billion over the study period, and are the largest component of ProjectCo's total operating cost structure.

FIGURE 5.7 WIND OPERATING POSITION, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$M



SOURCE: ACIL ALLEN CONSULTING

The capital expenditure and operating costs generate a steady state of revenue of around $970 million per annum by 2035. Over the study period, the revenues are estimated to total $17.9 billion at an average of $688 million per annum.

Figure 5.8 presents the major heads of taxation ProjectCo is liable to pay over the study period. Under the WIND development scenario, it is estimated that ProjectCo becomes liable for profit based taxation payments from 2037.

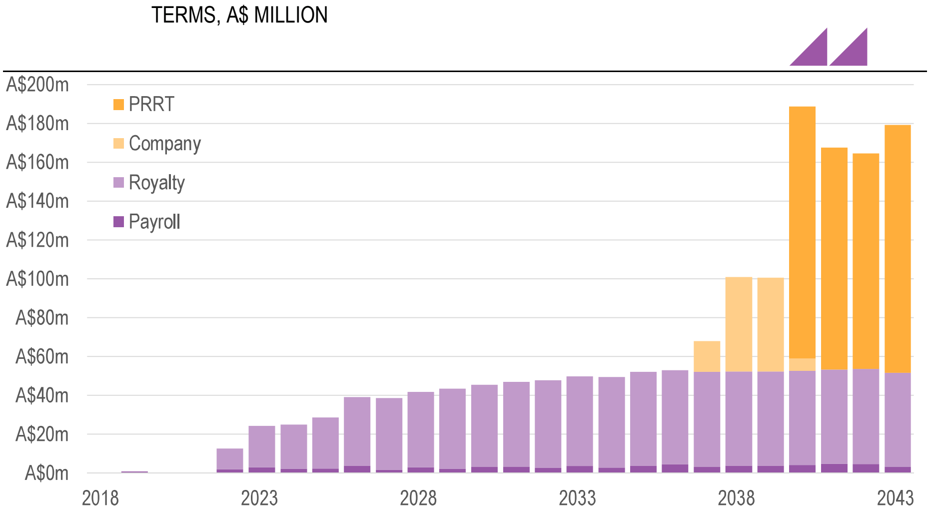
Company taxation payments to the Commonwealth are estimated to be first payable in 2037 and total $119 million at an average of $4.6 million per annum over the study period. As the taxable income of ProjectCo increases over time and the Project's PRRT credits are fully consumed, ProjectCo becomes liable for PRRT payments in 2040, and total $483 million over the study period.

Once ProjectCo becomes liable for PRRT payments, PRRT payments overtake company taxation payments as the major profits based tax.

Over the study period, the Northern Territory Government will be the primary beneficiary of taxation payments made by ProjectCo. This will largely occur through the form of royalty payments, which are estimated to total $875 million over the study period or $34.4 million per annum.

The Northern Territory Government will also receive payroll taxation payments from ProjectCo, which are estimated to total $71.1 million over the study period, or on average $2.7 million per annum.

FIGURE 5.8 WIND DIRECT TAXATION PAYMENTS, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$ MILLION



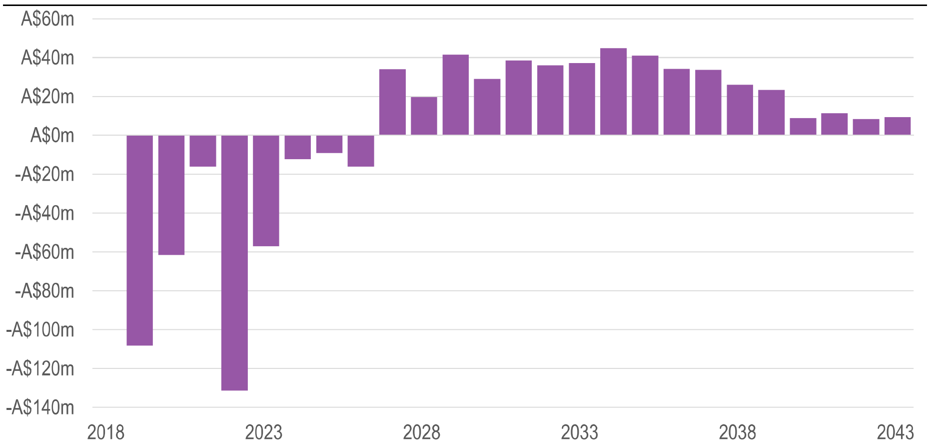
SOURCE: ACIL ALLEN CONSULTING

The level of taxation receipts collected by both Commonwealth and Territory governments are dependent on the magnitude of net cash flows generated by ProjectCo, which are of course highly sensitive to the inputs and assumptions that underpin the cash flow model.

Over the study period, the discounted net cash flows of ProjectCo are estimated to total $65.9 million, at an average of $2.5 million per annum. Under the set of inputs and assumptions presented above, interest payments on the debt required to fund ProjectCo's capital expenditure, and the cost of PRRT payments first being realised in 2040, are major determinants of the Project's overall economic viability from a discounted cash flow prospective.

This is because the cash flow model has been developed to fund capital expenditure via debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo in the early years reduce the level of debt the Project is required to take on, which reduces interest payments and further increases the Project's net cash flows.

FIGURE 5.9 WIND NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



Note: Discount rate of 10 per cent per annum.
SOURCE: ACIL ALLEN CONSULTING

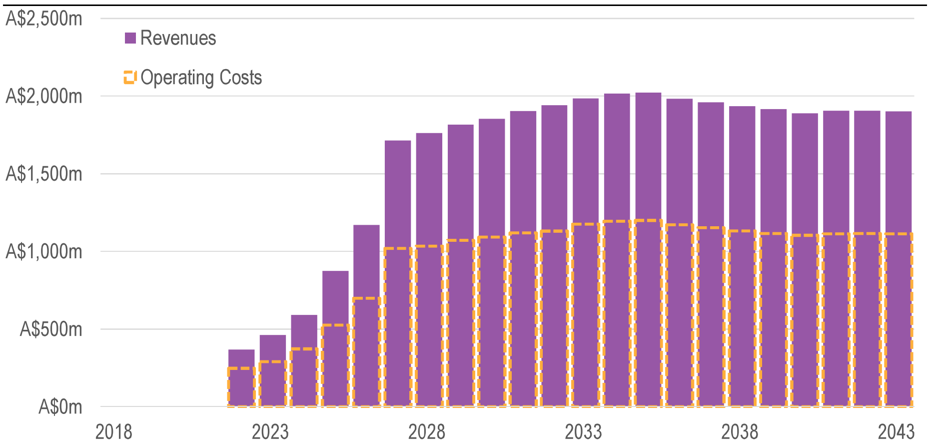
However, as taxation expenses increase when ProjectCo's taxable income increases towards the end of the study period, positive net cash flows are reduced, resulting in ProjectCo's financing more of its capital expenditure by debt, which increases interest payments and further reduces net cash flows.

5.2.4 GALE

Based on the production profile and the associated drilling schedule developed by ACIL Allen, it is estimated the capital requirements of ProjectCo under the GALE development scenario over the study period would total $9.8 billion, at an average of $378 million per annum. The cost of drilling and associated pad costs are estimated to total $8.5 billion over the study period, making them the largest component of total capital expenditure. The remainder of the capital expenditure consists of supporting infrastructure, such as gathering pipes, roads and camp construction costs.

The operating costs of ProjectCo reach a steady state of around $1.1 billion per annum in 2027 (refer to Figure 5.10).

FIGURE 5.10 GALE OPERATING POSITION, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$M



SOURCE: ACIL ALLEN CONSULTING

Over the study period, operating costs total $21 billion at an average of $816 million per annum. Transport costs total $11.8 billion over the study period, and are the largest component of ProjectCo's total operating cost structure. The capital expenditure and operating costs generate a steady state of revenue of around $1.9 billion per annum by 2030. Over the study period, the revenues are estimated to total $35.9 billion at an average of $1.4 billion per annum.

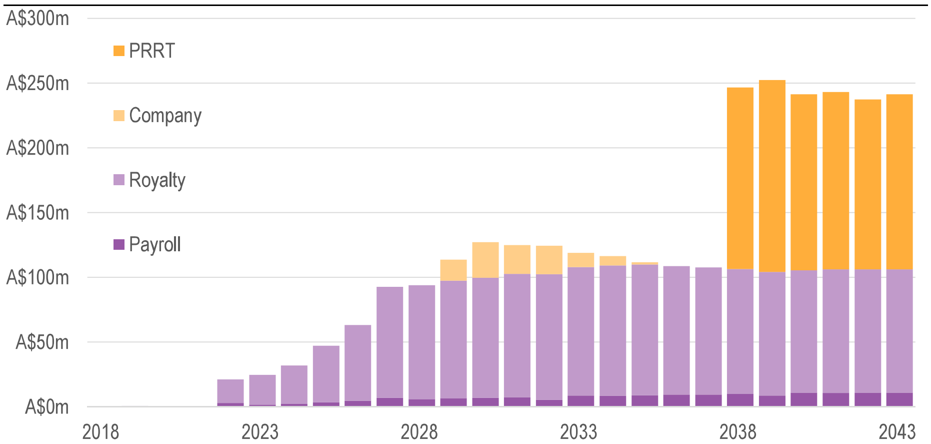
Figure 5.11 presents the major heads of taxation ProjectCo is liable to pay over the study period. Under the GALE development scenario, it is estimated that ProjectCo becomes liable for profit based taxation payments from 2029.

Company taxation payments to the Commonwealth are estimated to be first payable in 2029 and total $108 million at an average of $4.2 million per annum over the study period. As interest payments increase over time, the taxable income of ProjectCo decreases, as results in no company taxation payments in 2036 and 2037. However, as ProjectCo's taxable income for PRRT calculations increases, and over time and the Project's PRRT credits are fully consumed, ProjectCo will become liable for PRRT payments in 2038, totalling $828 million over the study period.

Over the study period, the Northern Territory Government will be the primary beneficiary of taxation payments made by ProjectCo. This will largely occur through the form of royalty payments, which are estimated to average $1.8 billion over the study period or $69 million per annum.

The Northern Territory Government will also receive payroll taxation payments from ProjectCo, which are estimated to total $163 million over the study period, or on average $6.3 million per annum.

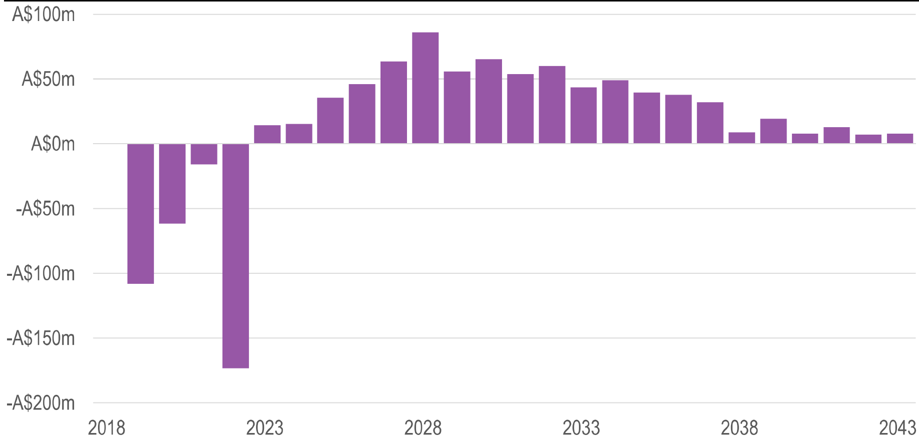
FIGURE 5.11 GALE DIRECT TAXATION PAYMENTS, FINANCIAL YEAR, PRESENT VALUE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

The level of taxation receipts collected by both Commonwealth and Territory governments are dependent on the magnitude of net cash flows generated by ProjectCo, which are of course highly sensitive to the inputs and assumptions that underpin the cash flow model.

FIGURE 5.12 GALE NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



Note: Discount rate of 10 per cent per annum.
SOURCE: ACIL ALLEN CONSULTING

Over the study period, the discounted net cash flows of ProjectCo are estimated to total $403 million, at an average of $15.5 million per annum. Under the set of inputs and assumptions presented above, interest payments on the debt required to fund ProjectCo's capital expenditure, and the cost of PRRT payments first being realised in 2038, are major determinants of the Project's overall economic viability from a discounted cash flow prospective.

This is because the cash flow model has been developed to fund capital expenditure via debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo in the early years reduce the level of debt the Project is required to take on, which reduces interest payments and further increases the Project's net cash flows. However, as taxation expenses increase when ProjectCo's taxable income increases towards the end of the study period, positive net cash flows are reduced, resulting in ProjectCo financing more of its capital expenditure by debt, which increases interest payments and further reduces net cash flows.

5.3 Sensitivity analysis – ProjectCo cash flow modelling results

The overall economics of ProjectCo are highly sensitive to a number of key assumptions presented in the above sections. In order to highlight the degree of sensitivity of ProjectCo to the inputs and assumptions used in this study, ACIL Allen has undertaken sensitivity analysis for four key inputs and assumptions, and have presented the results as the discounted net cash flows of each development scenario.

The key variables ACIL Allen has presented sensitivity analysis on are:

— EUR: +/- 3.8 PJ from the base case;
— interest rate: +/- 1 percentage point from the base case;
— market price: +/- 20 per cent from the base case; and
— learnings: +/- 20 per cent from the base case.

5.3.1 BREEZE

A summary of the change in total and average annual discounted net cash flows of ProjectCo are presented in Table 5.2 and Figure 5.13.

TABLE 5.2 SUMMARY OF SENSITIVITY ANALYSIS, BREEZE NET CASH FLOWS, DISCOUNTED, REAL TERMS, A$ MILLION

Sensitivity	Total	Average
	EUR	
Base case, 8.4 PJ	$19.4 million	$0.8 million
High case, 12.7 PJ	$135 million	$5.2 million
Low case, 4.2 PJ	-$83.6 million	-$3.2 million
	Interest Rate	
Base case, 6 per cent	$19.4 million	$0.8 million
High case, 7 per cent	-$11 million	-$0.4 million
Low case, 5 per cent	$45.4 million	$1.8 million
	Market Price	
Base case	$19.4 million	$0.8 million
High case, +20 per cent	$154 million	$5.9 million
Low case, -20 per cent	-$154 million	-$5.9 million
	Learnings	
Base case	$19.4 million	$0.8 million
High case, +20 per cent	$30.3 million	$1.2 million
Low case, -20 per cent	-$8.6 million	-$0.3 million

SOURCE: ACIL ALLEN CONSULTING

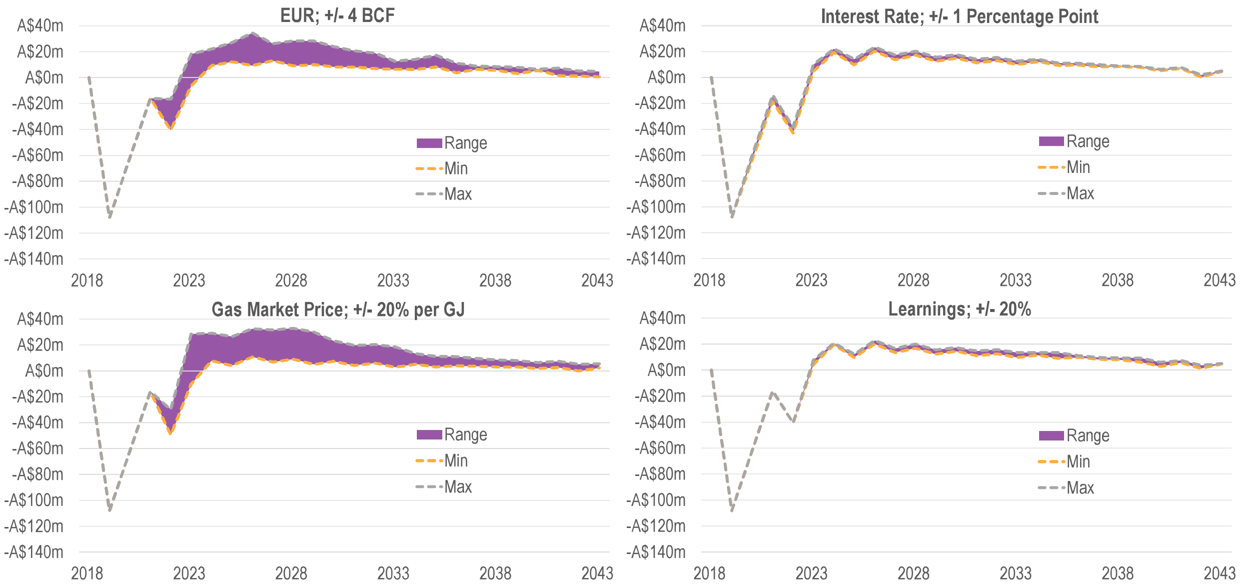
Table 5.2 and Figure 5.13 demonstrate that a change to the market price has the greatest variability on the discounted net cash flows of ProjectCo, while a change in the EUR also has a significant impact on the variability of ProjectCo's cash flows.

When the market price is increased by 20 per cent, the discounted net cash flows of ProjectCo increase from $19.4 million to $154 million. Similarly, when the EUR is increased to 12.7 PJ, the discounted net cash flows increase to $135 million.

The variability of the cash flows to changes in the interest rate or learnings are less pronounced, but still significant. For example, when the interest rate increases by one percentage point, total discounted net cash flows decrease from $19.4 million to -$11 million, and if the rate of learnings are decreased by 20 per cent, the discounted net cash flows fall to -$8.6 million.

Similar to the base case discount net cash flow results presented in Section 5.2, this variance is due to how the cash flow model has been developed, where capital expenditure is financed by debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo reduce the level of debt the Project is required to take on to finance its capital requirements, which reduces interest payments and further increases the Project's net cash flows. However, as net cash flows are reduced, the Project is required to finance more of its capital expenditure by debt, which increases interest payments and further reduces the Project's net cash flows.

FIGURE 5.13 SENSITIVITY ANALYSIS, BREEZE NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

5.3.2 WIND

A summary of the change in total and average annual discounted net cash flows of ProjectCo are presented in Table 5.3 and Figure 5.14.

TABLE 5.3 SUMMARY OF SENSITIVITY ANALYSIS, WIND NET CASH FLOWS, DISCOUNTED, REAL TERMS, A$ MILLION

Sensitivity	Total	Average
	EUR	
Base case, 10.6 PJ	$65.9 million	$2.5 million
High case, 14.8 PJ	$352 million	$13.5 million
Low case, 6.3 PJ	-$82.4 million	-$3.2 million
	Interest Rate	
Base case, 6 per cent	$65.9 million	$2.5 million
High case, 7 per cent	$2.1 million	-$0.1 million
Low case, 5 per cent	$129 million	$5 million
	Market Price	
Base case	$65.9 million	$2.5 million
High case, +20 per cent	$484 million	$18.6 million
Low case, -20 per cent	-$492 million	-$18.9 million
	Learnings	
Base case	$65.9 million	$2.5 million
High case, +20 per cent	$117 million	$4.5 million
Low case, -20 per cent	-$31.5 million	-$1.2 million

Sensitivity	Total	Average

SOURCE: ACIL ALLEN CONSULTING

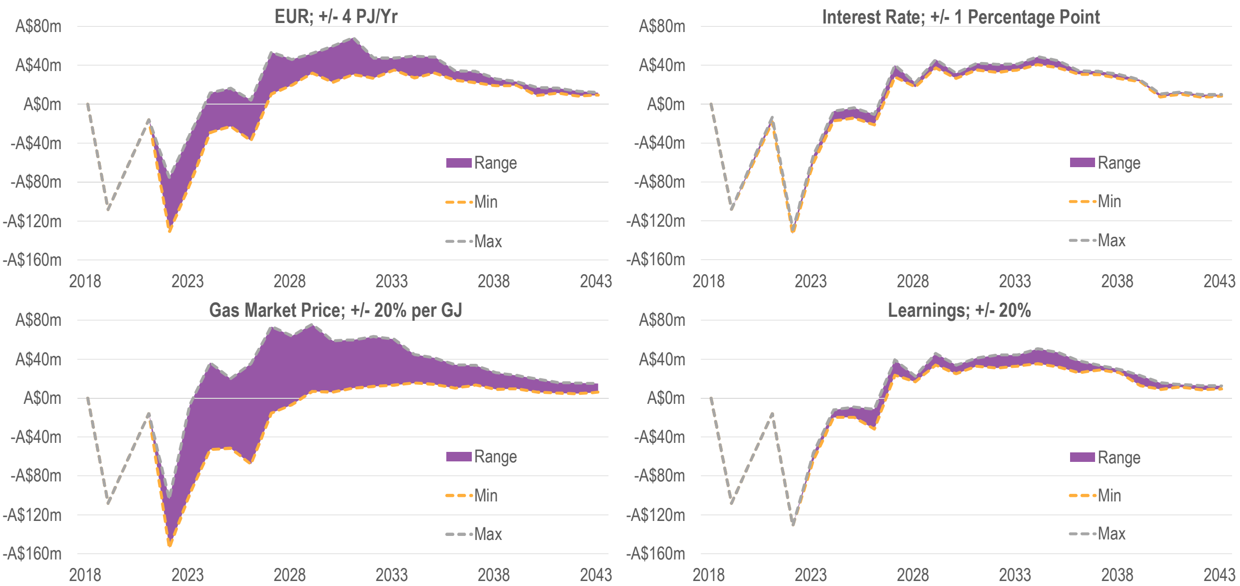
Table 5.3 and Figure 5.14 demonstrate that a change to the market price has the greatest variability on the discounted net cash flows of ProjectCo, while a change in the PJ also has a significant impact on the variability of ProjectCo's cash flows.

When the market price is increased by 20 per cent, the discounted net cash flows of ProjectCo increase from $65.9 million to $484 million. Similarly, when the BFC is increased to 14.8 PJ, the discounted net cash flows increase to $352 million.

The variability of the cash flows to changes in the interest rate or learnings are less pronounced, but still significant. For example, when the interest rate increases by one percentage point, total discounted net cash flows decrease from $65.9 million to $2.1 million, and if the rate of learnings are decreased by 20 per cent, the discounted net cash flows fall to -$31.5 million.

Similar to the base case discount net cash flow results presented in Section 5.2, this variance is due to how the cash flow model has been developed, where capital expenditure is financed by debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo reduce the level of debt the Project is required to take on to finance its capital requirements, which reduces interest payments and further increases the Project's net cash flows. However, as net cash flows are reduced, the Project is required to finance more of its capital expenditure by debt, which increases interest payments and further reduces the Project's net cash flows.

FIGURE 5.14 SENSITIVITY ANALYSIS, WIND NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

5.3.3 GALE

A summary of the change in total and average annual discounted net cash flows of ProjectCo are presented in Table 5.4 and Figure 5.15.

TABLE 5.4 SUMMARY OF SENSITIVITY ANALYSIS, GALE NET CASH FLOWS, DISCOUNTED, REAL TERMS, A$ MILLION

Sensitivity	Total	Average
	EUR	
Base case, 12.7 PJ	$403 million	$15.5 million
High case, 16.9 PJ	$777 million	$29.9 million
Low case, 8.4 PJ	$420 million	$16.2 million
	Interest Rate	
Base case, 6 per cent	$403 million	$15.5 million
High case, 7 per cent	$322 million	$12.4 million
Low case, 5 per cent	$483 million	$18.5 million
	Market Price	
Base case	$403 million	$15.5 million
High case, +20 per cent	$1,041 million	$40 million
Low case, -20 per cent	-$593 million	-$22.8 million
	Learnings	
Base case	$403 million	$15.5 million
High case, +20 per cent	$474 million	$18.3 million
Low case, -20 per cent	$224 million	$8.6 million

SOURCE: ACIL ALLEN CONSULTING

Table 5.4 and Figure 5.15 demonstrate that a change to the market price has the greatest variability on the discounted net cash flows of ProjectCo, while a change in the PJ also has a significant impact on the variability of ProjectCo's cash flows.

When the market price is increased by 20 per cent, the discounted net cash flows of ProjectCo increase from $403 million to $1 billion. Similarly, when the PJ is increased to 16.9 PJ, the discounted net cash flows increase to $777 million.

Over the study period, the variability of the cash flows to changes in the interest rate or learnings are less pronounced, and less pronounced than the BREEZE and WIND development scenarios. However, over the economic life of ProjectCo under the GALE development scenario, changes to the base case interest rate and learnings are significant.

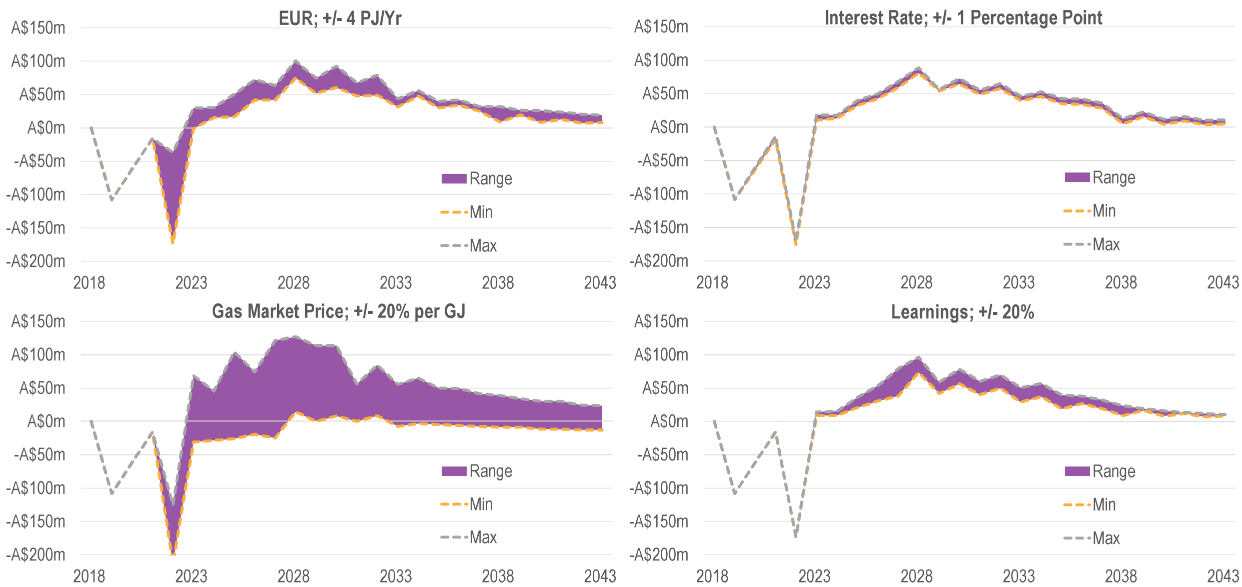
Over the study period, when the interest rate increases by one percentage point, total discounted net cash flows decrease from $403 million to $322 million, and if the rate of learnings are decreased by 20 per cent, the discounted net cash flows falls to $224 million.

It should be noted, however, under the low case EUR sensitivity, when the PJ is lowered to 8.4, the discounted net cash flows of ProjectCo are higher than the base case. This is due to the impact that payments for PRRT have on the economics of ProjectCo. Under a lower EUR, ProjectCo's taxable income is less, resulting PRRT payments being payable in later years. Over the economic life of ProjectCo, the base case total discounted net cash flows are greater than total discounted net cash flows of the lower EUR sensitivity.

The total discounted net cash flows under the lower sensitivities for the GALE development scenario are also positive, compared to the BREEZE and WIND development scenarios over the study period. However, over the economic life of ProjectCo under the GALE development scenario, total discounted net cash flows are negative, as is the case in the other development scenarios.

Similar to the base case discount net cash flow results presented in Section 5.2, this variance is due to how the cash flow model has been developed, where capital expenditure is financed by debt (66.6 per cent), equity (33.3 per cent) and/or by positive cash flows. Greater positive net cash flows generated by ProjectCo reduce the level of debt the Project is required to take on to finance its capital requirements, which reduces interest payments and further increases the Project's net cash flows. However, as net cash flows are reduced, the Project is required to finance more of its capital expenditure by debt, which increases interest payments and further reduces the Project's net cash flows.

FIGURE 5.15 SENSITIVITY ANALYSIS, GALE NET CASH FLOWS, FINANCIAL YEAR, DISCOUNTED, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

5.4 PipelineCo financial model

PipelineCo is modelled using a simple DCF model with a series of assumptions regarding the cost of development and operation, required pre-tax internal rate of return. Using the assumed pipeline diameters developed in Section 4.6, and the gas sales volumes of ProjectCo in each scenario developed in Section 0, PipelineCo aims to deliver its pipeline project in each scenario to an NPV = $0 after 40 years (the useful life of the pipeline infrastructure), using a six per cent discount rate (the pre-tax internal rate of return).

To do this, it sets a flat real tariff equal to the amount that will allow it to deliver on its financial target. These tariffs are presented below. The tariffs are charged to ProjectCo, where they accrue as an operating cost. This requires a special treatment in the economic impact assessment modelling, which is discussed in the next Chapter.

TABLE 5.5 PIPELINECO PIPELINE TARIFFS

Pipeline	Breeze tariff ($/GJ)	Wind tariff ($/GJ)	Gale tariff ($/GJ)
Tie into Amadeus pipeline (50km)	0.2479	0.1651	0.1884
Amadeus duplication	2.0060	0.4471	0.3719
Northern Gas Pipeline (NGP) duplication	N/A	0.9350	0.6458
Carpentaria Gas Pipeline (CGP) duplication	N/A	1.3563	0.8601
DLNG Feed Pipeline (new pipeline)	N/A	N/A	0.6882

SOURCE: ACIL ALLEN CONSULTING

III

ECONOMIC IMPACT ASSESSMENT

6 ECONOMIC IMPACT ASSESSMENT INTRODUCTION

This section of the reports explores the economic impacts of the development of a shale gas industry in the Northern Territory, through the lens of ProjectCo as it has been defined in Chapter II of this report. The tool for this exploration is ACIL Allen's in-house Computable General Equilibrium (CGE) model, *TasmanGlobal*. The model and critical underlying assumptions are outlined in Appendix E.

The modelling period lines up with cash flow modelling period outlined in previous sections: 2018 to 2043. The 25 year modelling period allows for an articulation of the initial capital intensive phase of a development, and a period of operation where capital intensity is lower, and means any economic impacts articulated are conservative relative to presenting a 50 or 100 year modelling period – which is subject to additional uncertainty.

In line with ACIL Allen's scope of works, the modelling outputs have been presented for three regions: Northern Territory, Rest of Australia, and Australia (which is the sum of the first two regions), and under the following macroeconomic variables:

— Real income (Gross Real Income)
— Real output (Gross State Product and Gross Domestic Product, and change in industry output from the base case)
— Real final demand (State Final Demand and Domestic Final Demand)
— Real investment (Business Investment)
— Real exports (for the Northern Territory, international and interstate; for Australia, international only)
— Real employment (FTE employment and employment by industry)
— Real wages
— Population
— Taxation (by major heads of taxation)

ACIL Allen has conducted this economic impact assessment under five scenarios; a base case, and four scenarios which are independent deviations from this base case.

The base case is ACIL Allen's assessment of the future growth of the Northern Territory and Australian economies under current policy settings, which is effectively an assessment of the economy if the moratorium on fracking was to remain in place. The four scenarios are in line with the cash flow modelling results presented in this report.

The results of the base case are presented in annual percentage change terms, where the scenarios are presented as a deviation in the base case, in millions of real dollars or FTE job years as relevant.

In order to complete this task, ACIL Allen has made a series of assumptions regarding the base case and the channel of economic impacts in the four scenarios. These are outlined below. The remainder of this chapter presents the results of the economic impact assessment in the base case and under each of the four scenarios.

6.1 Base case assumptions

Typically, ACIL Allen would model the base case of an economic impact assessment as a function of the continuation of recent economic trends in the particular regions being studied. During its research and stakeholder consultation, ACIL Allen discovered a series of additional assumptions to include in its base case assessment of the Northern Territory economy, which mostly centred on adding realism and nuance to the short and medium term outlook.

6.1.1 NT Government 10 year infrastructure plan

In June 2017, the Northern Territory Government released its 10 Year Infrastructure Plan, a document intended to guide the public and private sector's expectations regarding planned infrastructure investments to be made by the Northern Territory Government.[37] The Plan discusses a number of matters, but critically provides some quantitative guidance regarding the future infrastructure spending plans of the Northern Territory Government. ACIL Allen has attempted to give regard to the direction of infrastructure spending presented in this report in its base case, but has stopped short of including all planned investments as there is significant uncertainty regarding which projects will be funded, when they will commence, and who will fund them.

6.1.2 INPEX Ichthys LNG project

INPEX's LNG project is assumed to begin production in the fourth quarter of 2017-18, ramping up to 8.6 million tonnes 2018-19 before plateauing at 8.9 million tonnes a year from 2019-20 onwards. The start of operations results in a significant increase in the Northern Territory's Gross Territory Product (GTP) over this period, which can be seen in the significant growth in the Northern Territory's real exports in 2018-19.

6.1.3 Darwin LNG

As discussed in Section 4.3.4, the Darwin LNG facility is currently supplied feed gas from the Bayu Undan field. Although gas from the Bayu Undan field is anticipated to decline as the field reaches its end of life, Darwin LNG is assumed to continue LNG production of 3.7 million tonnes a year over the forecast period using gas sourced from the development of an alternative gas field or fields. As outlined previously, there is already significant exploration activity underway off the coast of the Northern Territory.

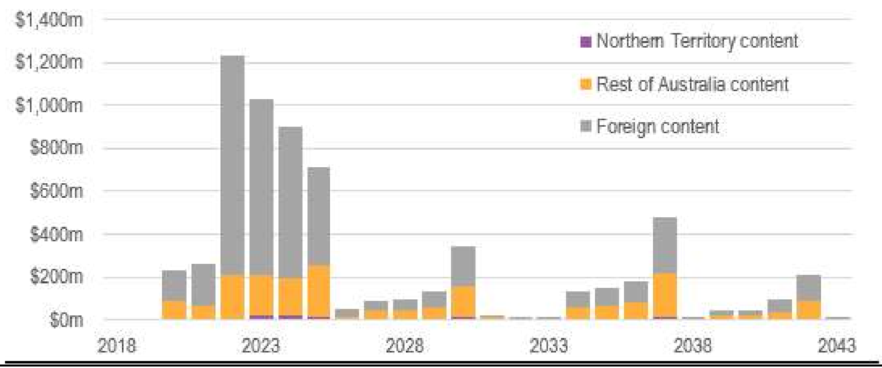
To model this, the base case includes explicit capital ($6.8 billion) and operating costs to construct and operate the necessary offshore infrastructure and a new subsea pipeline to facilitate this development. In the Gale production scenario, it is assumed that the onshore gas production replaces production from the offshore development, thereby eliminating the need to undertake much of the capital and operations expenditure, particularly from 2023 onwards. The capital and operating expenditure component of this assumed offshore development is provided in Figure 6.1.

ACIL Allen has produced these estimates based on previous confidential work associated with large scale offshore gas developments, and has right-sized the facility to provide enough feed gas to supply DLNG only. As the figure indicates, there is a high degree of imported content in this development, in line with the experience of recent major developments in Australia.

The critical implication of this assumption is there is **no incremental increase in LNG production** facilitated by the shale gas industry development.

[37] Department of Infrastructure, Planning and Logistics. 2017. *10 Year Infrastructure Plan*. Accessed online at http://www.dipl.nt.gov.au/

FIGURE 6.1 NEW OFFSHORE DEVELOPMENT TO FEED DLNG, CAPITAL AND OPERATING EXPENDITURE, BY JURISDICTION OF SPENDING, $M



SOURCE: ACIL ALLEN CONSULTING

6.1.4 Project Sea Dragon

Project Sea Dragon is a large-scale, integrated, land-based prawn aquaculture project in northern Australia designed to produce high-quality, year-round reliable volumes for export markets. At the time of the modelling, environmental approvals for Stage 1 of the project had progressed with approval of the project being recommended by the Northern Territory Environment Protection Authority (NT EPA).[38] In the reference case it has been assumed that production from Stage 1 begins in 2019-20 with further approvals and ramp-up to the full planned project by the early 2030's. Stage 1 will comprise approximately 1,080 ha of prawn farming capacity plus associated infrastructure onsite with the full scale Project reaching 10,000 ha of prawn farming capacity with production of 165,000 tonnes a year and revenues of over $3 billion a year.

6.1.5 Horticulture industry

During stakeholder consultation in the Northern Territory, ACIL Allen was presented with a report prepared for NT Farmers which articulated the value of the horticulture industry in the Northern Territory. NT Farmers provided a view to ACIL Allen that the Australian Bureau of Statistics significantly understated the value of the horticulture industry. This view was supported by other stakeholders, including NT Treasury.

ACIL Allen modified the base level of horticulture industry output, land use and employment using this report, which resulted in an increase to the size of agriculture industry relative to the standard definition used.

6.2 Scenario assumptions

ACIL Allen has made a series of assumptions regarding the transmission of economic benefits and costs in the policy scenarios, which are outlined below. These are in addition to the more standard assumptions like the CPI, currency and industry interactions, which are outlined throughout this document.

6.2.1 Local content

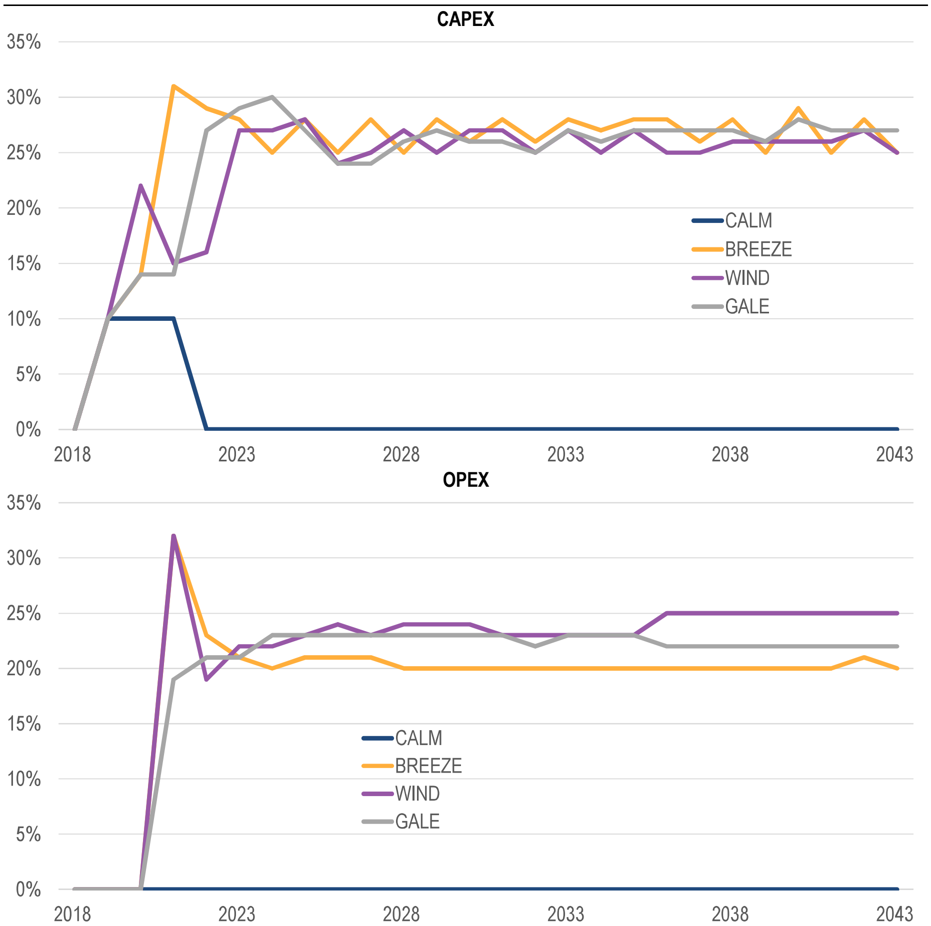
It is necessary to assume a level of local content provision in the delivery of the development scenarios, as there is no information regarding the actual or planned volume of local purchasing that ACIL Allen is able to rely upon. Broadly speaking, ACIL Allen assumed two dimensions to local content penetration: there would be an increasing share of supplies and services provided by Northern Territory firms over time, and there would a step change increase under each scenario.

[38] Seafarms. 2017. *Project Seadragon: Project Status*. Accessed online at http://seafarms.com.au/project-status/

In the case of an increased share over time, this is to reflect the plans of industry to engage local suppliers to assist in the industry's development, but also to reflect it is not as simple as suppliers being able to supply products and services from day one of the development. In the case of a step change increase under each scenario, this reflects ACIL Allen's view that the larger an industry gets, the more opportunities there are to deliver local providers opportunities as scale economies can develop. This manifests in a slightly lower share of local content in the GALE scenario compared to the WIND scenario, but the larger size of the GALE scenario means the value of local content in the project in dollar terms is larger.

ACIL Allen's assumed local content shares in the provision of capital and operating goods (excluding labour) is outlined in the tables below.

FIGURE 6.2 LOCAL CONTENT SHARES, PER CENT OF TOTAL SPENDING, EX LABOUR



SOURCE: ACIL ALLEN CONSULTING

6.2.2 Gas producers – price impact

Due to the complex nature of the gas market modelling undertaken for this task, ACIL Allen has made a simplifying assumption that there is no net change to the supply of or demand for gas in the national gas market resulting from the development of ProjectCo. Instead, the channel of impact is through a reduction in the prices paid by consumers, and a commensurate reduction in margins across the supply chain. The value of these quantum of these reductions is presented in Appendix C.

ACIL Allen adopted this assumption as there is significant uncertainty regarding national energy policy, and it was difficult to determine a credible way to treat which suppliers may choose to turn off their supply in the case of ProjectCo's development. To do this would have required a second round of gas market modelling, which could have then resulted in additional gas sales opportunities for ProjectCo, which would have then required a third round of gas market modelling and so on. Instead, by channelling the impact through prices, the modelling results articulate how a shale gas industry in the Northern Territory may impact on real incomes, real consumption and Commonwealth taxation revenue.

In reality, if a shale gas industry was able to penetrate the market to the degree assumed in this modelling task, it is possible some producers would exit the market. However it is difficult to determine who, when and where, and what the flow on effects may be given the uncertainty regarding both the industry development scenarios ACIL Allen has developed and the current state of the national market.

6.2.3 Employment – no net growth in Australia

As a conservative assumption, ACIL Allen assumed there would be no net employment growth in the Australian economy as whole resulting from the shale gas industry's development in the Northern Territory. This is because the Inquiry is mostly concerned with the potential impacts on the Northern Territory rather than the Australian economy as a whole, and the approach ACIL Allen has adopted with regards to the gas industry (ie no incremental increase in LNG production, and restricting gas industry impacts to price only) means adopting this assumption generates more conservative results.

In reality, it is likely there would be some net increase in employment outside of the Northern Territory, particularly in the development of pipeline infrastructure, the impact on Commonwealth finances, and the second round impacts of lower gas prices on consumer and business spending.

6.2.4 Agriculture – area of disturbance approach

ACIL Allen has made a broad assumption that no shale gas industry development will be allowed to occur:

— on or near sacred Aboriginal sites,
— on or near prime horticultural land,
— in proximate distance to major towns or cities
— on or near any major tourist attractions or locations
— on or near nature reserves, national parks and other land-based natural resources

Given this, ACIL Allen considers it highly unlikely there will be any impact on industries or stakeholders associated with these land uses in the event the industry develops, insofar as a reduced availability of land or conflicting land use goes.

However, it is possible, and indeed highly likely, that a shale gas industry will develop on pastoral properties, which cover approximately 45 per cent of the Northern Territory's land mass.[39] For example, Origin's exploration permit areas encompass 18,512km^2 of pastoral lease property.[40]

In order to model this, ACIL Allen has developed area of disturbance calculations under each scenario, centred on calculations of the land use associated with each element of a shale gas industry's development. We have calculated a gross square meterage of disturbance under each scenario using the table below and applying it to the volume of infrastructure developed, and then doubling it as a conservative assumption. The total area of disturbance under each scenario is presented in Table 6.1.

39 Pastoral Land Board. 2016. *Pastoral Land Board Annual Report: 2015-16*. Accessed online at http://www.denr.nt.gov.au/
40 Origin. 2017. *Environmental Plan Summary, Beetaloo Sub-Basin*. Accessed online at http://www.dpir.nt.gov.au/

ACIL Allen then assumed this land would become unavailable for the pastoral industry to raise cattle. To determine the impact, ACIL Allen calculated the average value per hectare of the cattle industry in the Northern Territory, multiplied this by the loss in land available for pastoral industry activities, and subtracted this from the future growth of the industry.

TABLE 6.1 TOTAL AREA OF LAND DISTURBANCE, BY SCENARIO

Scenario	Disturbance (km^2)
BREEZE	67.7
WIND	231.7
GALE	475.9

7 BASELINE SCENARIO

This section provides the results of ACIL Allen's base case economic modelling for the Northern Territory over the period from 2018 to 2043. This includes outputs for key macroeconomic variables only, and does not include real income and real taxation, which are calculated as levels in the scenarios only.

7.1 Scenario description

As discussed in Section 2, the Northern Territory's recent economic performance has been driven by the impact of INPEX's Ichthys offshore gas and LNG facility development. To this point, the impact has been mostly centred on the initial surge and subsequent fall in construction activity, with the lift in production and export still on the horizon. As discussed in Section 6, ACIL Allen has included a projection of the impact of Ichthys' production phase on the Northern Territory economy in its base case.

Other foreseen events for the Northern Territory included in the base case include:

— The impact of the Northern Territory Government's 10 Year Infrastructure Plan
— Project Seadragon, and the significant impact on the Northern Territory Government's aquaculture industry
— The highly likely development of an offshore gas project to support the backfill of DLNG as existing supplies deplete
— An expanded horticulture sector, in line with research presented by NT Farmers and the perspective of Northern Territory Government stakeholders

Other than the above modifications, the base case assumes that as a starting point the structure of the Northern Territory economy is as it is today. For instance, the largest employing sector is Government Services, with 47,390 employees in 2018.

7.2 Real output – total

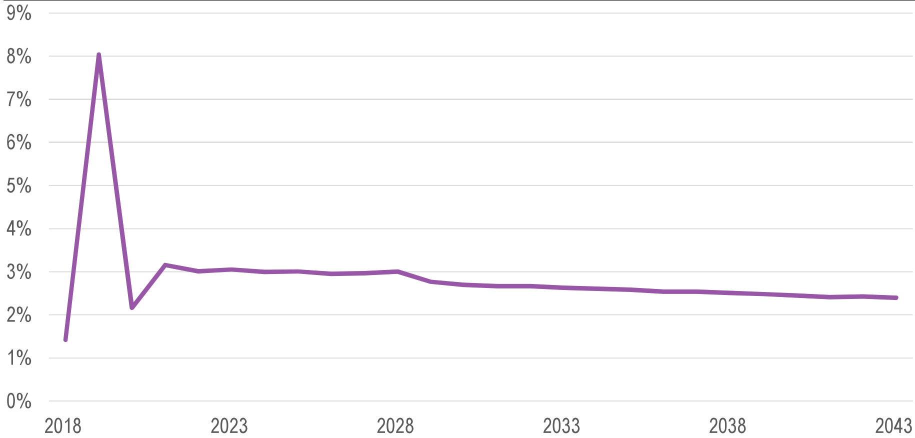
In Gross Territory Product (GTP) terms, ACIL Allen's base case projects the Northern Territory economy will grow by an average of 2.9 per cent over the forecast period (2018-2043) (Figure 7.1). This is lower than the average GTP growth of four per cent recorded over the past decade, which was mostly influenced by the impact of first the DLNG project and then the Ichthys LNG project.

Growth is forecast to spike in the short term, with GTP growth of eight per cent forecast in 2019 on account of the ramp up in Ichthys LNG production. This manifests as an increase in the Petroleum sector's output, and a lift in the real export base of the Northern Territory economy. As LNG production ramps up and then reaches a steady-state level of production, this is only anticipated to have a one year impact on the Territory's growth rate.

Following the ramp up of Ichthys LNG Project, ACIL Allen forecasts there will be a period of slightly above average growth through the 2020s, as the Territory's aquaculture and horticulture industries growth faster than the rest of the economy, and the Northern Territory Government's 10 Year Infrastructure Plan plays out. The impact of the new offshore gas development to back fill DLNG is somewhat limited, as much of the supplies and services for an offshore development are by necessity imported. This manifests in a strong increase in Business Investment (and therefore State Final Demand), but a commensurate increase in imports, therefore a near-zero impact on overall GTP.

Beyond the 2020s, ACIL Allen projects the Northern Territory economy will grow in line with population growth, labour force participation and productivity growth. All up, the Northern Territory economy is projected to grow from a $23.4 billion economy (2018 dollars) in 2018 to a $47.9 billion economy by the end of the forecast period.

FIGURE 7.1 GROSS TERRITORY PRODUCT, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE



SOURCE: ACIL ALLEN CONSULTING

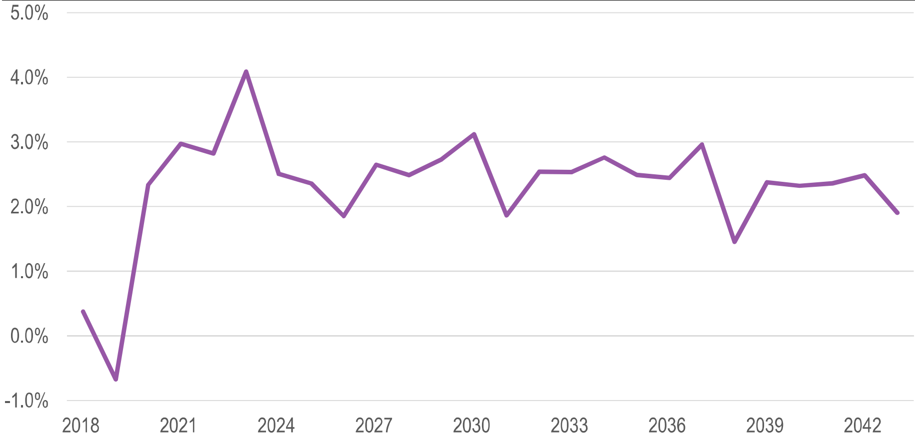
7.2.1 State Final Demand

ACIL Allen's base case projects the Northern Territory's State Final Demand will grow by an average of 2.3 per cent over the forecast period. This compares to growth of 4.4 per cent over the previous decade, where State Final Demand both grew and declined in excess of 10 per cent per annum on three separate occasions as a result of investments in LNG processing facilities.

ACIL Allen has not assumed the development of new onshore LNG processing facilities in its base case, and so the Northern Territory's State Final Demand is projected to be less volatile in the years ahead. Notwithstanding, State Final Demand is projected to be relatively flat over the next two years as the remainder of the uplift associated with the Ichthys LNG project comes out of the economy.

State Final Demand growth is projected to be strongest in the years leading up to 2023, as a result of the impact of the development of the new offshore gas extraction facility to backfill the DLNG facility. State Final Demand growth is forecast to hit 4.1 per cent in 2023, before easing to 1.9 per cent in 2026 (Figure 7.2).

FIGURE 7.2 STATE FINAL DEMAND, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE



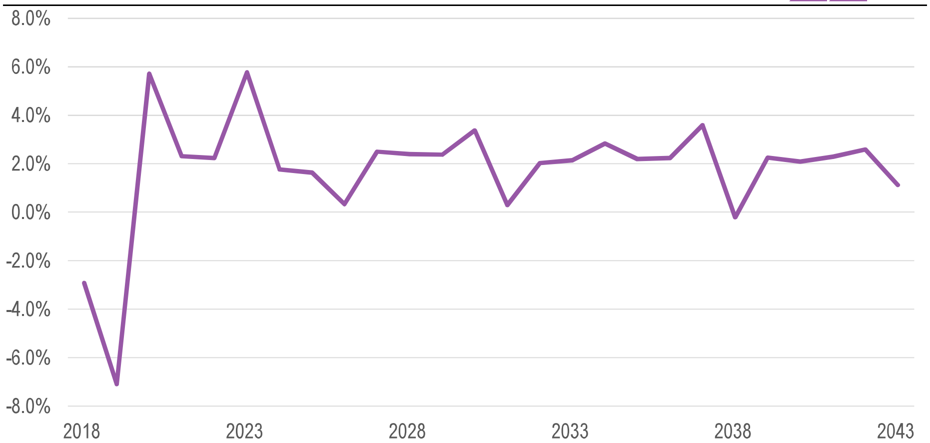
SOURCE: ACIL ALLEN CONSULTING

Business investment

The biggest driver of changes in State Final Demand on an annual basis is business investment, which is often subject to large, lumpy periods of spending by the private sector. This has been the experience of the Northern Territory economy in recent years, as discussed in Section 2.

ACIL Allen's base case forecasts two more years of declining business investment in the Northern Territory associated with the final stages of the Ichthys LNG project. Thereafter, business investment is forecast to grow by an average of four per cent per annum between 2020 and 2023, as the new offshore gas industry development progresses and other investments in aquaculture and horticulture progress. Over the full forecast period (2018 to 2043), business investment is forecast to grow by 1.8 per cent per annum (Figure 7.3). This is slower than the average growth of eight per cent per annum over the past decade, which was characterised by two years of 35 per cent and 65 per cent growth in investment in 2012 and 2013, respectively.

FIGURE 7.3 BUSINESS INVESTMENT, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE

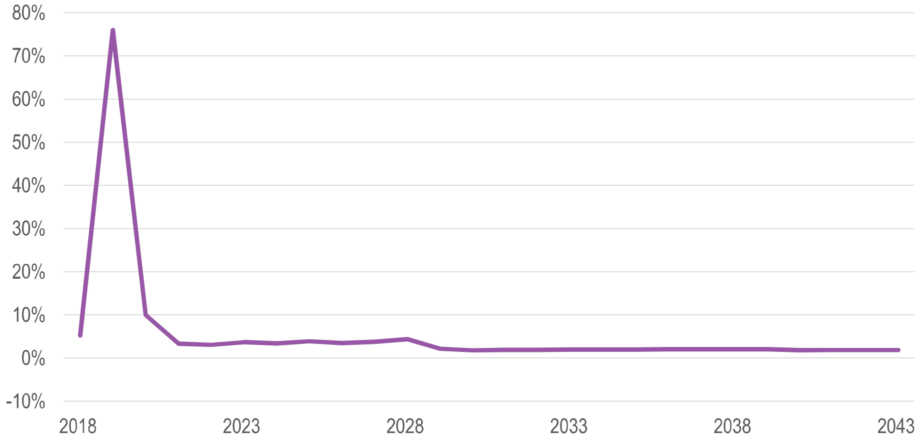


SOURCE: ACIL ALLEN CONSULTING

7.2.2 Real Exports

In ACIL Allen's base case, the Northern Territory's export outlook is dominated by the impact of the progression of the Ichthys LNG project to full production in 2019. In this year alone, the base case forecasts the Northern Territory's real exports will increase by 76 per cent (Figure 7.4).

FIGURE 7.4 REAL EXPORTS, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE



SOURCE: ACIL ALLEN CONSULTING

This is effectively a structural increase in the Northern Territory's real exports base, as the Ichthys LNG project is projected to produce at its steady state level 8.9 million tonnes of LNG per annum. Excluding this one off increase, ACIL Allen's base case forecasts real exports from the Northern Territory will increase by 2.8 per cent per annum, largely on account of the increased activity associated with the Territory's horticulture and aquaculture industries.

7.3 Real output – industry

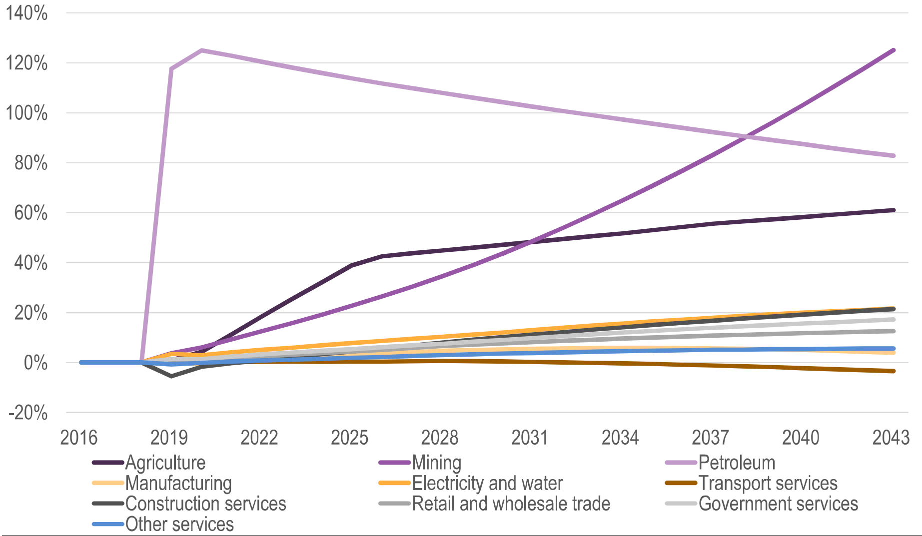
ACIL Allen produced estimates of future industry output growth on the basis of growth or decline from a starting level observed in actual Australian Bureau of Statistics data (2016). To progress these estimates to the modelling period, ACIL Allen has rebased its industry growth projections to the 2018 year and presented the results as a cumulative change in output from the 2018 year.

The fastest growing industry in the base case is Agriculture, which is forecast to grow by 9.1 per cent over the modelling period. This is on account of the impact of Project Seadragon, the rebased estimates of the size and growth potential of the Northern Territory's horticulture industry, and the Northern Territory Government's policies to improve the prospects of the whole agriculture industry (including pastoral industries).

The petroleum industry is also projected to grow faster than average, albeit all of the growth occurs in the first three years of the study period of account of the lift in production from the Ichthys LNG project. Direct industry output from the petroleum industry does not show the same characteristics as export growth for the Northern Territory as a whole as most of the industry output component of the petroleum industry occurs in the extraction of hydrocarbons, which in this case occurs off the coast of Western Australia rather than the Northern Territory. In a similar vein, the addition of a new offshore gas development assumed in the base case simply replaces otherwise lost industry output rather than adding new industry output.

Most other sectors are projected to grow around the same pace as the Northern Territory economy more broadly (Figure 7.5).

FIGURE 7.5 REAL OUTPUT, INDUSTRY LEVEL, NORTHERN TERRITORY, CUMULATIVE PERCENTAGE CHANGE FROM BASE YEAR (2018), BASE CASE



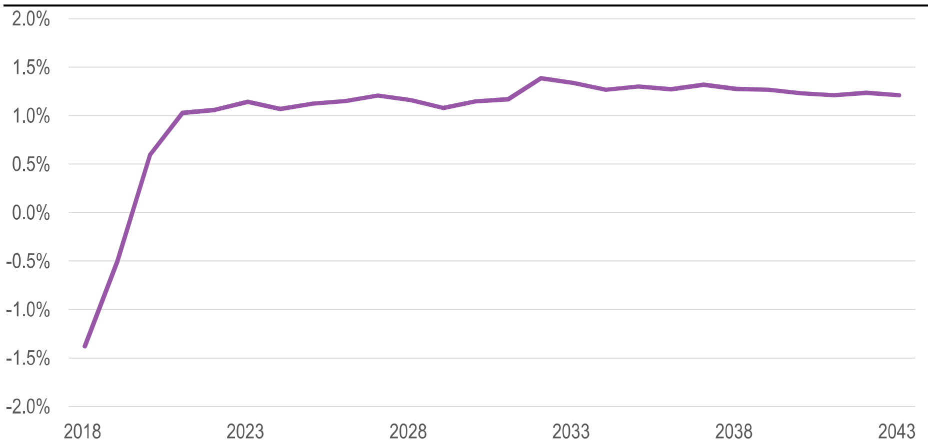
SOURCE: ACIL ALLEN CONSULTING

7.4 Labour market

7.4.1 Total employment

ACIL Allen's base case assumes total employment in the Northern Territory economy will grow by an average of one per cent per annum over the forecast period (Figure 7.6). Similar to the State Final Demand and Business Investment variables, short term employment growth follows the trajectory of the unwinding of the remainder of the Ichthys LNG project, with employment forecast to fall by 1.4 per cent in 2018 and 0.5 per cent in 2019. Thereafter, total employment is forecast to grow by an average of 1.2 per cent per annum.

FIGURE 7.6 REAL EMPLOYMENT, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE



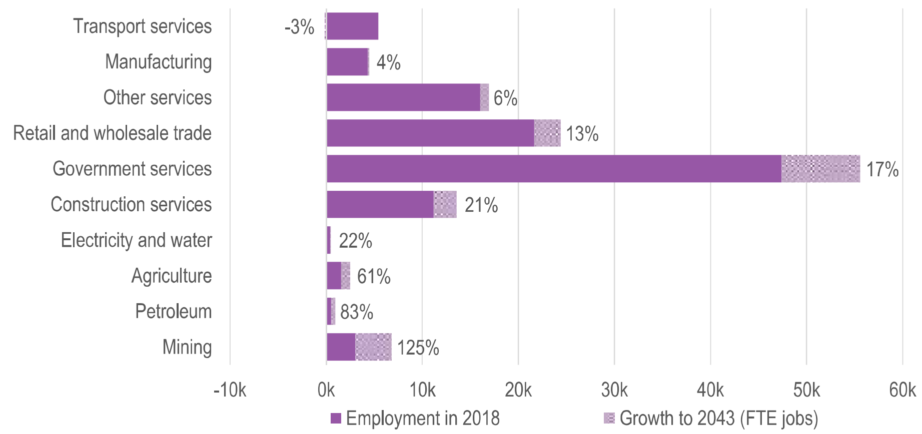
SOURCE:ACIL ALLEN CONSULTING

7.4.2 Industry employment

While total employment growth is forecast to remain relatively stable, ACIL Allen's base case forecasts a shift in the composition of employment in the Northern Territory. Employment growth is forecast to be largest in the Government Services sector, with an additional 8,181 FTE jobs created over the study period. This sector accounts for almost half of total FTE employment growth in the Northern Territory over the period. The other two sectors recording large growth in FTE numbers are similarly already large: retail and wholesale trade (2,729 FTE jobs) and construction (2,397 FTE jobs). However, in percentage change terms these sectors produce relatively modest results (between 13 per cent and 21 per cent, respectively).

The three sectors forecast to see large percentage increases in employment growth are mining (125 per cent), petroleum (83 per cent) and agriculture (61 per cent). In total FTE job terms however, these three sectors are forecast to deliver just over one third of the total employment growth of the three largest employing sectors in the Northern Territory (Figure 7.7).

FIGURE 7.7 REAL EMPLOYMENT, INDUSTRY CHANGES, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE

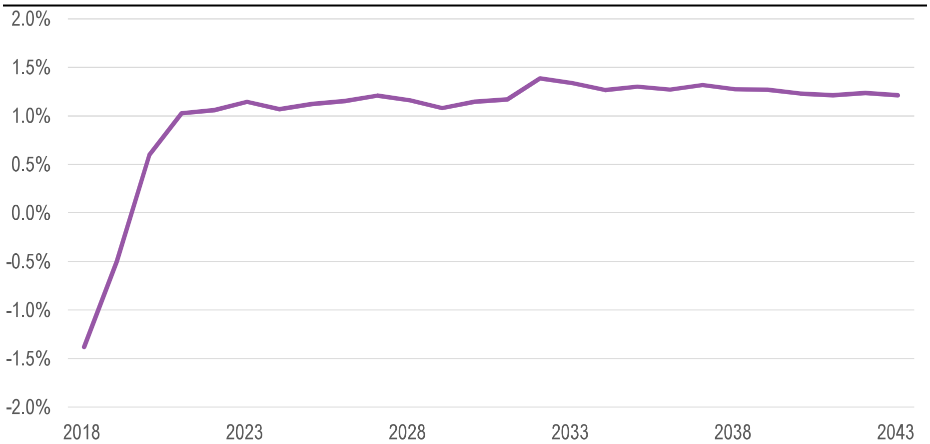


SOURCE: ACIL ALLEN CONSULTING

7.5 Population

ACIL Allen forecasts the Northern Territory's population will shrink modestly in the first two years of the forecast period, on account of the impact of the wind down of the construction phase of the Ichthys LNG project on the Northern Territory economy. Thereafter, ACIL Allen forecasts the Northern Territory's population will grow by an average of 1.2 per cent per annum, reaching 334,037 in 2043 (Figure 7.8)

FIGURE 7.8 POPULATION GROWTH, NORTHERN TERRITORY, ANNUAL PERCENTAGE CHANGE, BASE CASE



SOURCE: ACIL ALLEN CONSULTING

7.6 Summary

Table 7.1 presents a summary of the base case economic forecasts presented in this section.

TABLE 7.1 ACIL ALLEN BASE CASE, SUMMARY OF ECONOMIC MODELLING RESULTS

	2018 level	2043 level	Annual Average Percentage Change
Real output			
Northern Territory	$23,402m	$47,852m	2.9%
Real Final Demand			
Northern Territory	$28,457m	$51,318m	2.3%
Real investment			
Northern Territory	$10,027m	$16,149m	1.8%
Northern Territory real exports			
Northern Territory	$6,299m	$21,575m	5.7%
Real Output, Industry Growth (Index; 2018 = 100)			
Agriculture	100	109.1	
Mining	100	102.9	
Petroleum	100	103.0	
Manufacturing	100	102.0	
Electricity and water	100	102.0	
Transport services	100	102.1	
Construction services	100	101.9	
Retail and wholesale trade	100	102.0	
Government services	100	101.6	
Other services	100	102.0	
Real employment (total)			
Northern Territory	131,310	173,018	1.0%
Real employment by industry (FTE)			
Agriculture	1,546	2,489	1.9%
Mining	3,017	6,789	3.3%
Petroleum	518	947	4.0%
Manufacturing	4,325	4,497	0.2%
Electricity and water	400	487	0.8%
Transport services	5,425	5,237	-0.1%
Construction services	11,189	13,586	0.8%
Retail and wholesale trade	21,664	24,393	0.5%
Government services	47,390	55,571	0.6%
Other services	16,024	16,924	0.2%

	2018 level	2043 level	Annual Average Percentage Change
Real population			
Northern Territory	245,872	334,037	1.2%

SOURCE: ACIL ALLEN CONSULTING

8 CALM SCENARIO

This section explores the broader economic impacts of development of an onshore unconventional shale gas industry, as represented in the previous sections as ProjectCo and PipelineCo. The economic impact will be assessed over the period from 2018 to 2043 for the Northern Territory and Rest of Australian economies on the following terms:

— the impact on **real incomes** (a measure of economic welfare or standard of living);
— the impact on **real output** (as measured in terms of Gross Domestic Product, Gross State/Territory Product, National/State Final Demand, Business Investment and Exports),
— the impact on **employment** (as measured on a full time equivalent job basis);
— the impact on **real wages growth**;
— the impact on **population growth**; and
— the impact on **total taxation payments** (those taxes directly paid by the industry, and the indirect taxes paid as a result of the activity generated from the industry).

For purposes of the reporting, the economic impact of ProjectCo and PipelineCo will be referred to as the "Onshore Unconventional Gas Industry" or "the Industry".

The economic impact of the development of the Industry under the CALM development scenario, as detailed in Section 6, was assessed using ACIL Allen's *Tasman Global* CGE model. Further details on *Tasman Global* are presented in Appendix E.

8.1 Scenario description

As discussed in Section 4.3, The CALM scenario is the scenario that sees ProjectCo undertake a three year program of exploration and appraisal, but fail to progress beyond this due to an inability to find a commercial quality shale gas reserve. The CALM scenario is also the basis for the first four years (in Year 0, nothing occurs as the moratorium is lifted) of the production scenarios discussed below, but instead of an assumption that no commercial quality shale gas is discovered, the assumption is a requisite scale commercial shale gas reserve is discovered.

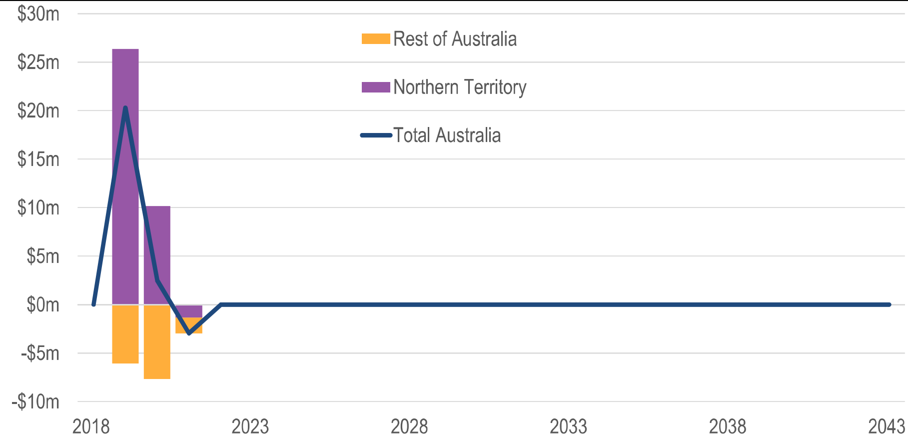
8.2 Real income

Real income impacts are realised in the Territory through increased employment, payroll taxation payments made to the Northern Territory Government and payments made to pastoralists and native title owners.

In total, the real income impact of the Industry is estimated to total $19.8 million at over the study period (refer to Figure 8.1). In the Northern Territory, real income is estimated to total $35.2 million, while in the

Rest of Australia real income will fall by $15.4 million, as a result of a reallocation of labour to the Territory for the Industry's appraisal phase.

FIGURE 8.1 CALM REAL INCOME, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



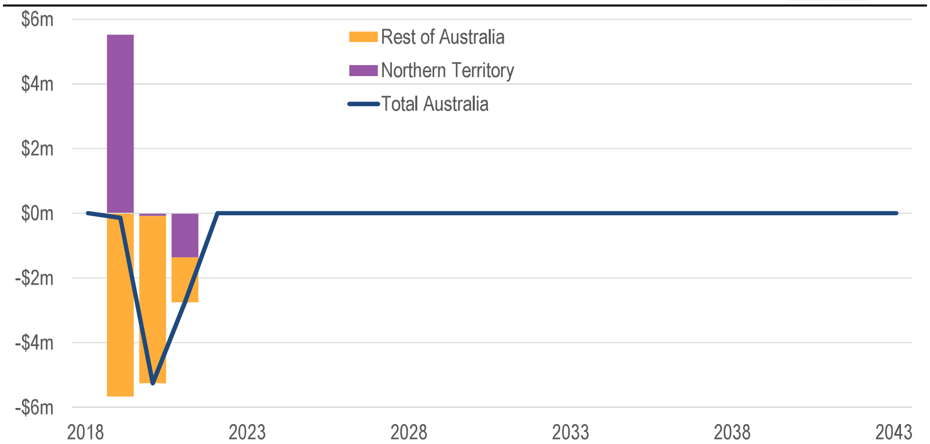
SOURCE: ACIL ALLEN CONSULTING

8.3 Real output

The real output impact of the Industry is different to the real income impact because output does not include increases to welfare that is generated through additional employment and wages growth.

Under the CALM development scenario, real output is estimated to fall by a total of $8.2 million (refer to Figure 8.2). In the Northern Territory, it is estimated real output will increase by $4.1 million and fall by $12.2 million across the Rest of Australia (the result of a reallocation of labour to the Territory for the Industry's appraisal phase) over the study period.

FIGURE 8.2 CALM REAL OUTPUT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION

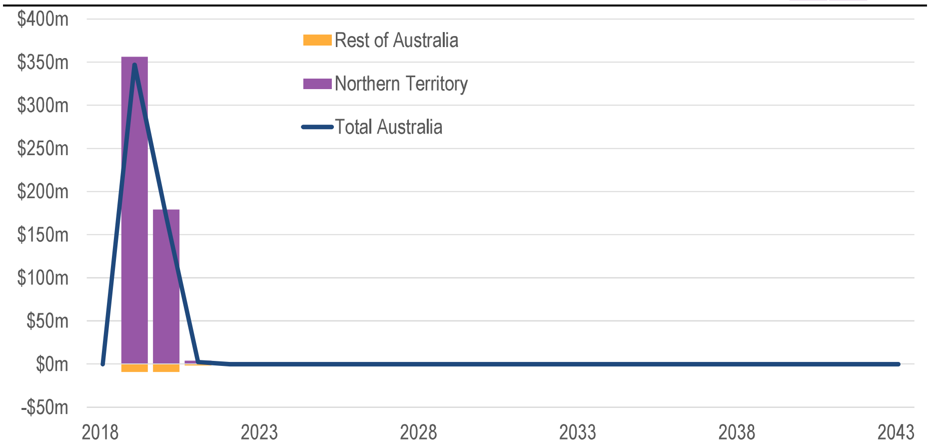


SOURCE: ACIL ALLEN CONSULTING

8.3.1 Real Final Demand

Final Demand is the component of real output that accounts for all domestic economic activity. As it does not include exports or imports, the magnitude and timing of the impacts on Final Demand differ from the broader measure of real output. In total, the real Final Demand impact of development under the CALM scenario is estimated to total $519 million over the study period (refer to Figure 8.3). In the Northern Territory it is estimated real Final Demand will increase by $539 million and fall by $19.7 million across the Rest of Australia (the result of a reallocation of labour to the Territory for the Industry's appraisal phase) over the study period.

FIGURE 8.3 CALM REAL FINAL DEMAND, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION

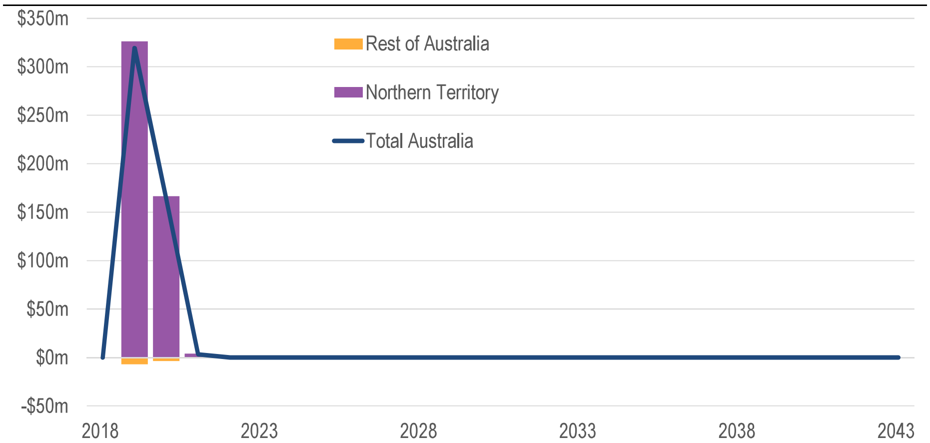


SOURCE: ACIL ALLEN CONSULTING

Real investment

In the Northern Territory, the major component of the Industry's real Final Demand impact is in relation to investment. The real investment impact of the Industry is estimated to total $486 million over the study period (refer to Figure 8.4). In the Northern Territory it is estimated real investment will increase by $497 million and fall by $11.4 million across the Rest of Australia (the result of a reallocation of labour to the Territory for the Industry's appraisal phase) over the study period.

FIGURE 8.4 CALM REAL INVESTMENT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

8.3.2 Real exports

The reallocation of labour resources to the Northern Territory under the CALM development scenario for the appraisal of the Industry results in labour not generating export revenue in other industries in the economy, which results in a net loss to exports in the Territory (refer to Figure 8.5).

In total, the *Tasman Global* CGE model estimates that real exports in the Territory will contract by $39.9 million. The majority of this will be lost from international exports ($23.8 million), with $16.1 million from interstate exports.

FIGURE 8.5 CALM NORTHERN TERRITORY REAL EXPORTS, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION

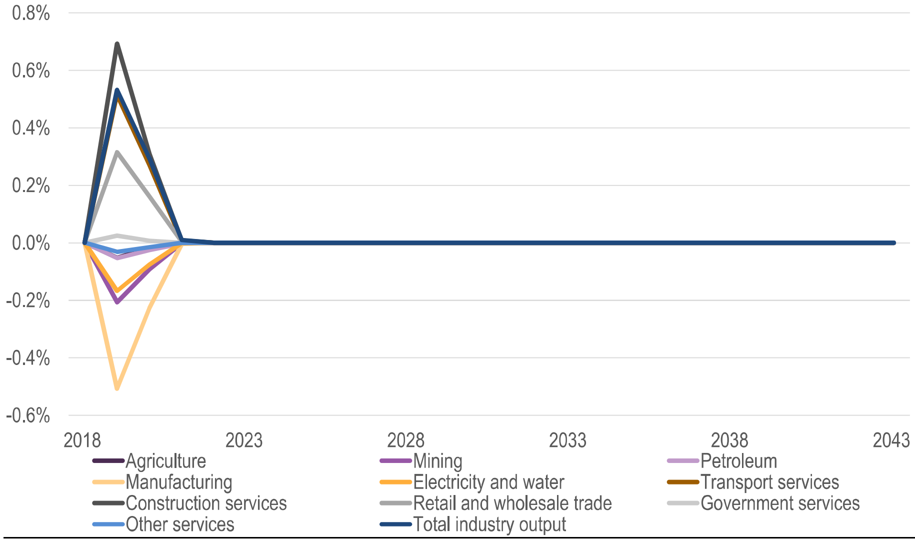
SOURCE: ACIL ALLEN CONSULTING

8.4 Real output – industry

Figure 9.7 displays the impact the Industry has on the real output by industry in the Northern Territory. Under the CALM development scenario, the largest impact will be realised in the Construction Services industry, which between 2019 and 2021 will generate average growth over and above the base case by 0.34 per cent per annum. The Transport Services industry also will generate additional growth of 0.26 per cent per annum between 2019 and 2021 over and above the base case.

The largest negative impact of the Industry under the CALM development scenario is estimated to occur in the Manufacturing industry, which is estimated to contract by 0.25 per cent per annum between 2019 and 2021 relative to the base case. For the remaining Northern Territory industries, the impact of the Industry under the CALM development scenario is negligible.

FIGURE 8.6 CALM NORTHERN TERRITORY REAL OUTPUT BY INDUSTRY, PERCENTAGE CHANGE FROM BASELINE, REAL TERMS, PERCENTAGE



SOURCE: ACIL ALLEN CONSULTING

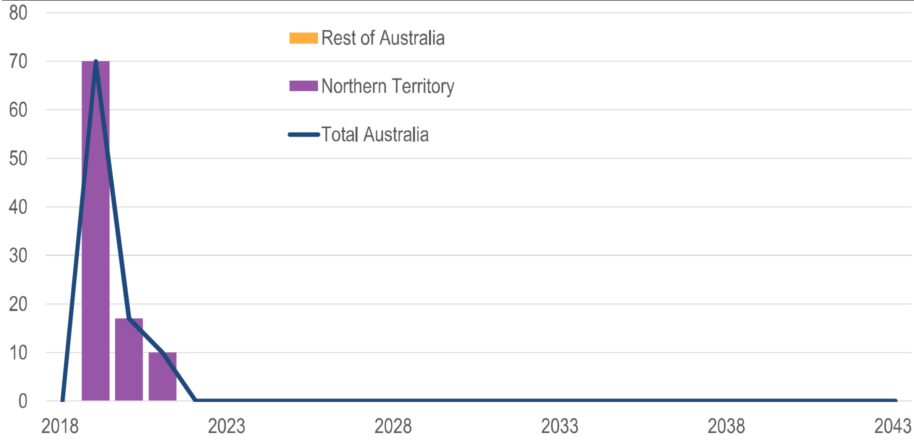
8.5 Labour market

8.5.1 Employment

Under the CALM development scenario, the Industry is expected to require some short term employment opportunities.

Over the study period, it is estimated the development of the Industry will require direct employment of 97 FTE jobs, there is no labour requirements after 2021 (refer to Figure 8.7). Overall, it is estimated that the Industry under the CALM scenario will generate total direct and indirect jobs of 119 FTE jobs over the study period.

FIGURE 8.7 CALM DIRECT EMPLOYMENT, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



SOURCE: ACIL ALLEN CONSULTING

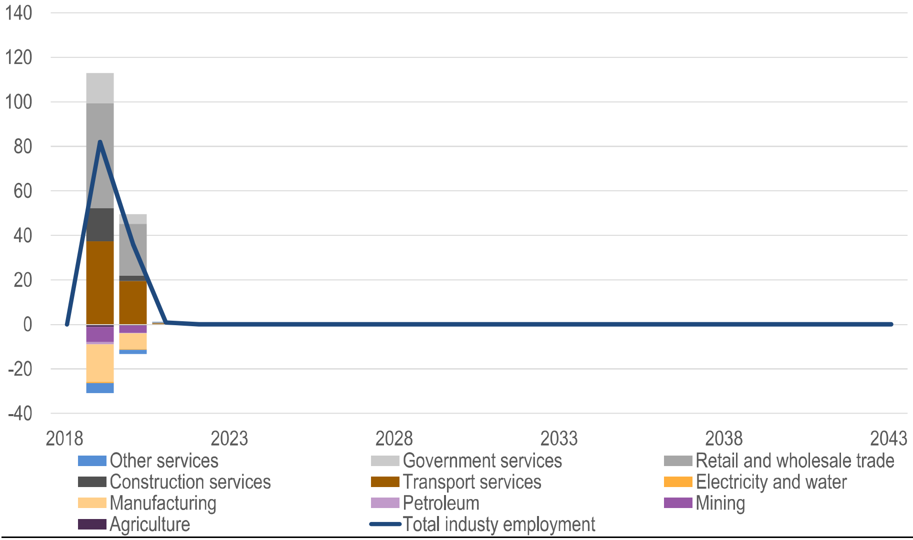
8.5.2 Industry real employment

While the development of the Industry under the CALM development scenario results in the reallocation of some labour resources from other industries, on average the real employment impact is significantly positive for the Territory. Figure 9.9 displays the impact the Industry has on direct and indirect employment by industry in the Northern Territory. Under the CALM development scenario, the largest impact will be realised in the Retail and Wholesale Trade industry, which between 2019 and 2021 will generate total additional jobs over and above the base case of 71 FTE jobs, and is a result of the consumption impacts arising from the boost to real incomes in the Territory.

The Transport Services (57 FTE jobs), Government Services (18 FTE jobs) and Construction Services Industry (17 FTE jobs) will also receive a boost to employment over and above the base case over the study period.

The largest negative impact of the Industry under the CALM development scenario is estimated to occur in the Manufacturing industry, which is estimated to contract by 24 FTE jobs over the study period relative to the base case. For the remaining Northern Territory industries, the impact of the Industry under the CALM development scenario is negligible.

FIGURE 8.8 CALM NORTHERN TERRITORY DIRECT AND INDIRECT EMPLOYMENT BY INDUSTRY, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS

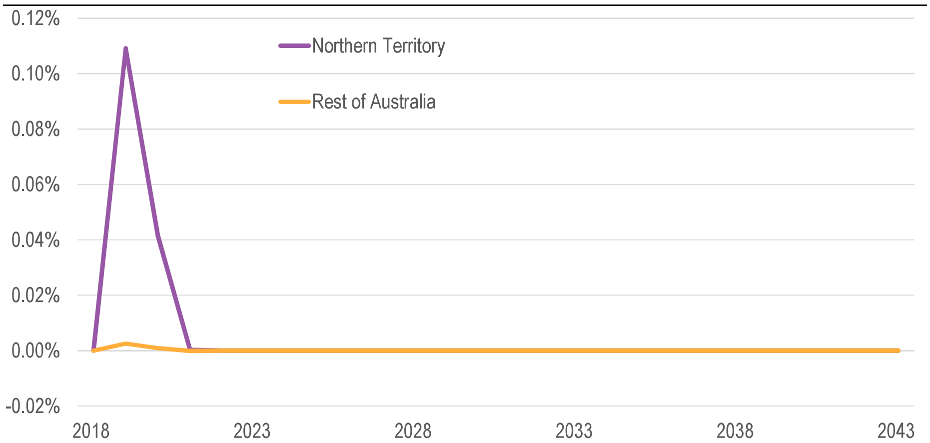


SOURCE: ACIL ALLEN CONSULTING

8.5.3 Real wages

The development of the Industry is estimated to provide a temporary boost to real wages in the Northern Territory between 2019 and 2021 of 0.05 per cent per annum. The impact across the Rest of Australia is negligible, given that there is no job creation under the CALM scenario (refer to Figure 8.9).

FIGURE 8.9 CALM REAL WAGE GROWTH, DEVIATION FROM BASELINE, REAL TERMS, PERCENTAGE

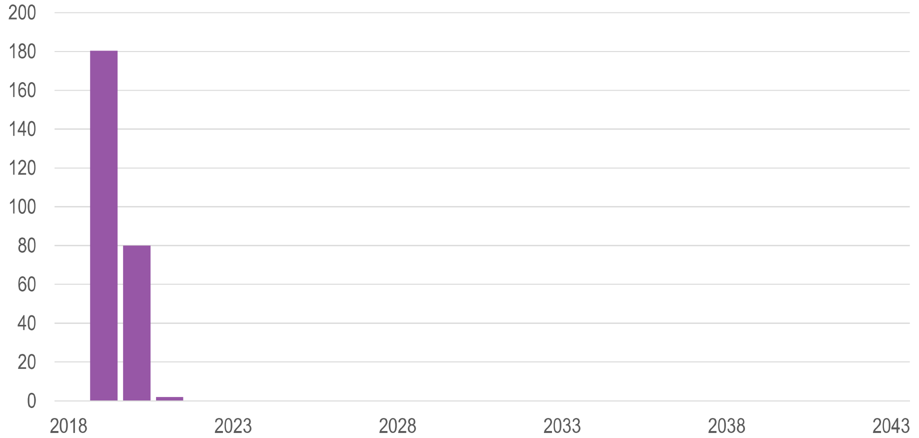


SOURCE: ACIL ALLEN CONSULTING

8.6 Population

The development of the Industry is estimated to provide a temporary boost to population in the Northern Territory of 180 persons in 2019, 80 persons in 2020 and two persons in 2021. After 2021 there is no impact on the Territory's population.

FIGURE 8.10 CALM NORTHERN TERRITORY REAL POPULATION, DEVIATION FROM BASELINE, REAL TERMS, NUMBER

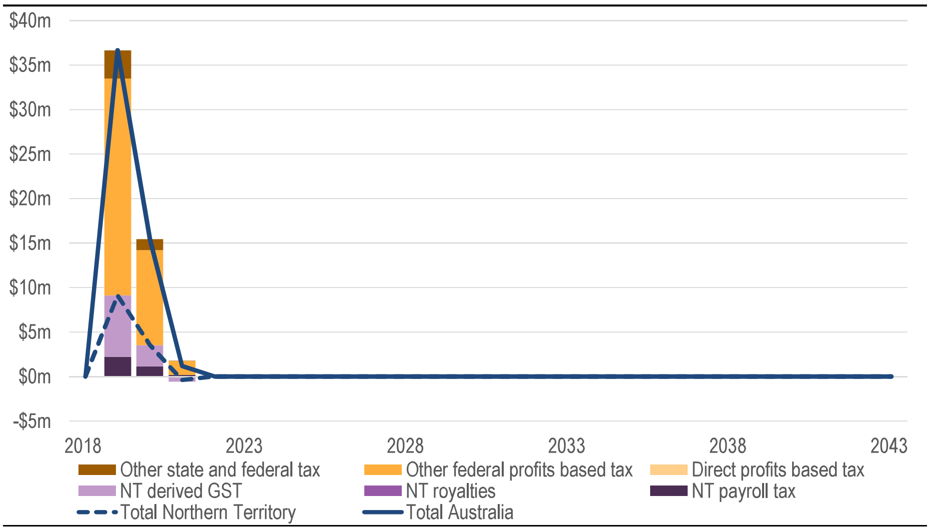


SOURCE: ACIL ALLEN CONSULTING

8.7 Real taxation

The development of the Industry under the CALM scenario will generate a short term taxation benefits to the Northern Territory and the Commonwealth Governments, primarily in the form of indirect profits based taxes and GST (refer to Figure 8.11).

FIGURE 8.11 CALM REAL TAXATION, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Between 2019 and 2021, it is estimated the Commonwealth Government will be in receipt of $36.6 million of indirect company taxation payments, and a further $8.7 million is estimated to be generated in GST collections.

The Industry under the CALM development scenario will also generate $3.5 million in payroll taxation payments to the Northern Territory Government, while $4.5 million is expected to be generated in other state and federal taxes (such as personal income, excises, fringe benefits and capital gains tax receipts).

8.8 Summary

Table 8.1 presents a summary of the economic modelling results presented in the section.

TABLE 8.1 CALM DEVELOPMENT SCENARIO, SUMMARY OF ECONOMIC IMPACT RESULTS

	Total	Average	NPV (7 per cent)
Real income			
Northern Territory	$35.2m	$1.4m	$30.3m
Rest of Australia	-$15.4m	-$0.6m	-$12.8m
Total Australia	**$19.8m**	**$0.8m**	**$17.5m**
Real output			
Northern Territory	$4.1m	$0.2m	$3.7m
Rest of Australia	-$12.2m	-$0.5m	-$10.2m
Total Australia	**-$8.2m**	**-$0.3m**	**-$6.5m**
Real Final Demand			
Northern Territory	$539.1m	$20.7m	$460.2m
Rest of Australia	-$19.7m	-$0.8m	-$16.5m
Total Australia	**$519.4m**	**$20.0m**	**$443.7m**
Real investment			
Northern Territory	$496.9m	$19.1m	$424.0m
Rest of Australia	-$11.4m	-$0.4m	-$9.6m
Total Australia	**$485.5m**	**$18.7m**	**$414.4m**
Northern Territory real exports			
International	-$23.8m	-$0.9m	-$20.0m
Interstate	-$16.1m	-$0.6m	-$13.6m
Total	**-$39.9m**	**-$1.5m**	**-$33.6m**
Real employment			
Northern Territory	119 FTEs	5 FTEs	
Rest of Australia	-119 FTEs	-5 FTEs	
Total Australia	**0 FTEs**	**0 FTEs**	
Real employment by industry			
Agriculture	-2 FTEs	0 FTEs	
Mining	-10 FTEs	0 FTEs	
Petroleum	-1 FTEs	0 FTEs	

	Total	Average	NPV (7 per cent)
Manufacturing	-24 FTEs	-1 FTEs	
Electricity and water	-1 FTEs	0 FTEs	
Transport services	57 FTEs	2 FTEs	
Construction services	17 FTEs	1 FTEs	
Retail and wholesale trade	71 FTEs	3 FTEs	
Government services	18 FTEs	1 FTEs	
Other services	-6 FTEs	0 FTEs	
Total industry employment	**119 FTEs**	**5 FTEs**	
Real population			
Northern Territory	262 persons	10 persons	
Real taxation			
Northern Territory			
Payroll tax	$3.5m	$0.1m	$3.0m
Royalties	$0.0m	$0.0m	$0.0m
Derived GST	$8.7m	$0.3m	$7.5m
Total Northern Territory	**$12.2m**	**$0.5m**	**$10.5m**
Commonwealth			
Direct profits based tax	$0.0m	$0.0m	$0.0m
Other federal profits based tax	$36.6m	$1.4m	$31.2m
Other state and federal tax	$4.5m	$0.2m	$3.8m
Total Commonwealth	**$41.1m**	**$1.6m**	**$35.0m**
Total Australia	**$53.3m**	**$2.0m**	**$45.5m**

SOURCE: ACIL ALLEN CONSULTING

9 BREEZE SCENARIO

This section explores the broader economic impacts of development of an onshore unconventional shale gas industry, as represented in the previous sections as ProjectCo and PipelineCo. The economic impact will be assessed over the period from 2018 to 2043 for the Northern Territory and Rest of Australian economies on the following terms:

— the impact on **real incomes** (a measure of economic welfare or standard of living);
— the impact on **real output** (as measured in terms of Gross Domestic Product, Gross State/Territory Product, National/State Final Demand, Business Investment and Exports),
— the impact on **employment** (as measured on a full time equivalent job basis);
— the impact on **real wages growth**;
— the impact on **population growth**; and
— the impact on **total taxation payments** (those taxes directly paid by the industry, and the indirect taxes paid as a result of the activity generated from the industry).

For purposes of the reporting, the economic impact of ProjectCo and PipelineCo will be referred to as the "Onshore Unconventional Gas Industry" or "the Industry".

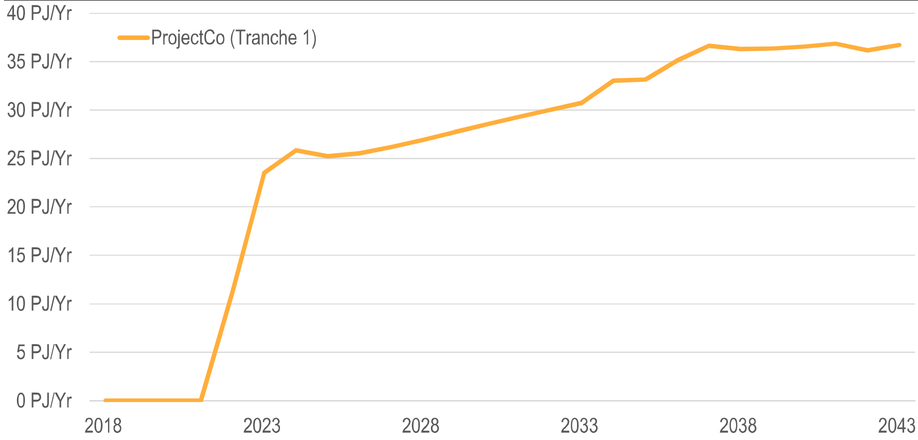
The economic impact of the development of the Industry under the BREEZE development scenario, as detailed in Section 4.3.2, was assessed using ACIL Allen's *Tasman Global* CGE model. Further details on *Tasman Global* are presented in Appendix E.

9.1 Scenario description

As discussed in Section 4.3.2, under the BREEZE development scenario it is assumed shale gas production commences in FY2022, with the current moratorium on activities lifting at the end of FY2018 and the exploration/appraisal phase of development occurring in FY2019, FY2020 and FY2021. At the tail end of FY2021, facilities required to tie into the Amadeus Gas Pipeline are built and then linked to the East Coast market via the NGP. Gas is produced at an initial rate of 33.4 TJ/day in 2022, ramping up to 90 TJ/day in 2034.

The profile of gas production by ProjectCo in BREEZE is below in Figure 9.1.

FIGURE 9.1 GAS PRODUCTION, BREEZE SCENARIO, PJ/ANNUM



SOURCE: ACIL ALLEN CONSULTING

9.2 Real income

The development of the Industry has a significant impact on the real income of Australia. Real income is a measure of the economic welfare (or standard of living) improvement as a result of the developments. The change in real income captures the effect of net foreign income transfers associated with ownership of the capital along with changes in the purchasing power of Australian residents.

The real income impact of the Industry is largely accrued through the profits generated by the Industry once it is operational, which also determines the level of profits based taxation paid by the Industry. Overall, the majority of the real income impact of the development under the BREEZE scenario is transferred from the Northern Territory to the Rest of Australia, in the form of Commonwealth Government taxes and because the equity ownership of the Industry is assumed to be largely on the east coast of Australia.

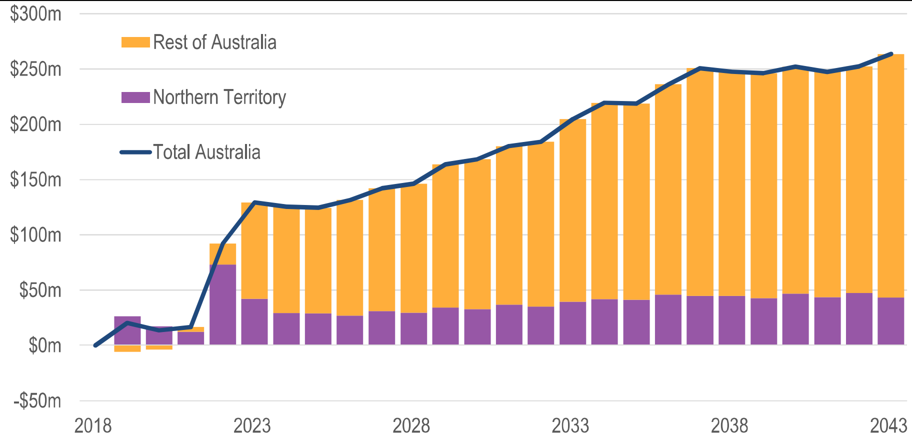
Real income impacts are still realised in the Territory, through increased employment and a redistribution of the profits based taxation payments from the Commonwealth back to the Territory. Royalty and payroll taxation payments made to the Northern Territory Government and payments made to pastoralists and native title owners also contribute to the real income impact in the Territory.

In total, the real income impact of the Industry is estimated to total $4.3 billion at an average of $165 million per annum over the study period (refer to Figure 9.2). The real income impact reaches a steady state of around $250 million per annum in 2037, once the Industry reaches its steady state of production.

Over the study period, the real income impact in the Northern Territory is estimated to total $937 million, at an average of $36.1 million per annum. Real incomes are expected to peak at $73.2 million in 2022, which coincides with peak employment and peak wages growth in the Territory. Once the Industry reaches its steady state level of production, the real income impact in the Territory averages around $44.7 million per annum.

The real income impact is largely felt on the east coast of Australia, which is estimated to total $3.3 billion at an average of $128 million per annum over the study period. Real incomes are expected to peak in 2043 at $220 million, as the Industry reaches peak production.

FIGURE 9.2 BREEZE REAL INCOME, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

9.3 Real output

The real output impact is largely accrued through the impact the Industry has on investment in the Northern Territory and the value of the gas exported from the Territory to the Rest of Australia. The real output impact of the Industry is different to the real income impact because, in an output sense, the value of the gas exported is realised in the Territory, whereas in an income sense, the value of the gas exported is realised through profits generated and taxation payments, which largely accrue on the east coast of Australia.

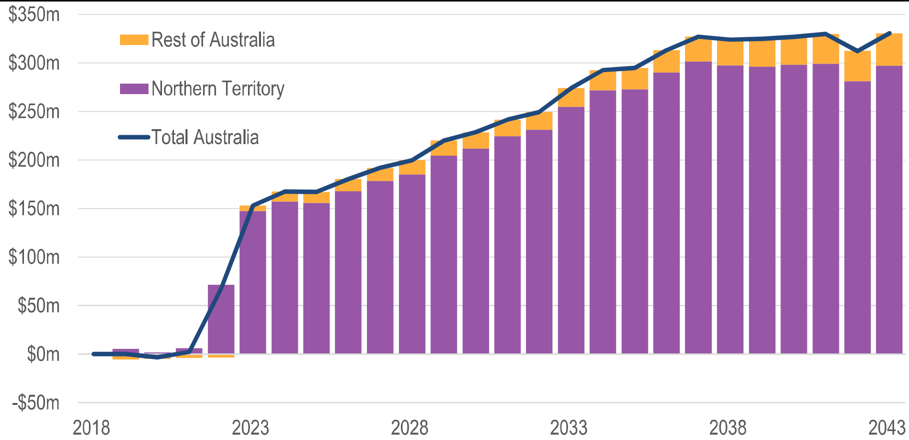
Under the BREEZE development scenario, real output is estimated to total $5.5 billion at an average of $205 million per annum over the study period (refer to Figure 9.3). The real output impact reaches a steady state of around $325 million per annum in 2037, as a steady state of production is reached.

Over the study period, the real output impact in the Northern Territory is estimated to total $5.1 billion, at an average of $196 million per annum. Real output is expected to increase over the study period in line with the increase in the level of production. At steady state production in 2037, output in the Territory is estimated to average $295 million per annum.

Relative to the size of the Northern Territory's economy, the increase in real output from the development of the Industry represents a boost to Gross Territory Product of 0.11 per cent in 2037, once the level of real output reaches a steady state.

Across the Rest of Australia, the real output impact is largely driven by an increase to consumption by the household sector, as a result of the rising real incomes from the development on the Rest of Australia. Over the study period, it is estimated the real output impact on the Rest of Australia will total $406 million at an average of $15.6 million per annum.

FIGURE 9.3 BREEZE REAL OUTPUT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

9.3.1 Real Final Demand

Final Demand is the component of real output that accounts for all domestic economic activity. As it does not include exports or imports, the magnitude and timing of the impacts on Final Demand differ from the broader measure of real output.

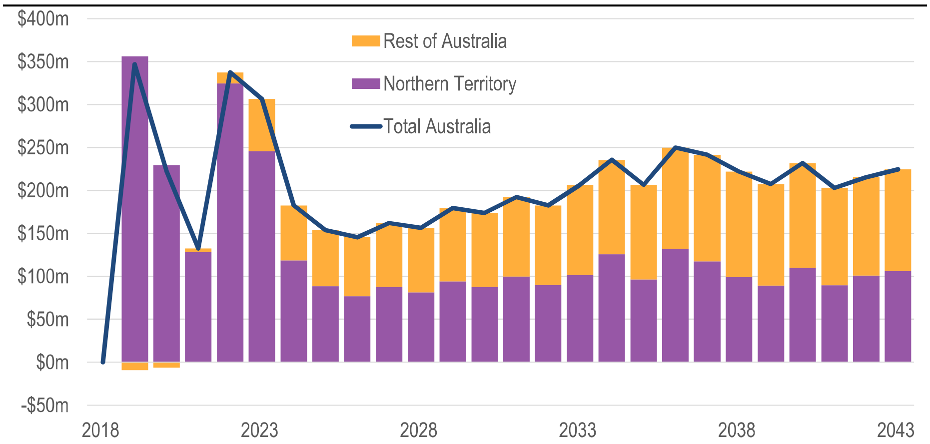
The real Final Demand impact of development under the BREEZE scenario in the Northern Territory is largely accrued through the investment needed to fund the Industry's capital requirements. For the Rest of Australia the impact largely results from the household consumption impacts that are accrued from rising real incomes resulting from the development.

In total, the real Final Demand impact of development under the BREEZE scenario is estimated to total $5.3 billion at an average of $205 million per annum over the study period (refer to Figure 9.4).

Real Final Demand in the Territory is expected to peak at $356 million in 2019, during the Industry's exploration phase, and be maintained at high level during the capital intensive development phase, where real Final Demand is estimated to increase by $325 million by 2020. Over the study period, the Final Demand impact is estimated to total $3.3 billion at an average of $196 million per annum.

Throughout the Rest of Australia, the real Final Demand impact of the Industry does not have a material impact until the Industry becomes profitable in 2023, and when the real income impact begins to impact on household consumption. Over the study period, the Final Demand impact is estimated to total $2 billion at an average of $79 million per annum.

FIGURE 9.4 BREEZE REAL FINAL DEMAND, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Real investment

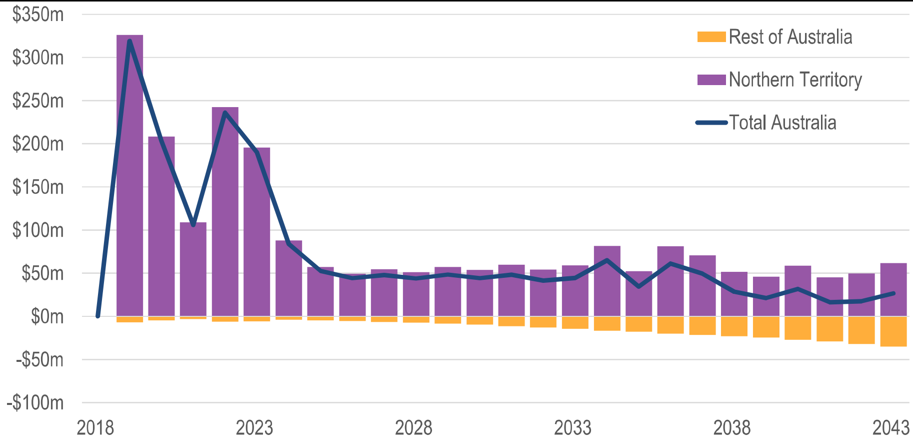
In the Northern Territory, the major component of the Industry's real Final Demand impact is in relation to investment, and is the result of the ongoing capital intensive nature of unconventional shale gas developments.

In total, the real investment impact of the Industry is estimated to total $1.9 billion at an average of $73.4 million per annum over the study period (refer to Figure 9.5). The exploration phase of the Industry is when the real investment impact of the Industry peaks ($326 million in 2019) and again during the development and the duplication of the Amadeus pipeline ($243 million in 2023).

Following the capital intensive initial production phase of the Industry, the real investment reduces as less capital is required to reach the target production level. Over the study period, real investment in the Territory is estimated to total $2.3 billion at an average of $87 million per annum.

Across the Rest of Australia, ACIL Allen estimates that as a result of a reallocation of labour resources to the Northern Territory, the impact on real investment throughout the Rest of Australia falls by of $359 million at an average of $13.8 million per annum over the study period.

FIGURE 9.5 BREEZE REAL INVESTMENT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



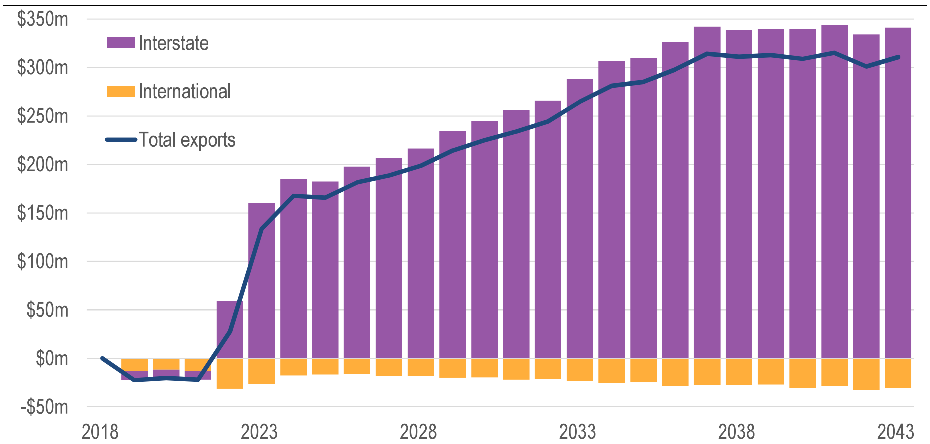
SOURCE: ACIL ALLEN CONSULTING

9.3.2 Real exports

The impact the Industry has on the Northern Territory's real exports is the other main driver of the impact on the Territory's real output. While gas is not exported to international markets under the BREEZE development scenario, it is exported from the Territory to the Rest of Australia (specifically the east coast of Australia).

Over the study period, the development is estimated to increase real exports by $5.2 billion at an average of $201 million per annum (refer to Figure 9.6). The increase in real exports is driven by the boost to interstate exports ($5.8 billion over the study period or $223 million per annum), which offsets the small decrease in international exports resulting from the impact of an expected appreciation in the Australian Dollar ($573 million over the study period or $22 million per annum).

FIGURE 9.6 BREEZE NORTHERN TERRITORY REAL EXPORTS, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Once a steady state of real exports is reached in 2037, it is estimated that the exports generated by the Industry under the BREEZE development scenario would account for 1.6 per cent of the Territory's total exports.

9.4 Real output – industry

Figure 9.7 displays the impact the Industry has on the real output by industry in the Northern Territory. Under the BREEZE development scenario, the largest impact will be realised in the Petroleum industry, given that the Industry would be captured under this industry classification. It is estimated that the Petroleum industry will generate growth over and above the base case of 1.9 per cent per annum on average over the study period.

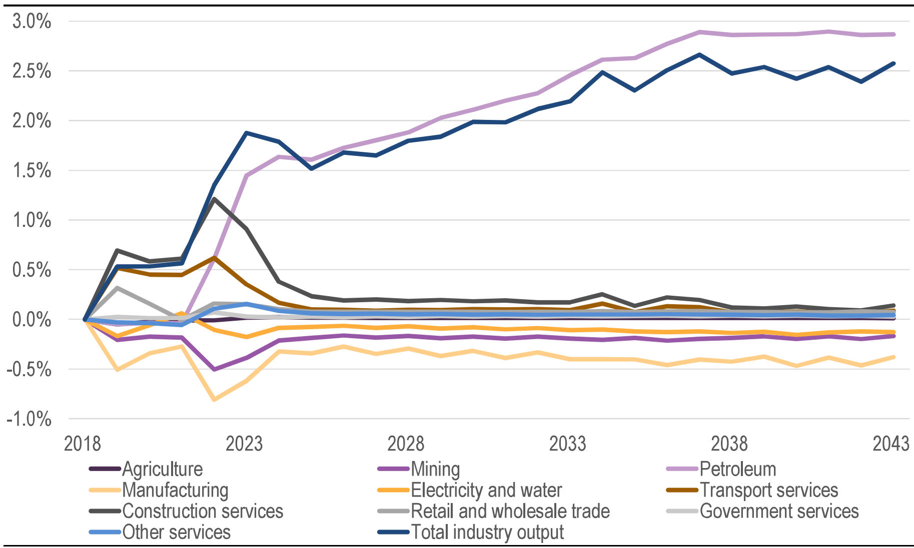
The Construction Services industry is also expected to increase over the study period, averaging growth of 0.3 per cent per annum. The majority of this growth will be realised in the early stages of the Industry's development, with growth expected to peak at 1.2 per cent in 2022.

The Transport Services industry is also estimated to follow a similar trend, growing on average by 0.2 per cent per annum and peaking at 0.6 per cent in 2022, relative to the base case.

The Manufacturing industry is estimated to contract on average by 0.4 per cent per annum over the study period. This reflects the impact of an appreciation in the Australian Dollar on the global competitiveness of export competing businesses in the Territory. In addition, a reallocation of labour away from the Manufacturing industry to the Petroleum industry results in lower output from that industry. A similar impact occurs in the Mining and Electricity and Water industries, which are estimated to contract on average by 0.2 per cent and 0.1 per cent per annum over the study period.

Across all industries, the development of the Industry in the Territory will have a marginal impact on the growth across most industries. Overall, industry growth is estimated to be 1.9 per cent per annum higher than what would otherwise have occurred if the Industry did not exist.

FIGURE 9.7 BREEZE NORTHERN TERRITORY REAL OUTPUT BY INDUSTRY, PERCENTAGE CHANGE FROM BASELINE, REAL TERMS, PERCENTAGE



SOURCE: ACIL ALLEN CONSULTING

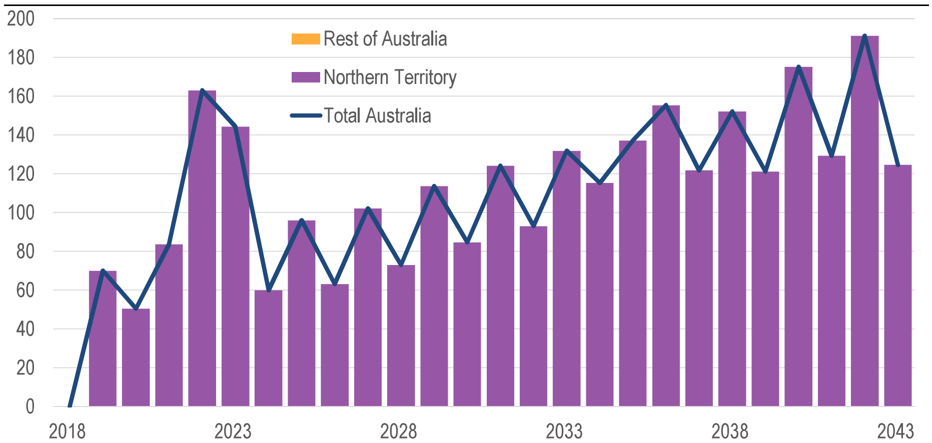
9.5 Labour market

9.5.1 Employment

The development of a new industry in the Territory under the BREEZE development scenario has significant workforce implications. The largest component of the Industry's direct workforce is the staff required to operate the wells and pads. The 'peaking' nature of the FTE requirements presented in Figure 9.8 is a result of the timing of the construction workforce requirements. Labour required for the construction of gas transmission pipelines in the Territory in 2021 and 2022 also contributes to this 'peaking' nature, but on a smaller scale.

Over the study period, it is estimated the development of the Industry will require direct employment of 2,874 FTE jobs at an average of 111 FTE jobs per annum in the Territory. The majority of these FTE jobs are in relation to the construction and operations of the Industry (total of 2,361 FTE jobs at an average of 91 FTE jobs per annum), while a total of 514 FTE jobs (average of 20 FTE jobs per annum) are in relation to the construction of transmission pipes.

FIGURE 9.8 BREEZE DIRECT EMPLOYMENT, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



SOURCE: ACIL ALLEN CONSULTING

However, the total employment impact of the Industry development under the BREEZE scenario is minimal, due to the resulting draw on labour from other industries in the Territory and other parts of Australia.

Over the study period, the Industry is estimated to create 2,145 FTE direct and indirect FTE jobs at an average of 82.5 FTE jobs per annum in the Northern Territory. However, ACIL Allen modelling assumes that these positive impacts will be completely offset by the reallocation of employment from the Rest of Australia to the Territory.

9.5.2 Industry real employment

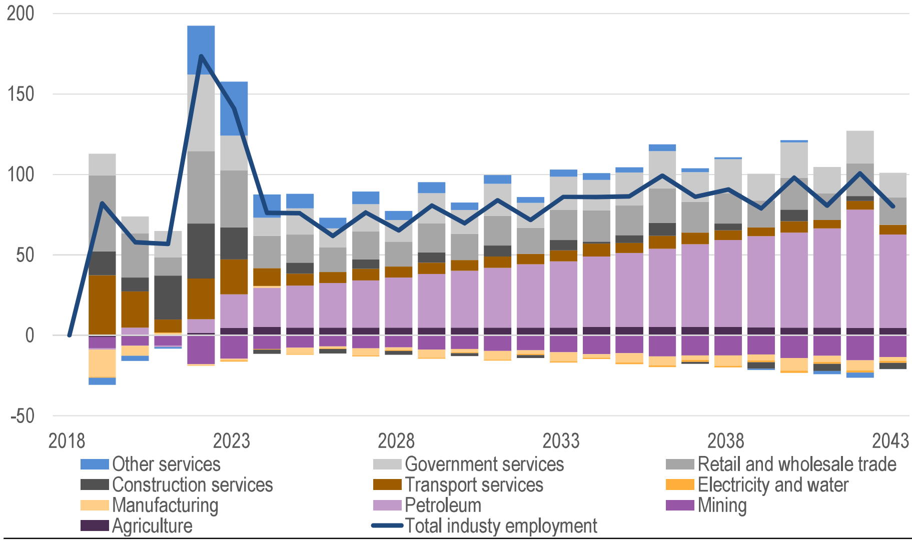
While the development of the Industry under the BREEZE development scenario results in the reallocation of some labour resources from other industries, on average the real employment impact is significantly positive for the Territory (refer to Figure 9.9).

Over the study period, the Petroleum industry is estimated to see the largest real employment impact, with the creation of 910 FTE jobs at an average of 35 FTE jobs per annum. Significant gains are also estimated in the Retail and Wholesale Trade industry, with a total of 526 FTE jobs at an average of 20.3 FTE jobs per annum to be created, as a result of increased household consumption in the Territory.

The Government Service industry (462 FTE jobs at an average of 17.8 FTE jobs per annum), Transport Services industry (253 FTE jobs at an average of 9.7 FTE jobs per annum) and Construction Services industry (141 FTE jobs at an average of 5.4 FTE jobs per annum) are also estimated to see solid employment gains over the study period under the BREEZE development scenario.

The majority of the labour reallocation, as a result of the development of the Industry, is estimated to occur in Mining (loss of 265 FTE jobs at an average of 10.2 FTE jobs per annum), Manufacturing (loss of 100 FTE jobs at an average of 3.9 FTE jobs per annum) and Electricity and Water (loss of 18.5 FTE jobs at an average of 0.7 FTE jobs per annum).

FIGURE 9.9 BREEZE NORTHERN TERRITORY DIRECT AND INDIRECT EMPLOYMENT BY INDUSTRY, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



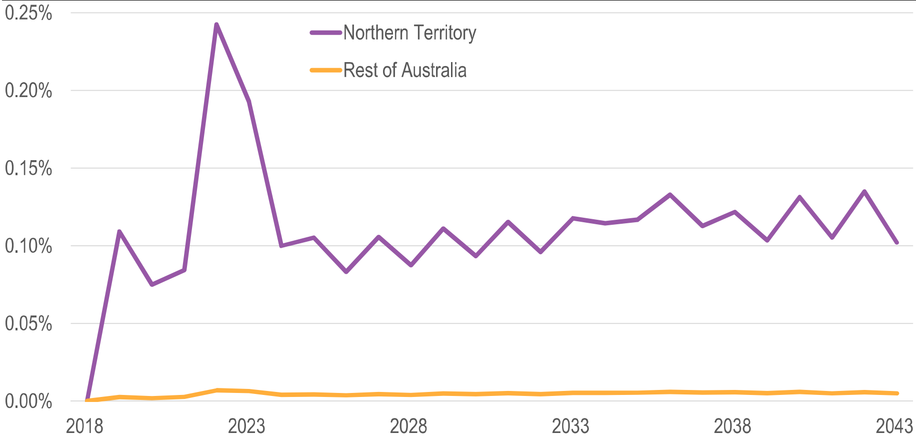
SOURCE: ACIL ALLEN CONSULTING

9.5.3 Real wages

The development of the Industry is estimated to boost real wages in the Northern Territory relative to the Rest of Australia (refer to Figure 9.10).

Over the study period, the increase in real wages is estimated to be on average 0.11 per cent per annum higher than the base case, peaking at 0.24 per cent in 2022 when the demand for labour in the Territory is at its highest. The impact across the Rest of Australia is negligible over the study period, given that there is no job creation under the BREEZE scenario.

FIGURE 9.10 BREEZE REAL WAGE GROWTH, DEVIATION FROM BASELINE, REAL TERMS, PERCENTAGE



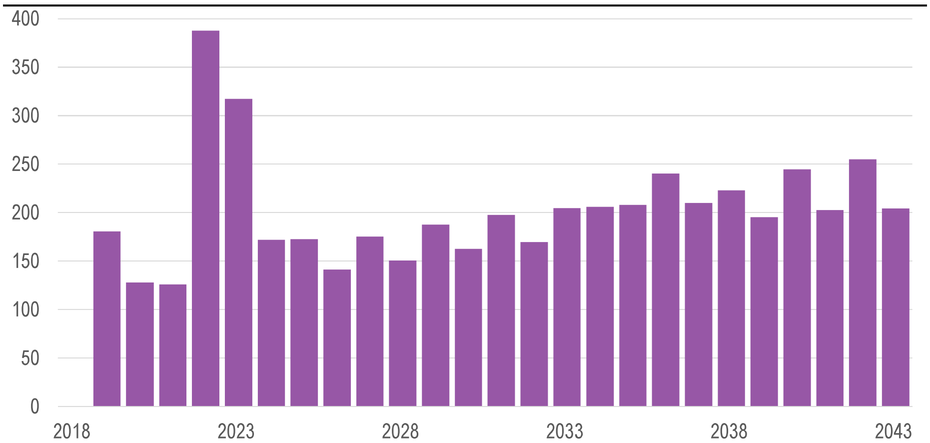
SOURCE: ACIL ALLEN CONSULTING

9.6 Population

The population of the Northern Territory, resulting from the development of the Industry under the BREEZE scenario, is largely driven by interstate migration as workers and their families relocate to the Territory to take up employment opportunities created by the development of the Industry.

Over the study period, it is estimated the population in the Northern Territory will increase by an average of 195 persons per annum. The population impact peaks during the capital intensive construction phase of the development of the Industry at 388 persons in 2022.

FIGURE 9.11 BREEZE NORTHERN TERRITORY REAL POPULATION, DEVIATION FROM BASELINE, REAL TERMS, NUMBER



SOURCE: ACIL ALLEN CONSULTING

9.7 Real taxation

The development of the Industry under the BREEZE scenario will generate significant taxation benefits to the Northern Territory and the Commonwealth Government, primarily in the form of profits based taxes, royalty revenues, payroll tax and a range of other taxes.

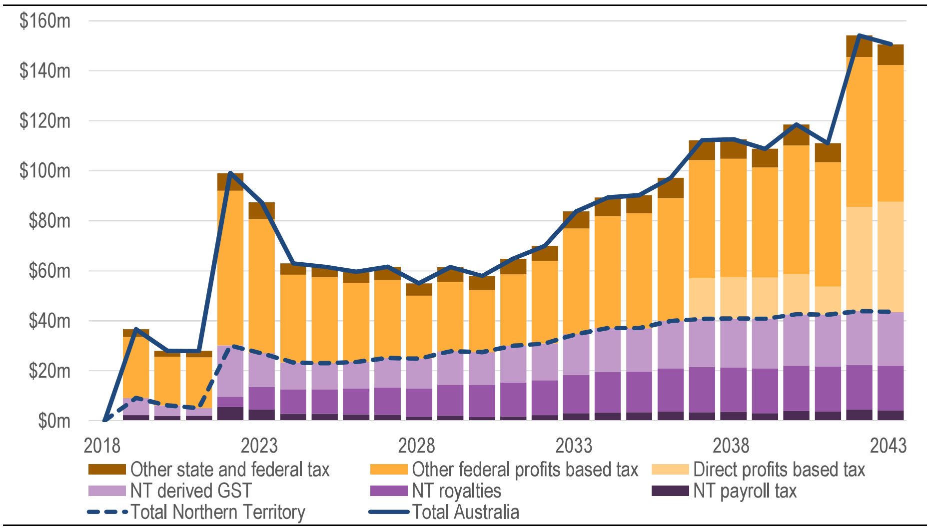
Over the study period, payments to the Commonwealth are projected to be substantial (refer to Figure 9.12). ACIL Allen estimates that the direct profits based taxation payments from the Industry would total $162 million at an average of $6.2 million per annum over the study period. There will also be significant indirect taxation payments collected by the Commonwealth, with payments totalling $989 million at an average of $38 million per annum.

The development of the Industry is estimated to generate other indirect taxation payments to the Commonwealth (such as personal income, excises, fringe benefits and capital gains tax receipts), totalling $154 million at an average of $5.9 million per annum.

Payments made to the Territory Government are expected to be largely accrued through royalty payments, which are estimated to total $309 million at an average of $11.9 million per annum over the study period. Direct and indirect payroll taxation payments to the Territory Government due to the development of the Industry are estimated to total $74.8 million at an average of $5.9 million per annum over the study period.

Increased commercial activity in the Territory is also estimated to result in GST revenues increasing by $373 million at an average of $14.3 million per annum over the study period.

FIGURE 9.12 BREEZE REAL TAXATION, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

9.8 Summary

Table 9.1 presents a summary of the economic modelling results presented in the section.

TABLE 9.1 BREEZE DEVELOPMENT SCENARIO, SUMMARY OF ECONOMIC IMPACT RESULTS

	Total	Average	NPV (7 per cent)
Real income			
Northern Territory	$937.2m	$36.0m	$380.1m
Rest of Australia	$3,339.9m	$128.5m	$1,099.0m
Total Australia	**$4,277.2m**	**$164.5m**	**$1,479.1m**
Real output			
Northern Territory	$5,107.9m	$196.5m	$1,742.3m
Rest of Australia	$406.5m	$15.6m	$118.7m
Total Australia	**$5,514.4m**	**$212.1m**	**$1,861.0m**
Real Final Demand			
Northern Territory	$3,277.7m	$126.1m	$1,683.0m
Rest of Australia	$2,042.2m	$78.5m	$684.8m
Total Australia	**$5,319.9m**	**$204.6m**	**$2,367.8m**
Real investment			
Northern Territory	$2,264.8m	$87.1m	$1,265.0m
Rest of Australia	-$359.3m	-$13.8m	-$113.7m
Total Australia	**$1,905.4m**	**$73.3m**	**$1,151.2m**
Northern Territory real exports			
International	-$572.5m	-$22.0m	-$225.9m
Interstate	$5,791.6m	$222.8m	$1,948.0m
Total	**$5,219.1m**	**$200.7m**	**$1,722.1m**
Real employment			
Northern Territory	2,145 FTEs	82 FTEs	
Rest of Australia	-2,145 FTEs	-82 FTEs	
Total Australia	**0 FTEs**	**0 FTEs**	
Real employment by industry			
Agriculture	103 FTEs	4 FTEs	
Mining	-265 FTEs	-10 FTEs	
Petroleum	910 FTEs	35 FTEs	
Manufacturing	-100 FTEs	-4 FTEs	
Electricity and water	-19 FTEs	-1 FTEs	
Transport services	253 FTEs	10 FTEs	
Construction services	141 FTEs	5 FTEs	

	Total	Average	NPV (7 per cent)
Retail and wholesale trade	526 FTEs	20 FTEs	
Government services	462 FTEs	18 FTEs	
Other services	133 FTEs	5 FTEs	
Total industry employment	**2,145 FTEs**	**82 FTEs**	
Real population			
Northern Territory	5,061 persons	195 persons	
Real taxation			
Northern Territory			
Payroll tax	$74.8m	$2.9m	$31.0m
Royalties	$309.2m	$11.9m	$105.3m
Derived GST	$372.9m	$14.3m	$139.9m
Total Northern Territory	**$757.0m**	**$29.1m**	**$276.1m**
Commonwealth			
Direct profits based tax	$162.3m	$6.2m	$32.8m
Other federal profits based tax	$988.8m	$38.0m	$395.9m
Other state and federal tax	$154.4m	$5.9m	$59.1m
Total Commonwealth	**$1,305.4m**	**$50.2m**	**$487.8m**
Total Australia	**$2,062.4m**	**$79.3m**	**$764.0m**

SOURCE: ACIL ALLEN CONSULTING

10 WIND SCENARIO

This section explores the broader economic impacts of development of an onshore unconventional shale gas industry, as represented in the previous sections as ProjectCo and PipelineCo. The economic impact will be assessed over the period from 2018 to 2043 for the Northern Territory and Rest of Australian economies on the following terms:

— the impact on **real incomes** (a measure of economic welfare or standard of living);
— the impact on **real output** (as measured in terms of Gross Domestic Product, Gross State/Territory Product, National/State Final Demand, Business Investment and Exports),
— the impact on **employment** (as measured on a full time equivalent job basis);
— the impact on **real wages growth**;
— the impact on **population growth**; and
— the impact on **total taxation payments** (those taxes directly paid by the industry, and the indirect taxes paid as a result of the activity generated from the industry).

For purposes of the reporting, the economic impact of ProjectCo and PipelineCo will be referred to as the "Onshore Unconventional Gas Industry" or "the Industry".

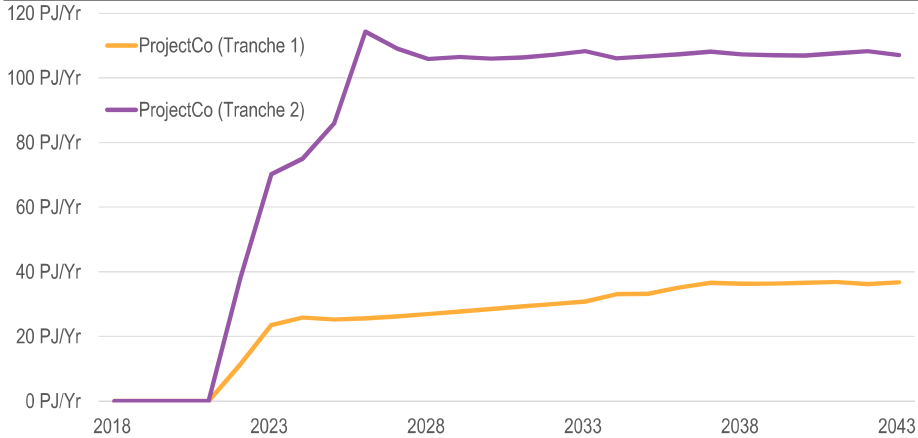
The economic impact of the development of the Industry under the WIND development scenario, as detailed in Section 4.3.3, was assessed using ACIL Allen's *Tasman Global* CGE model. Further details on *Tasman Global* are presented in Appendix E.

10.1 Scenario description

As discussed in Section 4.3.3, under the WIND development scenario, the target production rate increases to 400TJ/day. The majority of gas under this scenario is placed into the East Coast market, requiring additional pipeline infrastructure to be developed as the capacity of the existing NGP is reached. Pipeline-related assumptions are outlined in Section 3.5.1.

The production profile of Industry in the WIND scenario, relative to the BREEZE scenario, is presented in Figure 10.1.

FIGURE 10.1 GAS PRODUCTION, WIND SCENARIO, PJ/ANNUM



SOURCE: ACIL ALLEN CONSULTING

Under the WIND development scenario, the following investment into transmission gas pipelines is also assumed to occur:

— tie into Amadeus pipeline;
— Amadeus duplication;
— National Gas Pipeline duplication; and
— Carpentaria Gas Pipeline duplication.

These assumption are discussed in Section 4.7.

10.2 Real income

The development of the Industry has a significant impact on the real income of Australia. Real income is a measure of the economic welfare (or standard of living) improvement as a result of the developments. The change in real income captures the effect of net foreign income transfers associated with ownership of the capital along with changes in the purchasing power of Australian residents.

The real income impact of the Industry is largely accrued through the profits generated by the Industry once it is operational, which also determines the level of profits based taxation paid by the Industry. Overall, the majority of the real income impact of the development under the WIND scenario is transferred from the Northern Territory to the Rest of Australia, in the form of Commonwealth Government taxes and because the equity ownership of the Industry is assumed to be largely on the east coast of Australia.

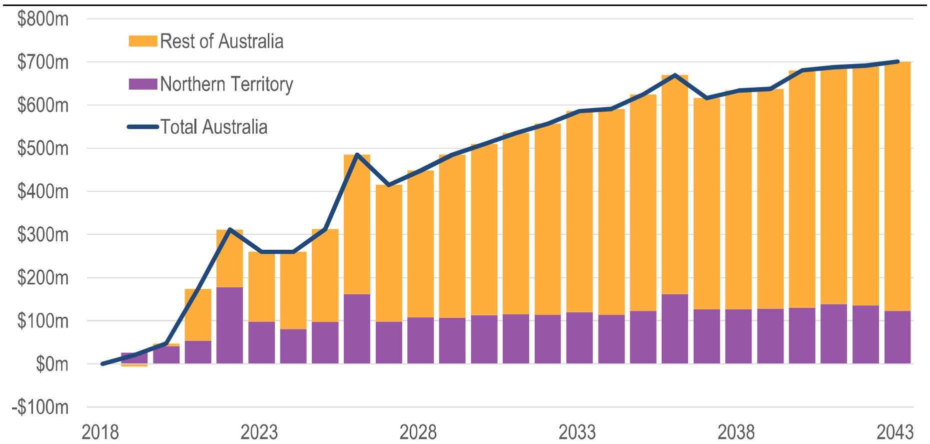
Real income impacts are still realised in the Territory, through increased employment and a redistribution of the profits based taxation payments from the Commonwealth back to the Territory. Royalty and payroll taxation payments made to the Northern Territory Government and payments made to pastoralists and native title owners also contribute to the real income impact in the Territory.

In total, the real income impact of the Industry is estimated to total $11.9 billion at an average of $459 million per annum over the study period (refer to Figure 10.2). The real income impact reaches a steady state of around $690 million per annum in 2040.

Over the study period, the real income impact in the Northern Territory is estimated to total $2.8 billion, at an average of $108 million per annum. Real incomes are expected to peak at $177 million in 2022, which coincides with peak employment and peak wages growth in the Territory. Once the Industry reaches its steady state level of production, the real income impact in the Territory averages around $130 million per annum, with further boosts in 2026 and 2036 as a result of investment in to transmission gas pipelines.

The real income impact is largely felt on the east coast of Australia, which is estimated to total $9.1 billion at an average of $351 million per annum over the study period. Real incomes are expected to peak in 2043 at $578 million, when the Industry is at a steady state of production.

FIGURE 10.2 WIND REAL INCOME, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

10.3 Real output

The real output impact is largely accrued through the impact the Industry has on investment in the Northern Territory and the value of the gas exported from the Territory to the Rest of Australia. The real output impact of the Industry is different to the real income impact because, in an output sense, the value of the gas exported is realised in the Territory, whereas in an income sense, the value of the gas exported is realised through profits generated and taxation payments, which largely accrue on the east coast of Australia.

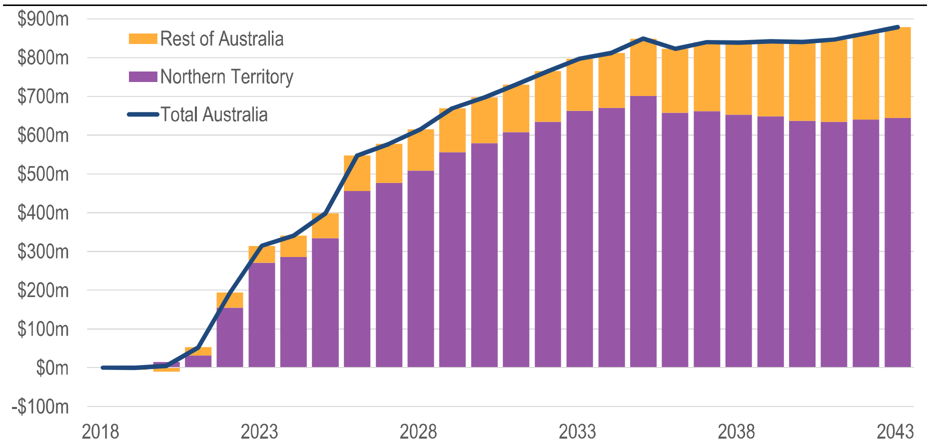
Under the WIND development scenario, real output is estimated to total $15.1 billion at an average of $582 million per annum over the study period (refer to Figure 10.3). The real output impact reaches a steady state of around $846 million per annum in 2036.

Over the study period, the real output impact in the Northern Territory is estimated to total $12.1 billion, at an average of $466 million per annum. Real output is expected to increase over the study period in line with the increase in the level of production. At steady state production in 2037, output in the Territory is estimated to average $646 million per annum.

Relative to the size of the Northern Territory's economy, the increase in real output from the development of the Industry represents a boost to Gross Territory Product of 0.31 per cent in 2037, once the level of real output reaches a steady state.

Across the Rest of Australia, the real output impact is largely driven by an increase to consumption by the household sector, as a result of the rising real incomes from the development on the Rest of Australia. Over the study period, it is estimated the real output impact on the Rest of Australia will total $406 million at an average of $15.6 million per annum.

FIGURE 10.3 WIND REAL OUTPUT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

10.3.1 Real Final Demand

Final Demand is the component of real output that accounts for all domestic economic activity. As it does not include exports or imports, the magnitude and timing of the impacts on Final Demand differ from the broader measure of real output.

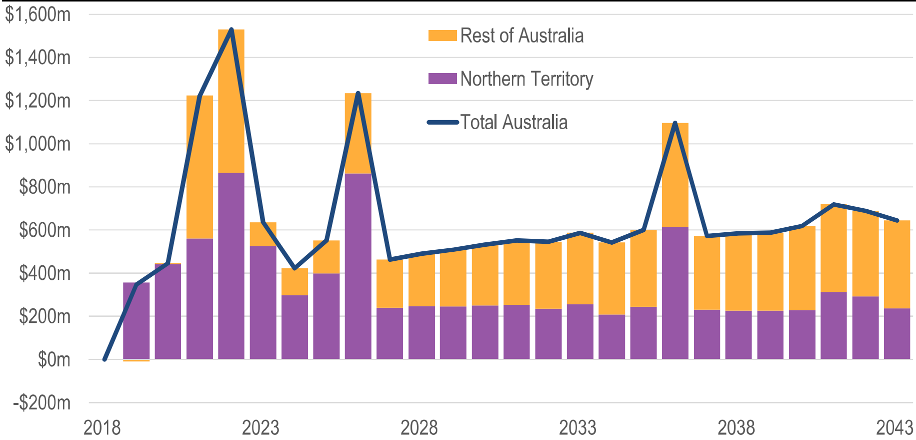
The real Final Demand impact of development under the WIND scenario in the Northern Territory is largely accrued through the investment needed to fund the Industry's capital requirements and the additional investment needed for transmission gas pipelines. For the Rest of Australia the impact largely results from the household consumption impacts that are accrued from rising real incomes resulting from the development, as well as further investment in transmission gas pipelines in Eastern Australia.

In total, the real Final Demand impact of development under the WIND scenario is estimated to total $16.7 billion at an average of $643 million per annum over the study period (refer to Figure 10.4).

Real Final Demand in the Territory is expected to peak at $865 million in 2022, during the Industry's capital intensive development phase and transmission pipeline construction. Over the study period, the Final Demand impact is estimated to total $8.9 billion at an average of $340 million per annum.

Throughout the Rest of Australia, the real Final Demand impact of the Industry is more significant than the impact under the BREEZE development scenario, due to the estimated increase in household consumption and also the construction of transmission gas pipelines on the east coast of Australia. Over the study period, the Final Demand impact is estimated to total $7.9 billion at an average of $303 million per annum.

FIGURE 10.4 WIND REAL FINAL DEMAND, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

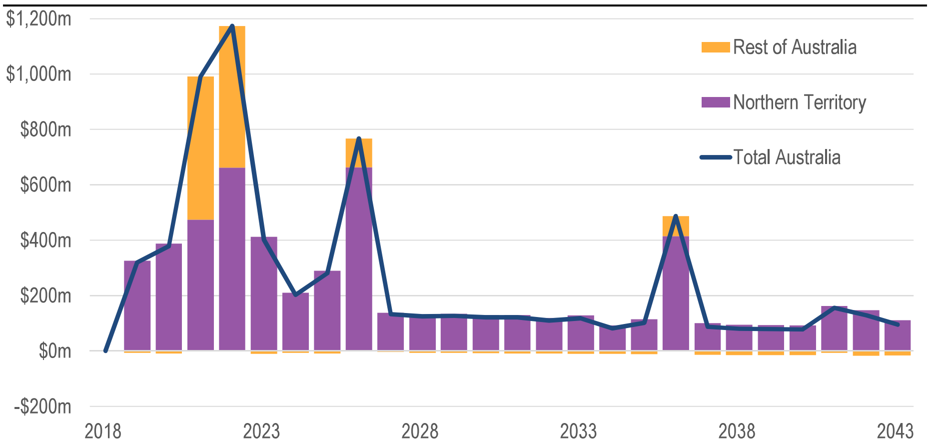
Real investment

In the Northern Territory, the major component of the Industry's real Final Demand impact is in relation to investment, and is the result of the ongoing capital intensive nature of unconventional shale gas developments.

In total, the real investment impact of the Industry is estimated to total $6.7 billion at an average of $259 million per annum over the study period (refer to Figure 10.5). Real investment peaks in 2022 during the development of the Industry and construction of the transmission gas pipelines at $1.5 billion.

Following the capital intensive initial production phase of the Industry, the real investment reduces as less capital is required to reach the target production level. Over the study period, real investment in the Territory is estimated to total $5.8 billion at an average of $222 million per annum.

FIGURE 10.5 WIND REAL INVESTMENT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Across the Rest of Australia, a small boost to real investment is realised through the construction of gas transmission pipelines. However, ACIL Allen also estimates that as a result of a reallocation of labour resources to the Northern Territory, real investment falls in most years through the study period across the

Rest of Australia. The impact on real investment throughout the Rest of Australia increases by $983 million at an average of $37.8 million per annum over the study period.

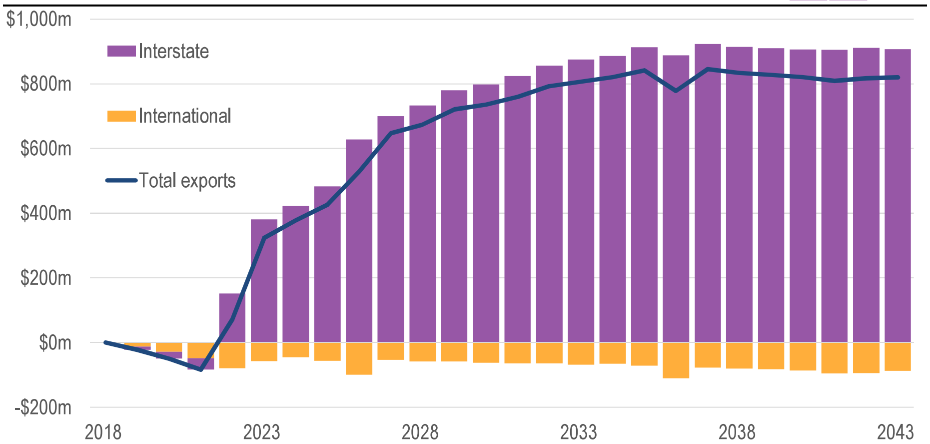
10.3.2 Real exports

The impact the Industry has on the Northern Territory's real exports is the other main driver of the impact on the Territory's real output. While gas is not exported to international markets under the WIND development scenario, it is exported from the Territory to the Rest of Australia (specifically the east coast of Australia).

Over the study period, the development is estimated to increase real exports by $14.9 billion at an average of $574 million per annum (refer to Figure 10.6). The increase in real exports is driven by the boost to interstate exports ($16.6 billion over the study period or $640 million per annum), which offsets the small decrease in international exports resulting from the impact of an expected appreciation in the Australian Dollar ($1.7 billion over the study period or $65.7 million per annum).

Once a steady state of real exports is reached in 2037, it is estimated that the exports generated by the Industry under the WIND development scenario would account for 4.4 per cent of the Territory's total exports.

FIGURE 10.6 WIND NORTHERN TERRITORY REAL EXPORTS, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

10.4 Real output – industry

Figure 10.7 displays the impact the Industry has on the real output by industry in the Northern Territory. Under the WIND development scenario, the largest impact will be realised in the Petroleum industry, given that the Industry would be captured under this industry classification. It is estimated that the Petroleum industry will generate growth over and above the base case of 5.7 per cent per annum on average over the study period.

The Construction Services industry is also expected to increase over the study period, averaging growth of 0.9 per cent per annum. The majority of this growth will be realised in the early stages of the Industry's development, with growth expected to peak at 3.3 per cent in 2022.

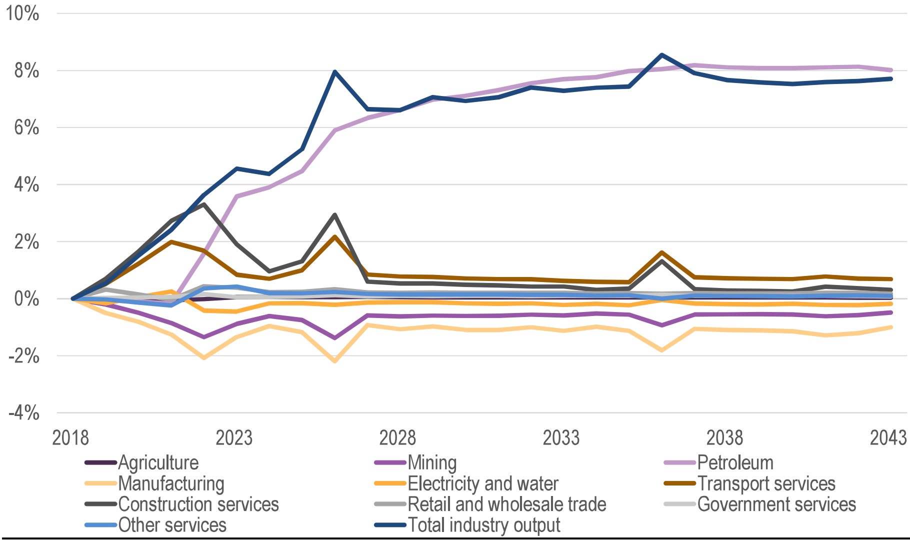
The Transport Services industry is also estimated to follow a similar trend, growing on average by 0.9 per cent per annum and peaking at two per cent in 2021, relative to the base case.

The Manufacturing industry is estimated to contract on average by 1.1 per cent per annum over the study period. This reflects the impact of an appreciation in the Australian Dollar on the global competitiveness of export competing businesses in the Territory. In addition, a reallocation of labour away from the

Manufacturing industry to the Petroleum industry results in lower output from the industry. A similar impact occurs in the Mining and Electricity and Water industries, which are estimated to contract on average by 0.6 per cent and 0.2 per cent per annum over the study period.

Across all industries, the development of the Industry in the Territory will have a marginal impact on the growth across most industries. Overall, industry growth is estimated to be six per cent per annum higher than what would otherwise have occurred, if the development of the Industry did not occur.

FIGURE 10.7 WIND NORTHERN TERRITORY REAL OUTPUT BY INDUSTRY, PERCENTAGE CHANGE FROM BASELINE, REAL TERMS, PERCENTAGE



SOURCE: ACIL ALLEN CONSULTING

10.5 Labour market

10.5.1 Employment

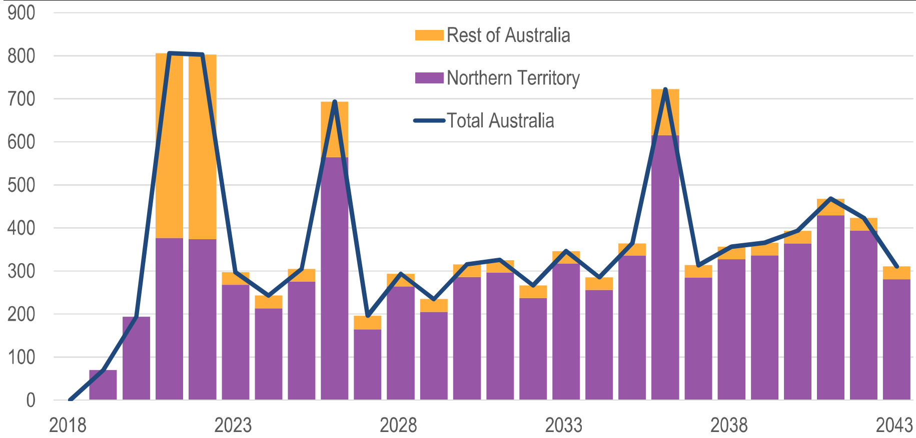
The development of a new industry in the Territory under the WIND development scenario has significant workforce implications. The largest component of the Industry's direct workforce is the staff required to operate the wells and pads. Staff required to operate additional transmission gas pipelines also has a significant impact of direct employment in the Rest of Australia.

The 'peaking' nature of the FTE requirements presented in Figure 10.8 is a result of the timing of the construction workforce requirements. Labour required for the construction of gas transmission pipelines in the Territory in 2021, 2022, 2026 and 2036 also contributes to this 'peaking' nature, but on a smaller scale.

Over the study period, it is estimated the development of the Industry will require direct employment of 7,730 FTE jobs at an average of 297 FTE jobs per annum in the Territory. The majority of these FTE jobs are in relation to the construction and operations of the Industry (total of 5,905 FTE jobs at an average of 227 FTE jobs per annum), while a total of 1,824 FTE jobs (average of 70 FTE jobs per annum) are in relation to the construction and operations of transmission pipes.

Throughout the Rest of Australia, the construction and operations of transmission gas pipelines will require direct employment of 1,663 FTE jobs at an average of 63.9 FTE jobs per annum.

FIGURE 10.8 WIND DIRECT EMPLOYMENT, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



SOURCE: ACIL ALLEN CONSULTING

However, the total employment impact of the Industry development under the WIND scenario is minimal, due to the resulting draw on labour from other industries in the Territory and other parts of Australia.

Over the study period, the Industry is estimated to create 6,559 FTE direct and indirect FTE jobs at an average of 252 FTE jobs per annum in the Northern Territory. However, ACIL Allen estimates that these positive impacts will be completely offset by the reallocation of employment from the Rest of Australia to the Territory.

10.5.2 Industry real employment

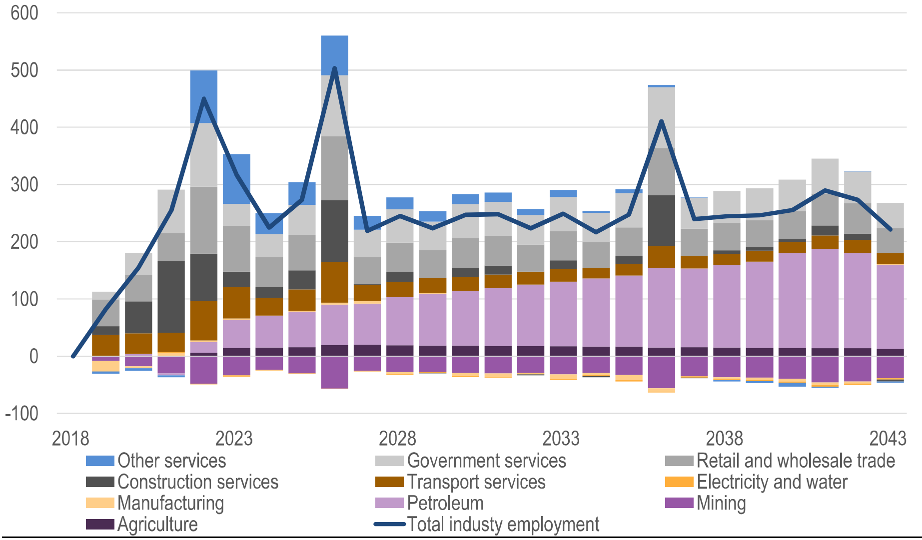
While the development of the Industry under the WIND development scenario results in the reallocation of some labour resources from other industries, on average the real employment impact is significantly positive for the Territory (refer to Figure 10.9).

Over the study period, the Petroleum industry is estimated to see the largest real employment impact, with the creation of 2,384 FTE jobs at an average of 92 FTE jobs per annum. Significant gains are also estimated in the Retail and Wholesale Trade industry, with a total of 1,437 FTE jobs at an average of 55 FTE jobs per annum to be created, as a result of increased household consumption in the Territory.

The Government Service industry (1,461 FTE jobs at an average of 56 FTE jobs per annum), Transport Services industry (765 FTE jobs at an average of 29 FTE jobs per annum) and Construction Services industry (671 FTE jobs at an average of 26 FTE jobs per annum) are also estimated to see solid employment gains over the study period under the WIND development scenario.

The majority of the labour reallocation, as a result of the development of the Industry, is estimated to occur in Mining (loss of 843 FTE jobs at an average of 32 FTE jobs per annum), Manufacturing (loss of 56 FTE jobs at an average of two FTE jobs per annum) and Electricity and Water (loss of 34 FTE jobs at an average of one FTE jobs per annum).

FIGURE 10.9 WIND NORTHERN TERRITORY DIRECT AND INDIRECT EMPLOYMENT BY INDUSTRY, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



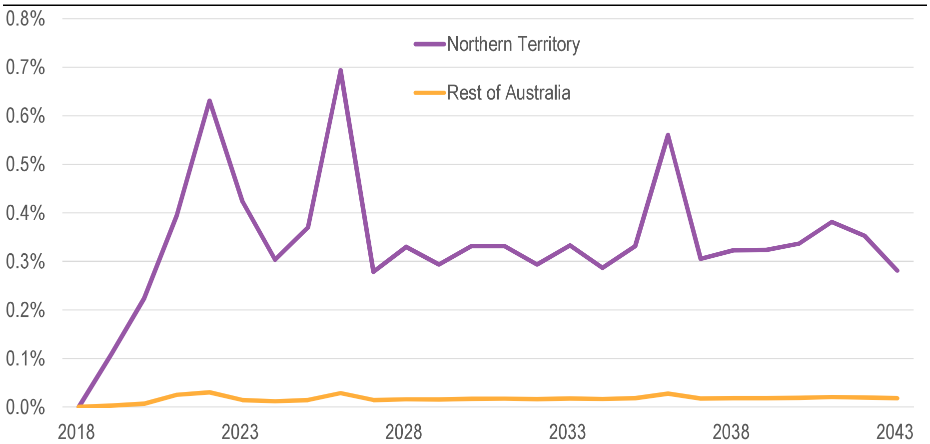
SOURCE: ACIL ALLEN CONSULTING

10.5.3 Real wages

The development of the Industry is estimated to boost real wages in the Northern Territory relative to the Rest of Australia (refer to Figure 10.10).

Over the study period, the increase in real wages is estimated to be on average 0.34 per cent per annum higher than the base case, peaking at 0.69 per cent in 2026 when the demand for labour in the Territory is at its highest. The impact across the Rest of Australia is negligible over the study period, given that there is no net job creation under the WIND scenario.

FIGURE 10.10 WIND REAL WAGE GROWTH, DEVIATION FROM BASELINE, REAL TERMS, PERCENTAGE



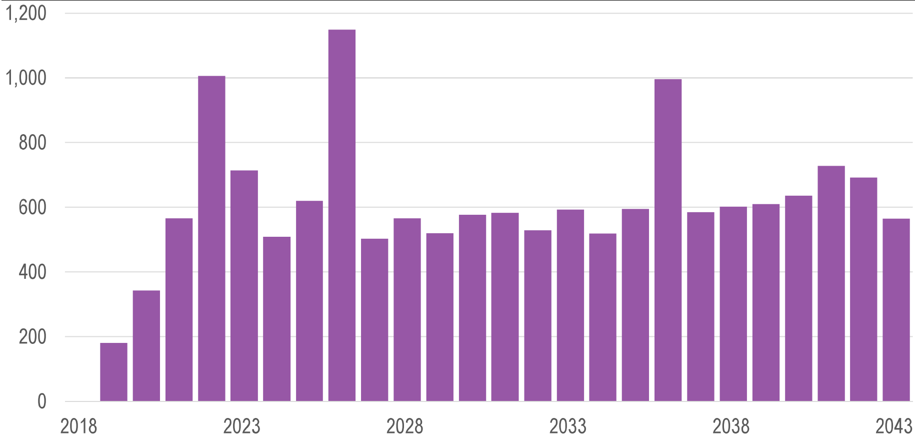
SOURCE: ACIL ALLEN CONSULTING

10.6 Population

The population of the Northern Territory, resulting from the development of the Industry under the WIND scenario, is largely driven by interstate migration as workers and their families relocate to the Territory to take up employment opportunities created by the development of the Industry.

Over the study period, it is estimated the population in the Northern Territory will increase by an average of 595 persons per annum. The population impact peaks during the capital intensive construction phase of the development of the Industry at 1,005 persons in 2022.

FIGURE 10.11 WIND NORTHERN TERRITORY REAL POPULATION, DEVIATION FROM BASELINE, REAL TERMS, NUMBER



SOURCE: ACIL ALLEN CONSULTING

10.7 Real taxation

The development of the Industry under the WIND scenario will generate significant taxation benefits to the Northern Territory and the Commonwealth Government, primarily in the form of profits based taxes, royalty revenues, payroll tax and a range of other taxes.

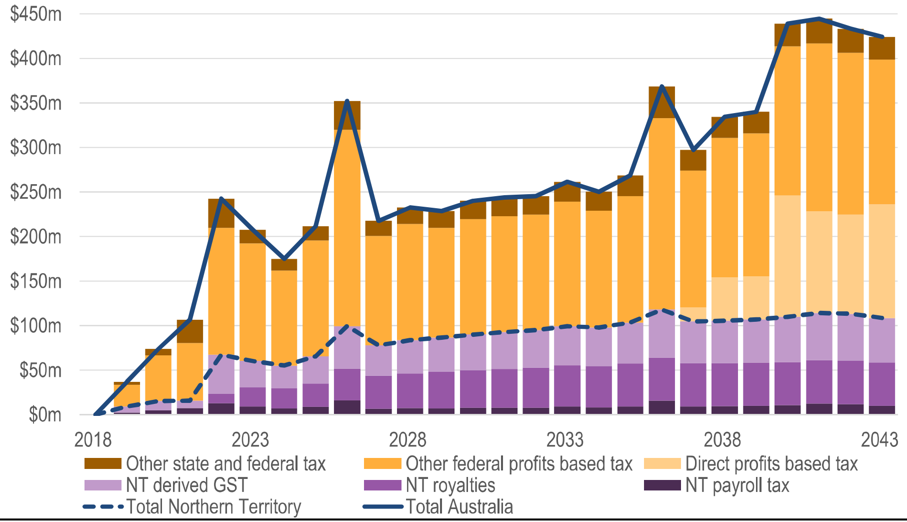
Over the study period, payments to the Commonwealth are projected to be substantial (refer to Figure 10.12). ACIL Allen estimates that the direct profits based taxation payments from the Industry would total $602 million at an average of $23.2 million per annum over the study period. There will also be significant indirect taxation payments collected by the Commonwealth, with payments totalling $3.4 billion at an average of $132 million per annum.

The development of the Industry is estimated to generate other indirect taxation payments to the Commonwealth (such as personal income, excises, fringe benefits and capital gains tax receipts), totalling $542 million at an average of $20.8 million per annum.

Payments made to the Territory Government are expected to be largely accrued through royalty payments, which are estimated to total $895 million at an average of $34.4 million per annum over the study period. Direct and indirect payroll taxation payments to the Territory Government due to the development of the Industry are estimated to total $227 million at an average of $8.7 million per annum over the study period.

Increased commercial activity in the Territory is also estimated to result in GST revenues increasing by $973 million at an average of $37.4 million per annum over the study period.

FIGURE 10.12 WIND REAL TAXATION, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

10.8 Summary

Table 10.1 presents a summary of the economic modelling results presented in the section.

TABLE 10.1 WIND DEVELOPMENT SCENARIO, SUMMARY OF ECONOMIC IMPACT RESULTS

	Total	Average	NPV (7 per cent)
Real income			
Northern Territory	$2,818.1m	$108.4m	$1,116.2m
Rest of Australia	$9,120.0m	$350.8m	$3,074.0m
Total Australia	**$11,938.1m**	**$459.2m**	**$4,190.2m**
Real output			
Northern Territory	$12,126.1m	$466.4m	$4,178.0m
Rest of Australia	$3,011.7m	$115.8m	$958.6m
Total Australia	**$15,137.8m**	**$582.2m**	**$5,136.6m**
Real Final Demand			
Northern Territory	$8,851.0m	$340.4m	$4,351.2m
Rest of Australia	$7,869.6m	$302.7m	$3,127.5m
Total Australia	**$16,720.6m**	**$643.1m**	**$7,478.7m**
Real investment			
Northern Territory	$5,759.1m	$221.5m	$3,098.7m
Rest of Australia	$983.0m	$37.8m	$754.0m
Total Australia	**$6,742.0m**	**$259.3m**	**$3,852.7m**
Northern Territory real exports			

	Total	Average	NPV (7 per cent)
International	-$1,707.8m	-$65.7m	-$658.8m
Interstate	$16,632.2m	$639.7m	$5,657.9m
Total	**$14,924.3m**	**$574.0m**	**$4,999.1m**
Real employment			
Northern Territory	6,559 FTEs	252 FTEs	
Rest of Australia	-6,559 FTEs	-252 FTEs	
Total Australia	**0 FTEs**	**0 FTEs**	
Real employment by industry			
Agriculture	345 FTEs	13 FTEs	
Mining	-843 FTEs	-32 FTEs	
Petroleum	2,384 FTEs	92 FTEs	
Manufacturing	-56 FTEs	-2 FTEs	
Electricity and water	-34 FTEs	-1 FTEs	
Transport services	765 FTEs	29 FTEs	
Construction services	671 FTEs	26 FTEs	
Retail and wholesale trade	1,437 FTEs	55 FTEs	
Government services	1,461 FTEs	56 FTEs	
Other services	429 FTEs	17 FTEs	
Total industry employment	**6,559 FTEs**	**252 FTEs**	
Real population			
Northern Territory	15,480 persons	595 persons	
Real taxation			
Northern Territory			
Payroll tax	$227.2m	$8.7m	$91.8m
Royalties	$894.6m	$34.4m	$307.5m
Derived GST	$972.7m	$37.4m	$362.7m
Total Northern Territory	**$2,094.4m**	**$80.6m**	**$762.1m**
Commonwealth			
Direct profits based tax	$602.1m	$23.2m	$120.5m
Other federal profits based tax	$3,437.5m	$132.2m	$1,332.6m
Other state and federal tax	$541.7m	$20.8m	$215.8m
Total Commonwealth	**$4,581.3m**	**$176.2m**	**$1,668.8m**
Total Australia	**$6,675.7m**	**$256.8m**	**$2,430.9m**

SOURCE: ACIL ALLEN CONSULTING

11 GALE SCENARIO

This section explores the broader economic impacts of development of an onshore unconventional shale gas industry, as represented in the previous sections as ProjectCo and PipelineCo. The economic impact will be assessed over the period from 2018 to 2043 for the Northern Territory and Rest of Australian economies on the following terms:

— the impact on **real incomes** (a measure of economic welfare or standard of living);
— the impact on **real output** (as measured in terms of Gross Domestic Product, Gross State/Territory Product, National/State Final Demand, Business Investment and Exports),
— the impact on **employment** (as measured on a full time equivalent job basis);
— the impact on **real wages growth**;
— the impact on **population growth**; and
— the impact on **total taxation payments** (those taxes directly paid by the industry, and the indirect taxes paid as a result of the activity generated from the industry).

For purposes of the reporting, the economic impact of ProjectCo and PipelineCo will be referred to as the “Onshore Unconventional Gas Industry” or “the Industry”.

The economic impact of the development of the Industry under the GALE development scenario, as detailed in Section 4.3.4, was assessed using ACIL Allen’s *Tasman Global* CGE model. Further details on *Tasman Global* are presented in Appendix E.

11.1 Scenario description

The Darwin LNG plant (DLNG) is currently supplied feed gas from the Bayu-Undan gas project off the coast of the Northern Territory in the Australia Timor-Leste Joint Petroleum Development Area. DLNG has a single production train[41], producing up to 3.7 million tonnes of LNG per annum for sales to Japan[42]. To produce 3.7 million tonnes of LNG, the plant requires approximately 225 PJ/year of feed gas.

As it stands, Bayu-Undan provides 100 per cent of the feed in gas to the plant. The field is set to reach maturity in 2022-23, and will progressively reduce its production. Unless replacement gas is found, DLNG will cease production some time towards the end of the next decade. Acknowledging this, the owners of the Bayu-Undan joint venture have begun independently investigating new sources of gas for the plant, at this stage focussed on a new large scale offshore development off the coast of the Northern Territory.[43]

Under the GALE scenario, ACIL Allen assumes the development of an onshore unconventional gas industry is able to build to a scale that would allow it to progressively replace the Bayu-Undan gas field as the feed in gas for DLNG, allowing the existing train to continue production beyond 2022-23 at current

[41] ConocoPhillips. 2017. *Our Business Activities – DLNG*. Accessed online at http://www.conocophilips.com.au/
[42] Santos. 2017. *Bayu-Undan/Darwin LNG Joint Venture*. Accessed online at http://www.santos.com/
[43] Energy News Bulletin. 2017. *Barossa development begins.* Accessed online at http://www.energynewsbulletin.net/

rates. This necessitates investment to expand the Amadeus Gas Pipeline to allow more gas to flow north to DLNG.

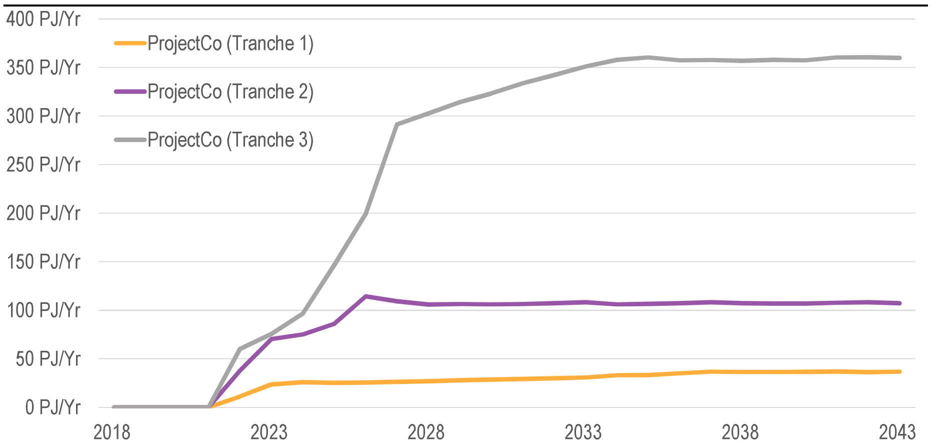
For the purposes of economic modelling, it is assumed that DLNG will continue to produce LNG at its current rate with or without gas from the onshore unconventional gas industry. In the base case, it is assumed one of the new offshore developments discussed above comes to pass and this gas backfills DLNG. This is a critical assumption, as it means there is no incremental value associated with LNG production attributable to onshore unconventional gas industry – the incremental value is any change to the production profile, profitability and local content of gas required to backfill DLNG in an onshore scenario versus an offshore scenario. This is discussed further in Section 6.

It is also assumed that due to increasing scale economies, the cost of production falls below the rate of the WIND scenario, allowing for increased gas sales into the East Coast gas market – potentially including partial backfill of an LNG train at Gladstone – versus the WIND scenario. In any event, the cascading effect of the onshore unconventional gas production results in a reduction in the wholesale price of gas in the East Coast market, with the "ripple" effect of injection of more gas flowing west to east leading to less gas produced in Queensland fields moving south. Similarly to DLNG, there is no incremental value associated with LNG backfill.

As such, this necessitates further investment in the NGP and Carpentaria Gas Pipeline over and above the investment assumed to be required to meet WIND East Coast exports. As a result, the Industry is able to fulfil its full target production of 1000 TJ/day by 2035. Economies of scale in production allowing it to increase its penetration of the East Coast market over the WIND scenario.

The production profile in the GALE scenario is presented in Figure 11.1.

FIGURE 11.1 GAS PRODUCTION, GALE SCENARIO, PJ/ANNUM



SOURCE: ACIL ALLEN CONSULTING

Under the GALE development scenario, the following investment into transmission gas pipelines are also assumed to occur:

- tie into Amadeus pipeline;
- Amadeus duplication;
- National Gas Pipeline duplication;
- Carpentaria Gas Pipeline duplication; and
- construction of DLNG feed pipeline.

These assumption are discussed in Section 4.7.

11.2 Real income

The development of the Industry has a significant impact on the real income of Australia. Real income is a measure of the economic welfare (or standard of living) improvement as a result of the developments. The change in real income captures the effect of net foreign income transfers associated with ownership of the capital along with changes in the purchasing power of Australian residents.

The real income impact of the Industry is largely accrued through the profits generated by the Industry once it is operational, which also determines the level of profits based taxation paid by the Industry. Overall, the majority of the real income impact of the development under the GALE scenario is transferred from the Northern Territory to the Rest of Australia, in the form of Commonwealth Government taxes and given the assumption that the equity ownership of ProjectCo is assumed to be largely on the east coast of Australia.

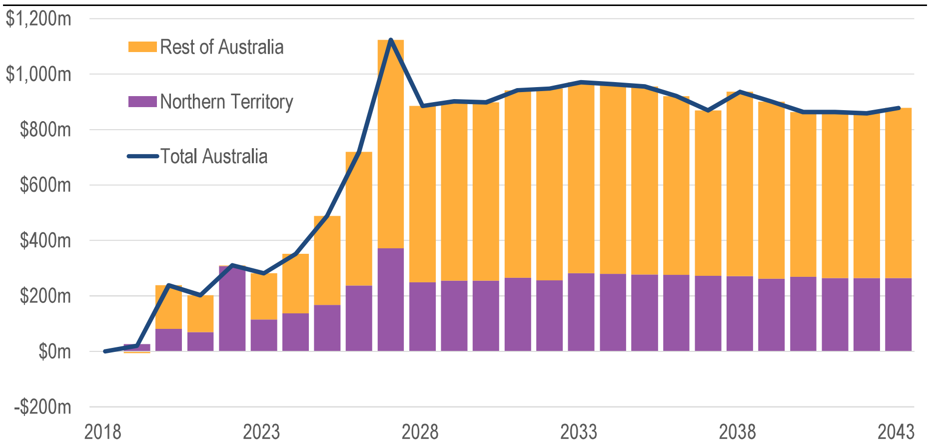
Real income impacts are still realised in the Territory, through increased employment and a redistribution of the profits based taxation payments from the Commonwealth back to the Territory. Royalty and payroll taxation payments made to the Northern Territory Government and payments made to pastoralists and native title owners also contribute to the real income impact in the Territory.

In total, the real income impact of the Industry is estimated to total $18.3 billion at an average of $703 million per annum over the study period (refer to Figure 11.2). The real income impact reaches a steady state of around $909 million per annum in 2028. Importantly, the real income impact under the GALE development scenario does not continue to increase like under the BREEZE and WIND development scenarios, because of the reallocation of feed-in gas to DLNG.

Over the study period, the real income impact in the Northern Territory is estimated to total $5.8 billion, at an average of $222 million per annum. Real incomes are expected to peak at $372 million in 2027, which coincides with peak employment and peak wages growth in the Territory. Once the Industry reaches its steady state level of production in 2037, the real income impact in the Territory averages around $267 million per annum.

The real income impact is largely felt on the east coast of Australia, which is estimated to total $12.5 billion at an average of $481 million per annum over the study period. Real incomes are also expected to peak in 2027 at $751 million.

FIGURE 11.2 GALE REAL INCOME, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

11.3 Real output

The real output impact is largely accrued through the impact the Industry has on investment in the Northern Territory and the value of the gas exported from the Territory to the Rest of Australia. The real output impact of the Industry is different to the real income impact because, in an output sense, the value of the gas exported is realised in the Territory, whereas in an income sense, the value of the gas exported is realised through profits generated and taxation payments, which largely accrue on the east coast of Australia.

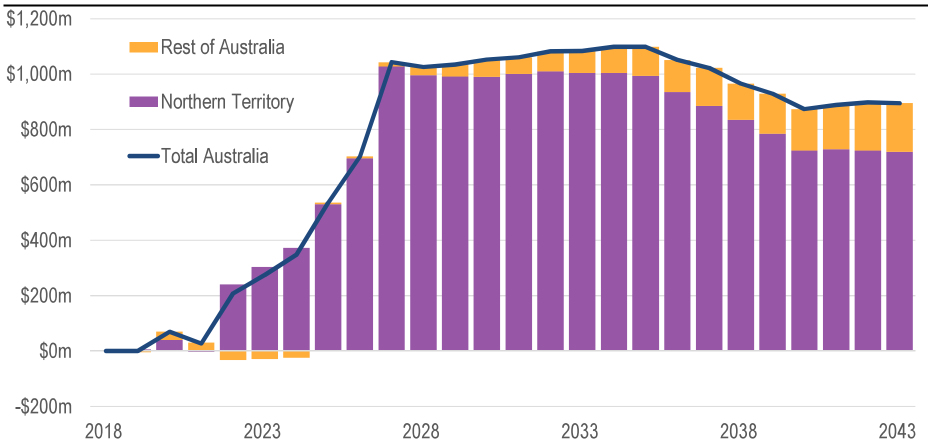
Under the GALE development scenario, real output is estimated to total $19.3 billion at an average of $741 million per annum over the study period (refer to Figure 11.3). Between 2027 and 2035 the real output impact average $1.1 billion per annum, and between 2036 and 2043 the average falls to $940 million per annum. This is due to a transfer between onshore and offshore gas for feed in stock for DLNG that occurs in 2036, which has no significant net real output impact. The majority of this impact is realised in the Territory.

Over the study period, the real output impact in the Northern Territory is estimated to total $17.5 billion, at an average of $674 million per annum. Real output is expected to increase over the study period in line with the increase in the level of production, until 2036 when the transfer between onshore and offshore gas occurs. Between 2027 and 2035 the real output impact average $1 billion per annum, and between 2036 and 2043 the average falls to $792 million per annum.

Relative to the size of the Northern Territory's economy, the increase in real output from the development of the Industry represents a boost to Gross Territory Product of 0.66 per cent in 2037. However, the boost to Gross Territory Product peaks at 1.2 per cent in 2027, and at the end of the study period falls to 0.55 per cent.

Across the Rest of Australia, the real output impact is largely driven by an increase to consumption by the household sector, as a result of the rising real incomes from the development on the Rest of Australia. Over the study period, it is estimated the real output impact on the Rest of Australia will total $1.7 billion at an average of $66.6 million per annum.

FIGURE 11.3 GALE REAL OUTPUT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

11.3.1 Real Final Demand

Final Demand is the component of real output that accounts for all domestic economic activity. As it does not include exports or imports, the magnitude and timing of the impacts on Final Demand differ from the broader measure of real output.

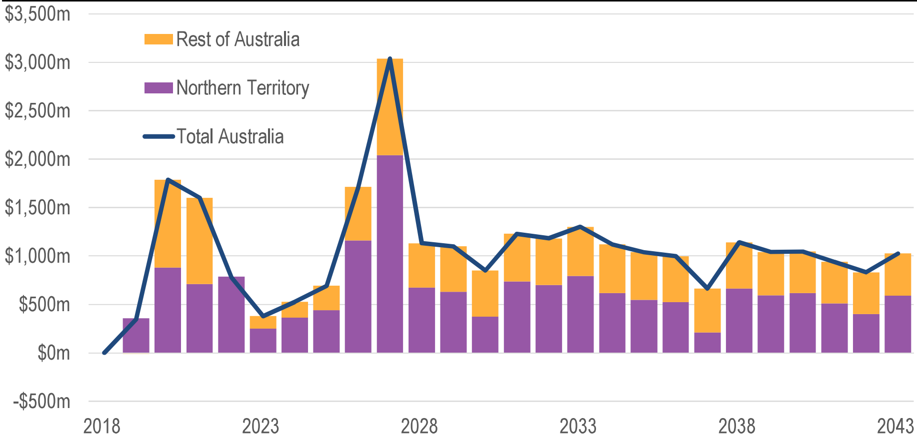
The real Final Demand impact of development under the GALE scenario in the Northern Territory is largely accrued through the investment needed to fund the Industry's capital requirements and investment needed for transmission gas pipelines. For the Rest of Australia the impact largely results from the household consumption impacts that are accrued from rising real incomes resulting from the development, and the additional investment into east coast transmission gas pipelines that is required.

In total, the real Final Demand impact of development under the GALE scenario is estimated to total $27.5 billion at an average of $1.1 billion per annum over the study period (refer to Figure 11.4).

Real Final Demand in the Territory is expected to peak at $2 million in 2022, during the Industry's capital intensive development phase and transmission pipeline construction. Over the study period, the Final Demand impact is estimated to total $16.2 billion at an average of $622 million per annum.

Throughout the Rest of Australia, the real Final Demand impact of the Industry is more significant than the impact under the BREEZE or WIND development scenarios, which is driven by an increase impact to household consumption and also the construction of transmission gas pipelines on the east coast of Australia. Over the study period, the Final Demand impact is estimated to total $11.3 billion at an average of $435 million per annum.

FIGURE 11.4 GALE REAL FINAL DEMAND, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Real investment

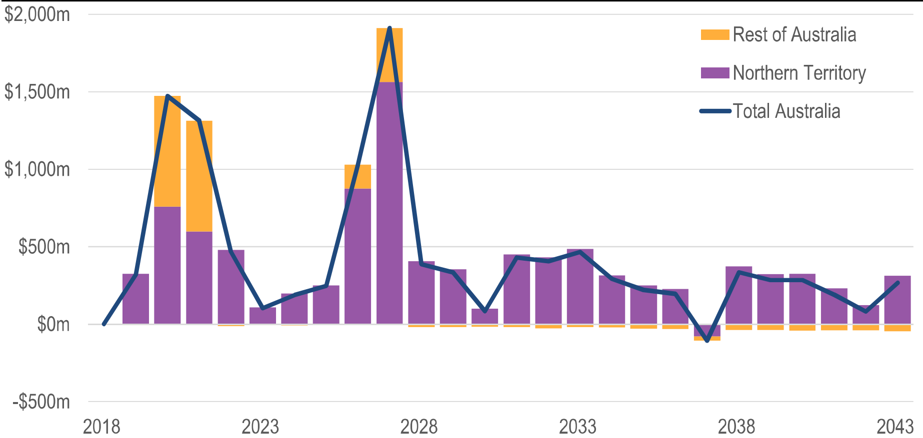
In the Northern Territory, the major component of the Industry's real Final Demand impact is in relation to investment, and is the result of the ongoing capital intensive nature of unconventional shale gas developments.

In total, the real investment impact of the Industry is estimated to total $11.2 billion at an average of $376 million per annum over the study period (refer to Figure 11.5). Real investment peaks in 2027 during the development of the Industry and construction of the transmission gas pipelines at $1.9 billion.

Following the capital intensive initial production phase of the Industry, the real investment reduces as less capital is required to reach the target production level. Over the study period, real investment in the Territory is estimated to total $9.8 billion at an average of $376 million per annum.

Across the Rest of Australia, a small boost to real investment is realised through the construction of gas transmission pipelines. However, ACIL Allen also estimates that as a result of a reallocation of labour resources to the Northern Territory, real investment falls in most years through the study period across the Rest of Australia. The impact on real investment throughout the Rest of Australia increases by $1.4 billion at an average of $54.6 million per annum over the study period.

FIGURE 11.5 GALE REAL INVESTMENT, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



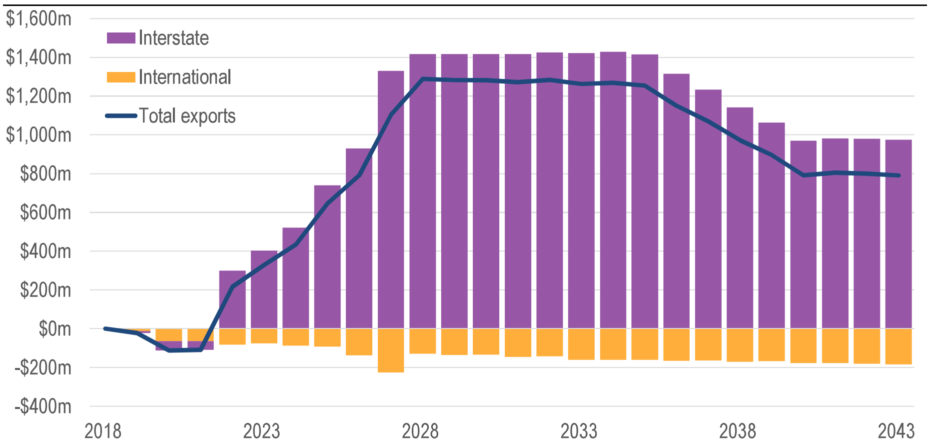
SOURCE: ACIL ALLEN CONSULTING

11.3.2 Real exports

The impact the Industry has on the Northern Territory's real exports is the other main driver of the impact on the Territory's real output. The majority of the gas is not exported to international markets under the GALE development scenario, but is exported from the Territory to the Rest of Australia (specifically the east coast of Australia). While some of the onshore stock from the development of the Industry replaces offshore feed-in stock to DLNG for international exports, because onshore gas is replacing offshore gas, the net impact on the value of the Territory's international exports is zero.

Over the study period, the development is estimated to increase real exports by $20.7 billion at an average of $798 million per annum (refer to Figure 11.6). The increase in real exports is driven by the boost to interstate exports ($24.1 billion over the study period or $929 million per annum), which offsets the small decrease in international exports resulting from the impact of an expected appreciation in the Australian Dollar ($3.4 billion over the study period or $131 million per annum).

FIGURE 11.6 GALE NORTHERN TERRITORY REAL EXPORTS, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

Between 2027 and 2035, the value of interstate exports from the Territory average $1.4 billion per annum, and by 2035 the Industry is estimated will account for 5.6 per cent of the Territory's exports. As the value of interstate exports falls to an average of $1.1 billion per annum thereafter, the Industry's contribution to the Territory's exports eases slightly to 3.7 per cent of total exports by 2043.

11.4 Real output – industry

Figure 11.7 displays the impact the Industry has on the real output by industry in the Northern Territory. Under the GALE development scenario, the largest impact will be realised in the Petroleum industry, given that the Industry would be captured under this industry classification. It is estimated that the Petroleum industry will generate growth over and above the base case of 10.6 per cent per annum on average over the study period. In 2036 when the offshore feed-in stock for DNLG is replaced by onshore feed-in stock, the growth of the industry is estimated to fall to growth of 8.8 per cent per annum.

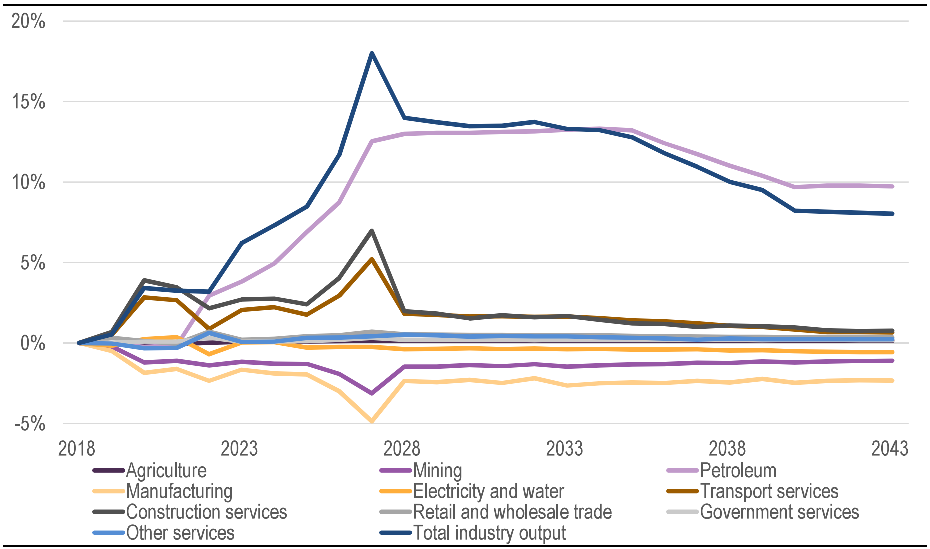
The Construction Services industry is also expected to increase over the study period, averaging growth of 1.9 per cent per annum. The majority of this growth will be realised in the early stages of the Industry's development, with growth expected to peak at seven per cent in 2027.

The Transport Services industry is also estimated to follow a similar trend, growing on average by 1.6 per cent per annum and peaking at 5.2 per cent in 2027, relative to the base case.

The Manufacturing industry is estimated to contract on average by 2.2 per cent per annum over the study period. This reflects the impact an appreciation in the Australian Dollar has on the global competitiveness of export competing businesses in the Territory. In addition, a reallocation of labour away from the Manufacturing industry to the Petroleum industry results in lower output from the industry. A similar impact occurs in the Mining and Electricity and Water industries, which are estimated to contract on average by 1.3 per cent and 0.3 per cent per annum over the study period.

Across all industries, the development of the Industry in the Territory will have a large impact on the growth across most industries. Overall, industry growth is estimated to be 9.4 per cent per annum higher than what would otherwise have occurred, if the development of the Industry did not occur.

FIGURE 11.7 GALE NORTHERN TERRITORY REAL OUTPUT BY INDUSTRY, PERCENTAGE CHANGE FROM BASELINE, REAL TERMS, PERCENTAGE



SOURCE: ACIL ALLEN CONSULTING

11.5 Labour market

11.5.1 Employment

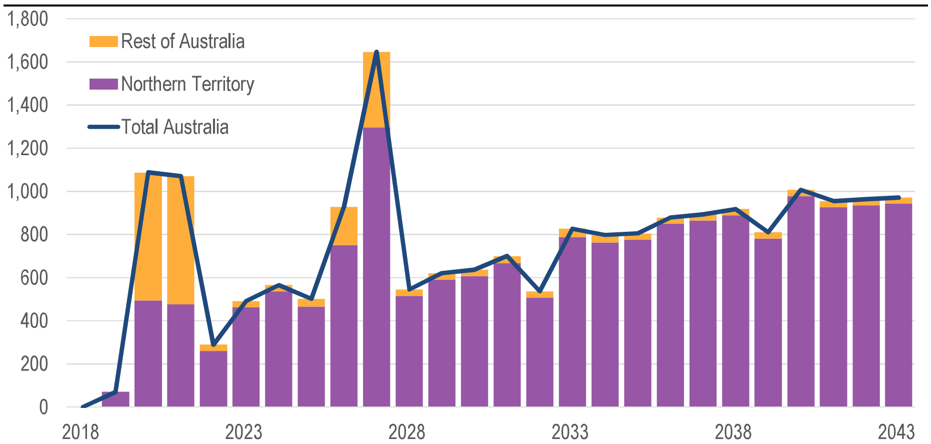
The development of a new industry in the Territory under the GALE development scenario has significant workforce implications. The largest component of the Industry's direct workforce is the staff required to operate the wells and pads. Staff required to operate additional transmission gas pipelines also has a significant impact on direct employment across the Rest of Australia.

The 'peaking' nature of the FTE requirements presented in Figure 11.8 is a result of the timing of the construction workforce requirements. Labour required for the construction of gas transmission pipelines in the Territory in 2021, 2022, 2026 also contributes to this 'peaking' nature, but on a smaller scale.

Over the study period, it is estimated the development of the Industry will require direct employment of 17,187 FTE jobs at an average of 661 FTE jobs per annum in the Territory. The majority of these FTE jobs are in relation to the construction and operations of the Industry (total of 13,300 FTE jobs at an average of 512 FTE jobs per annum), while a total of 3,887 FTE jobs (average of 149 FTE jobs per annum) are in relation to the construction and operations of transmission pipes.

Throughout the Rest of Australia, the construction and operations of transmission gas pipelines will require direct employment of 2,330 FTE jobs at an average of 90 FTE jobs per annum.

FIGURE 11.8 GALE DIRECT EMPLOYMENT, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



SOURCE: ACIL ALLEN CONSULTING

However, the total employment impact of the Industry development under the GALE scenario is minimal, due to the resulting draw on labour from other industries in the Territory and other parts of Australia.

Over the study period, the Industry is estimated to create 13,611 FTE direct and indirect FTE jobs at an average of 524 FTE jobs per annum in the Territory. However, ACIL Allen estimates that these positive impacts will be completely offset by the reallocation of employment from the Rest of Australia to the Territory.

11.5.2 Industry real employment

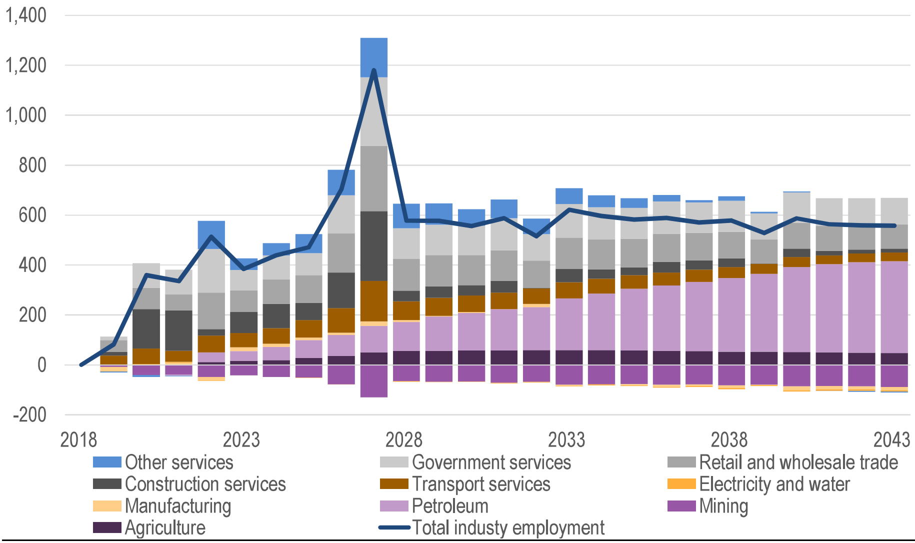
While the development of the Industry under the GALE development scenario results in the reallocation of some labour resources from other industries, on average the real employment impact is significantly positive for the Territory (refer to Figure 11.9).

Over the study period, the Petroleum industry is estimated to see the largest real employment impact, with the creation of 4,384 FTE jobs at an average of 169 FTE jobs per annum. Significant gains are also estimated in the Retail and Wholesale Trade industry, with a total of 2,850 FTE jobs at an average of 110 FTE jobs per annum to be created, as a result of increased household consumption in the Territory.

The Government Service industry (2,985 FTE jobs at an average of 115 FTE jobs per annum), Transport Services industry (1,511 FTE jobs at an average of 58 FTE jobs per annum) and Construction Services industry (1,538 FTE jobs at an average of 59 FTE jobs per annum) are also estimated to see solid employment gains over the study period under the GALE development scenario.

The majority of the labour reallocation, as a result of the development of the Industry, is estimated to occur in Mining (loss of 1,722FTE jobs at an average of 66 FTE jobs per annum), Manufacturing (loss of 18 FTE jobs at an average of one FTE jobs per annum) and Electricity and Water (loss of 62 FTE jobs at an average of two FTE jobs per annum).

FIGURE 11.9 GALE NORTHERN TERRITORY DIRECT AND INDIRECT EMPLOYMENT BY INDUSTRY, DEVIATION FROM BASELINE, REAL TERMS, FTES, THOUSANDS



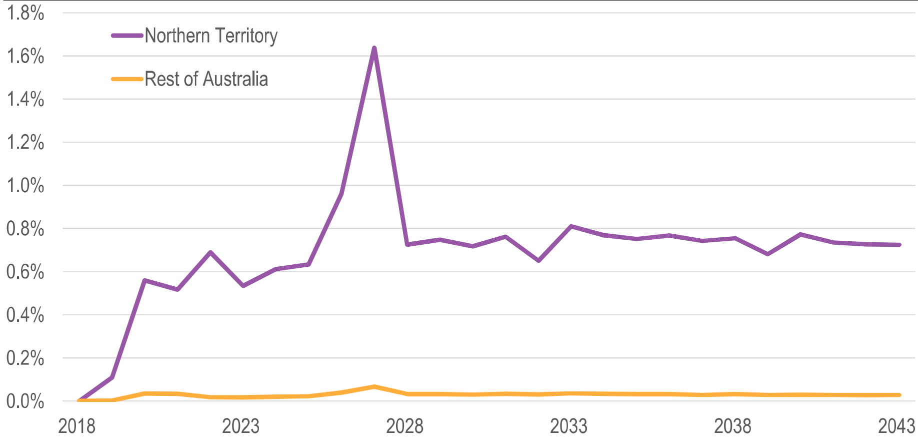
SOURCE: ACIL ALLEN CONSULTING

11.5.3 Real wages

The development of the Industry is estimated to boost real wages in the Northern Territory relative to the Rest of Australia (refer to Figure 11.10).

Over the study period, the increase in real wages is estimated to be on average 0.7 per cent per annum higher than the base case, peaking at 1.6 per cent in 2027 when the demand for labour in the Territory is at its highest. The impact across the Rest of Australia is negligible over the study period, increasing on average by 0.03 per cent per annum over the study period when compared to the base case.

FIGURE 11.10 GALE REAL WAGE GROWTH, DEVIATION FROM BASELINE, REAL TERMS, PERCENTAGE



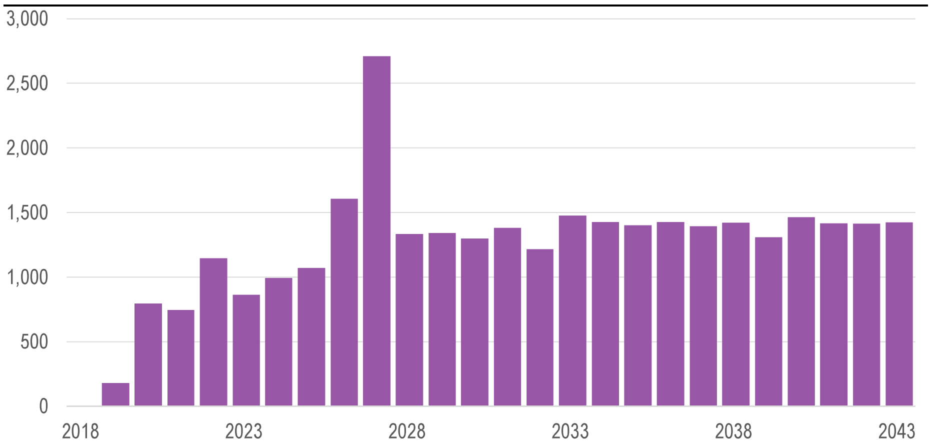
SOURCE: ACIL ALLEN CONSULTING

11.6 Population

The population of the Northern Territory, resulting from the development of the Industry under the GALE scenario, is largely driven by interstate migration as workers and their families relocate to the Territory to take up employment opportunities created by the development of the Industry.

Over the study period, it is estimated the population in the Northern Territory will increase by an average of 1,240 persons per annum. The population impact peaks during the capital intensive construction phase of the development of the Industry at 2,710 persons in 2027.

FIGURE 11.11 GALE NORTHERN TERRITORY REAL POPULATION, DEVIATION FROM BASELINE, REAL TERMS, NUMBER



SOURCE: ACIL ALLEN CONSULTING

11.7 Real taxation

The development of the Industry under the GALE scenario will generate significant taxation benefits to the Northern Territory and the Commonwealth Government, primarily in the form of profits based taxes, royalty revenues, payroll tax and a range of other taxes.

Over the study period, payments to the Commonwealth are projected to be substantial (refer to Figure 11.12). ACIL Allen estimates that the direct profits based taxation payments from the Industry would total $936 million at an average of $36 million per annum over the study period.

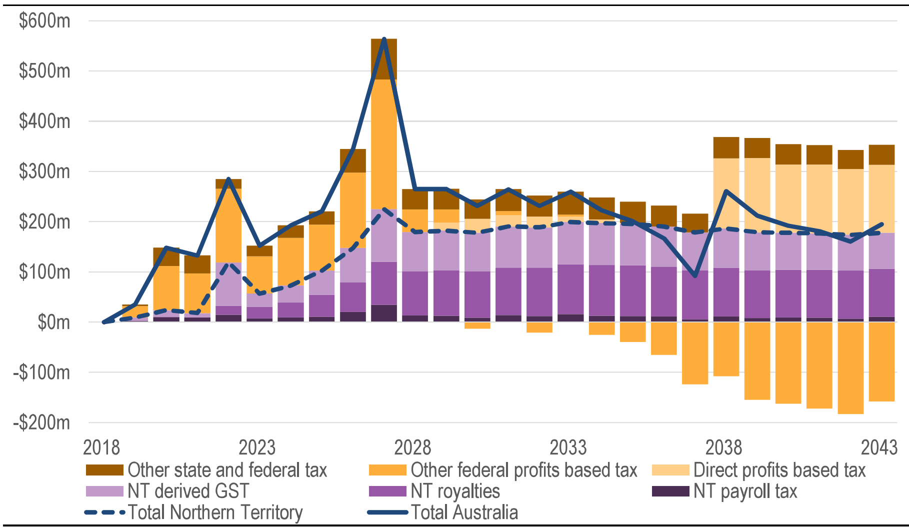
Under the GALE development scenario, when the offshore feed in stock for DNLG in replaced by onshore feed in stock in 2036, indirect profits based taxation payments are reduced because the offshore industry is no longer paying company tax and PRRT. As such, indirect taxation payments collected by the Commonwealth reduce by $136 million at an average of $5.3 million per annum over the study period.

The development of the Industry is estimated to generate other indirect taxation payments to the Commonwealth (such as personal income, excises, fringe benefits and capital gains tax receipts), totalling $950 million at an average of $36.5 million per annum.

Payments made to the Territory Government are expected to be largely accrued through royalty payments, which are estimated to total $1.8 billion at an average of $69 million per annum over the study period. Direct and indirect payroll taxation payments to the Territory Government due to the development of the Industry are estimated to total $288 million at an average of $11 million per annum over the study period.

Increased commercial activity in the Territory is also estimated to result in GST revenues increasing by $1.6 billion at an average of $63.1 million per annum over the study period.

FIGURE 11.12 GALE REAL TAXATION, DEVIATION FROM BASELINE, REAL TERMS, A$ MILLION



SOURCE: ACIL ALLEN CONSULTING

11.8 Summary

Table 11.1 presents a summary of the economic modelling results presented in the section.

TABLE 11.1 GALE DEVELOPMENT SCENARIO, SUMMARY OF ECONOMIC IMPACT RESULTS

	Total	Average	NPV (7 per cent)
Real income			

	Total	Average	NPV (7 per cent)
Northern Territory	$5,777.5m	$222.2m	$2,212.9m
Rest of Australia	$12,508.8m	$481.1m	$4,416.6m
Total Australia	**$18,286.3m**	**$703.3m**	**$6,629.5m**
Real output			
Northern Territory	$17,534.7m	$674.4m	$6,298.8m
Rest of Australia	$1,732.1m	$66.6m	$453.6m
Total Australia	**$19,266.9m**	**$741.0m**	**$6,752.4m**
Real Final Demand			
Northern Territory	$16,173.7m	$622.1m	$7,272.4m
Rest of Australia	$11,320.7m	$435.4m	$4,802.4m
Total Australia	**$27,494.4m**	**$1,057.5m**	**$12,074.8m**
Real investment			
Northern Territory	$9,778.6m	$376.1m	$4,768.6m
Rest of Australia	$1,419.3m	$54.6m	$1,233.3m
Total Australia	**$11,198.0m**	**$430.7m**	**$6,001.9m**
Northern Territory real exports			
International	-$3,395.5m	-$130.6m	-$1,261.0m
Interstate	$24,141.4m	$928.5m	$8,590.5m
Total	**$20,745.9m**	**$797.9m**	**$7,329.6m**
Real employment			
Northern Territory	13,611 FTEs	524 FTEs	
Rest of Australia	-13,611 FTEs	-524 FTEs	
Total Australia	**0 FTEs**	**0 FTEs**	
Real employment by industry			
Agriculture	1,023 FTEs	39 FTEs	
Mining	-1,722 FTEs	-66 FTEs	
Petroleum	4,384 FTEs	169 FTEs	
Manufacturing	-18 FTEs	-1 FTEs	
Electricity and water	-62 FTEs	-2 FTEs	
Transport services	1,511 FTEs	58 FTEs	
Construction services	1,538 FTEs	59 FTEs	
Retail and wholesale trade	2,850 FTEs	110 FTEs	
Government services	2,985 FTEs	115 FTEs	
Other services	1,124 FTEs	43 FTEs	
Total industry employment	**13,611 FTEs**	**524 FTEs**	

	Total	Average	NPV (7 per cent)
Real population			
Northern Territory	32,252 persons	1,240 persons	
Real taxation			
Northern Territory			
Payroll tax	$288.2m	$11.1m	$126.1m
Royalties	$1,793.8m	$69.0m	$606.3m
Derived GST	$1,640.2m	$63.1m	$618.8m
Total Northern Territory	**$3,722.2m**	**$143.2m**	**$1,351.3m**
Commonwealth			
Direct profits based tax	$935.8m	$36.0m	$212.2m
Other federal profits based tax	-$136.5m	-$5.3m	$396.4m
Other state and federal tax	$950.2m	$36.5m	$382.7m
Total Commonwealth	**$1,749.5m**	**$67.3m**	**$991.3m**
Total Australia	**$5,471.6m**	**$210.4m**	**$2,342.5m**

SOURCE: ACIL ALLEN CONSULTING

12

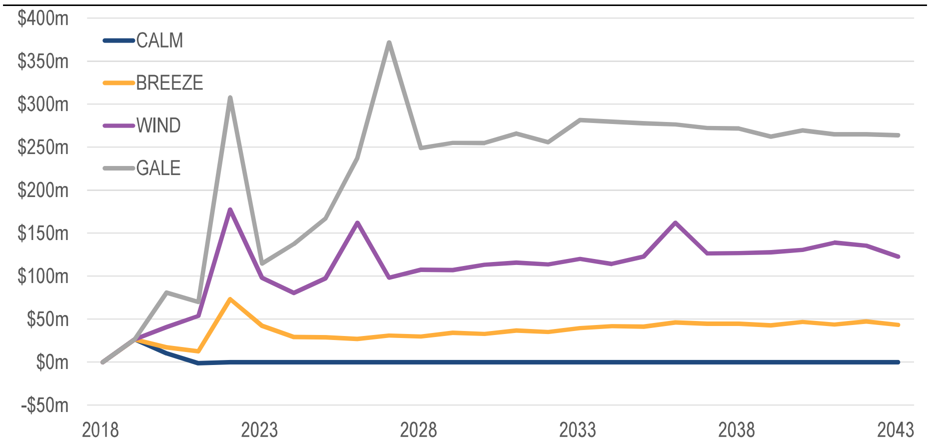
CONCLUSIONS AND SUMMARY

12.1 Economic impact assessment summary

ACIL Allen's economic impact assessment illustrates the potential economic upsides and downsides in the event of small, medium and large scale shale gas industry developments in the Northern Territory, and the flow on effects to the rest of the Australian economy. While the base case and CALM scenarios, where no shale gas industry development occurs, show the Northern Territory economy is set to grow in the years ahead, the development scenario modelling shows the shale gas industry could have an overall net positive impact on the future growth of the Northern Territory economy.

ACIL Allen projects a shale gas industry development could result in a net real income increase of between $937.2 million (BREEZE), $2.8 billion (WIND) and $5.8 billion (GALE) for the Northern Territory over the modelling period, or between $36 million, $108.4 million and $222.2 million per annum. This equates to a net real income per capita increase of $146, $439 to $903 per capita (based on the Northern Territory's 2018 population) over the modelling period. The rest of Australia also sees a lift in real income, of between $3.4 billion (BREEZE), $9.1 billion (WIND) and $12.5 billion (GALE) over the modelling period, on account of the flow on impact of lower gas prices across the economy and the increase in Commonwealth taxes associated with the development (refer to Figure 12.1).

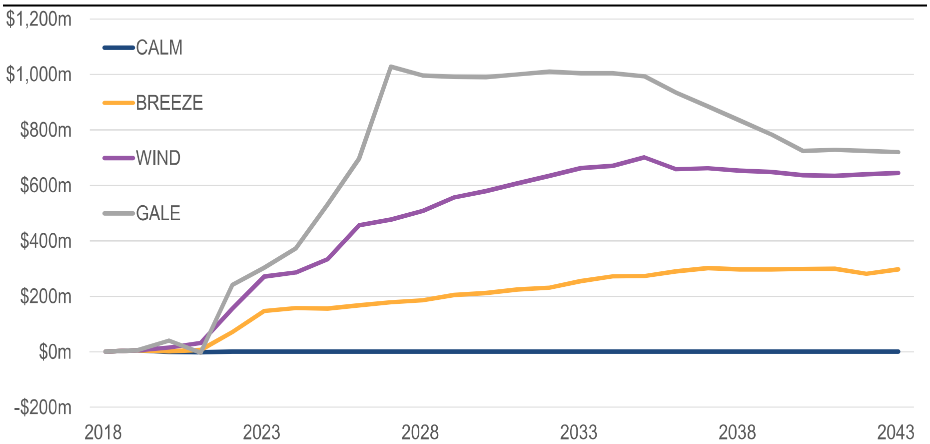
FIGURE 12.1 REAL INCOME, ANNUAL DEVIATION FROM BASE CASE, A$ MILLION, REAL TERMS



SOURCE: ACIL ALLEN CONSULTING

The net economic benefit to the Northern Territory ranges from $5.1 billion in the BREEZE scenario ($196.5m per annum), to $12.1 billion ($466.4m per annum) in the WIND scenario, to $17.5 billion ($674.4m per annum) in the GALE scenario, in real 2018 dollar terms. In annual average terms, this is the equivalent of an additional 0.8 per cent, 1.9 per cent to 2.9 per cent of the Northern Territory's forecast Gross Territory Product in 2018 (Figure 12.2).

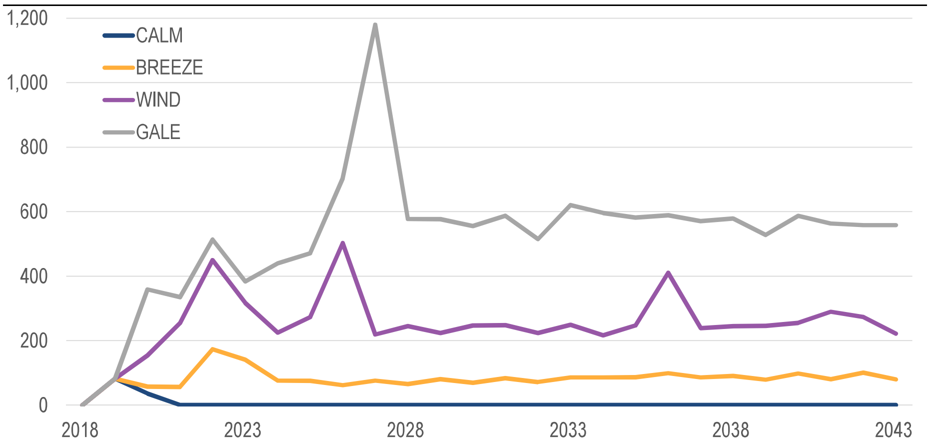
FIGURE 12.2 REAL OUTPUT, ANNUAL DEVIATION FROM BASE CASE, A$ MILLION, REAL TERMS



SOURCE: ACIL ALLEN CONSULTING

This additional economic activity will generate employment opportunities for Territorians, with an estimated 2,154 FTE job years (BREEZE), to 6,559 FTE job years (WIND) to 13,611 FTE job years (GALE) generated by the various development scenarios over the forecast period – over and above the existing employment growth ACIL Allen has forecast in its base case (Figure 12.3). This equates to between 82 FTEs, 252 FTEs, and 524 FTEs of net employment growth in each year on average. While modest overall, this represents the capital intensive nature of the shale gas industry, and is also a function of ACIL Allen's conservative treatment of employment growth in its modelling activities (see Section 6).

FIGURE 12.3 REAL EMPLOYMENT, FTE JOB YEARS, REAL TERMS, BY SCENARIO

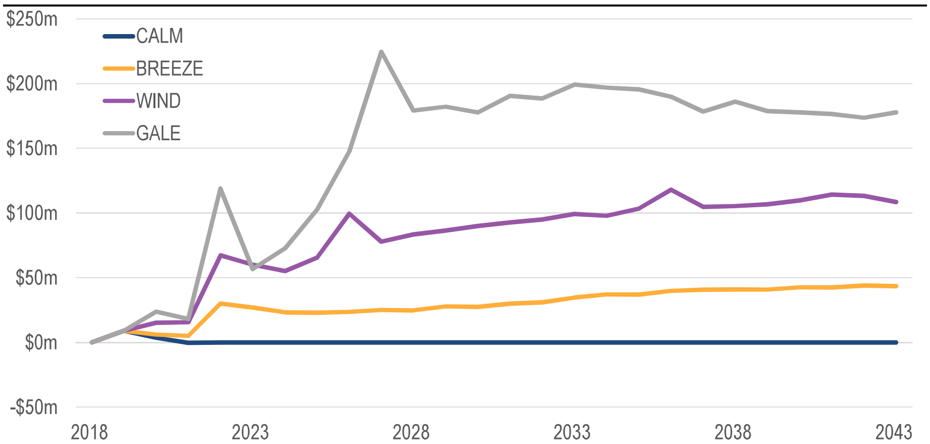


SOURCE: ACIL ALLEN CONSULTING

For Territorians, the primary channel of economic impact that is likely to be felt is the increase to Territory Government revenue. ACIL Allen estimates a successful shale gas industry development could generate between $757 million (BREEZE), $2.1 billion (WIND) and $3.7 billion (GALE) in additional revenue for the Northern Territory Government over the 25 year modelling period, or between $29.1 million, $80.6 million, and $143.2 million per annum (Figure 12.4). In the larger case, this represents a sizeable increase to the Northern Territory's recurrent revenue base of 2.2 per cent, or more than eight per cent if Commonwealth Government grants are excluded.

ACIL Allen's analysis shows a shale gas industry could also deliver windfall growth in Commonwealth revenue, even as the cascading impact of reduced gas prices from the development reduces the income earned by the gas sector outside of the Northern Territory.

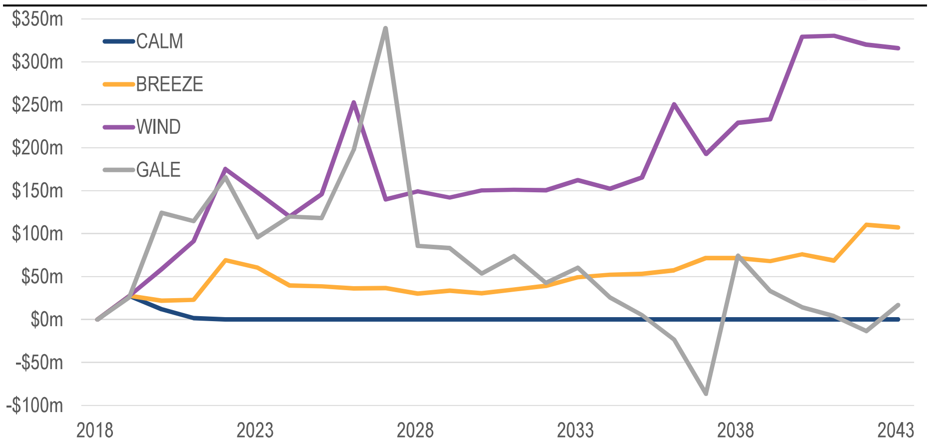
FIGURE 12.4 REAL TAXATION, NORTHERN TERRITORY GOVERNMENT, A$ MILLION, REAL TERMS, BY SCENARIO



SOURCE: ACIL ALLEN CONSULTING

ACIL Allen estimates the Commonwealth Government could expect to raise between $1.3 billion (BREEZE), $4.6 billion (WIND), and $5.5 billion (GALE) in income and profits based taxation over the forecast period, or $50.2 million, $176.2 million and $210.4 million per annum (refer to Figure 12.5).

FIGURE 12.5 REAL TAXATION, COMMONWEALTH GOVERNMENT, A$ MILLION, REAL TERMS, BY SCENARIO



SOURCE: ACIL ALLEN CONSULTING

As discussed in Section 4, the shale gas industry in the Northern Territory is at such an early stage that the modelling conducted in this engagement is subject to more than usual uncertainty. Below, ACIL Allen has presented the subjective probability matrix prepared to represent the qualitative likelihood of each scale of development occurring (Figure 12.6). This is not an assessment of the commercial prospects of a shale gas industry in the Northern Territory, as ACIL Allen has not been engaged to assess this, and it is too early in the industry's development to make a determination.

FIGURE 12.6 ACIL ALLEN POLICY SCENARIO PROBABILITY MATRIX

			POLICY SCENARIO PROBABILITY MATRIX		
INDUSTRY DEVELOPMENT SCENARIO	**Production Profile**	**Production Cost Regime**	**PERMANENT MORATORIUM**	**PARTIAL LIFT**	**FULL LIFT**
BASELINE	Nil Shale Production	N/A	CERTAIN	MODERATE	LOW
SHALE CALM	Exploration occurs Failure to commercialise	N/A	ZERO	VERY HIGH	VERY HIGH
SHALE BREEZE	**Scenario 1** Target production: 36PJ per annum	High cost	ZERO	MODERATE	HIGH
SHALE WIND	**Scenario 2** Target production: 150PJ per annum	Moderate cost	ZERO	LOW	MODERATE
SHALE GALE	**Scenario 3** Target production: 365PJ per annum	Low cost	ZERO	VERY LOW	LOW

SOURCE: ACIL ALLEN CONSULTING

Summary

ACIL Allen's economic impact assessment modelling suggests there will be limited impact on sectors outside of the shale gas industry and its supply chain. This is for a few reasons, some of which centre on the evidence-based assumptions ACIL Allen has made (and which have been endorsed by the Inquiry) related to the treatment of land and water resources. But more significantly is the relatively modest labour requirement of the sector, which means there is limited crowding out activity in the labour market in the Northern Territory. In addition, the shale gas industry is likely to disturb a small surface area relative to the size of the Northern Territory (as stated in Section 6.2.4, 67.2km^2 for BREEZE, 231.7km^2 for WIND, and 475.9km^2 for GALE, compared to the Northern Territory's total land area of 1,421,000km^2).

That is not to say there are no downside risks to a potential shale gas industry development in the Northern Territory. ACIL Allen's economic modelling simply demonstrates that there are quantified net economic benefits available to the Northern Territory economy. There are additional considerations – many of which are outside of the scope of ACIL Allen's work but are being dealt with by others involved in the Inquiry – which must be given due consideration in the process of determining whether the industry should be given a license to operate. ACIL Allen has provided a perspective on these issues in the next Chapter of this report.

12.2 Comparison of ACIL Allen economic impact assessment to APPEA/Deloitte economic impact assessment

As part of its scope of works, ACIL Allen is required to compare the inputs and outputs of its economic impact assessment with the inputs and outputs of the 2015 APPEA/Deloitte study, *Economic impact of shale and tight gas development in the NT*. This is presented in the table below.

Item	APPEA/Deloitte		ACIL Allen		
Case name	"Success"	"Aspirational"	"BREEZE"	"WIND"	"GALE"
Development modelling approach	Deloitte took the price of LNG, subtracted cost of processing and transmission pipeline, and used that to determine its target gas price. From there, it scaled CAPEX & OPEX estimates from a starting position that would allow all gas to be sold assuming a their market price, and had a different breakeven price for three market demand tranches (NT, East Coast and LNG). Deloitte assumed no market constraints.		ACIL Allen began by sizing its developments based on market tolerance, using *GasMark*. From there, ACIL Allen build its developments from the ground up using data to build a single average type curve, a well scheduling model, development cost assumptions by key components, and pipeline assumptions combining current pipeline capacity and new pipelines. ACIL Allen did not assume gas would be used to facilitate any new LNG development, and instead assumed in its base case that an offshore development would be required to backfill the DLNG facility.		
Economic impact assessment modelling approach	In-house CGE model		In-house CGE model		
Volume of gas (peak PJ/annum)	586 PJ/annum in 2040	910 PJ/annum in 2040	36.9 PJ/annum (2041)	108.3 PJ/annum (2042)	365 PJ/annum in 2043
Incremental LNG?	Yes, 100% incremental LNG. Two additional LNG trains to be built, with capital costs included in the economic impact assessment.	Yes, 100% incremental LNG. Three additional LNG trains to be built, with capital costs included in the economic impact assessment.	No LNG in this scenario.	No LNG in this scenario.	No incremental LNG in this scenario. It is assumed the onshore development displaces an offshore development.
CAPEX per well	$6.2m - $9.75m		$19.1m on average (including learnings)	$16.3m on average (including learnings)	$12.7m on average (including learnings)
OPEX per GJ	$0.53 - $0.89/GJ		$1.77/GJ on average (including learnings)	$1.59/GJ on average (including learnings)	$1.46/GJ on average (including learnings)
Wellhead cost per GJ (maximum case)	$1.90 - $2.67/GJ		$6.07/GJ on average	$5.03/GJ on average	$4.01/GJ on average
GTP impact (deviation from baseline in final year of study)	+$5.1bn (2040)	+$7.5bn (2040)	+$0.30bn (2043)	+$0.64bn (2043)	+$0.72bn (2043)
FTE impact (deviation from baseline in final year of study)	+4,195 FTE (2040)	+6,321 FTE (2040)	+80.1 FTE (2043)	+221.5 FTE (2043)	+558.1 FTE (2043)

IV

ECONOMIC POLICY CONSIDERATIONS

13 SHALE GAS ECONOMICS LITERATURE REVIEW

The Northern Territory Hydraulic Fracturing Inquiry has sought information on options for "leading practice" fiscal and regulatory policy reform that would allow exploitation of shale gas resources in a way that would generate sustainable development from an economic perspective in the Northern Territory of Australia. More specifically, the Inquiry is seeking information on a policy regime that would:

- maximise benefits from the industry
- mitigate and manage costs (including risks of adverse impacts)
- capture net benefits for Territorians in general and those in regions affected by development, without impeding investment
- sustain net benefits over time.

The Inquiry stipulated that this advice should include coverage of measures or instruments to mitigate and manage any adverse effects on other Northern Territory industries, and "boom and bust" economic cycles arising from development of a shale gas industry. This requirement indicates that the Inquiry wants advice on policy instruments that would address potential "Resource Curse" consequences, including "Dutch Disease" effects, of development of a shale gas industry in the Northern Territory.

13.1 The efficiency/equity trade off

Economic assessments of policy regimes or changes typically are undertaken by reference to two widely accepted principles relating to comparison of benefits and costs. An economic efficiency criterion focuses on the aggregate of benefits (positive impacts) and costs (negative impacts). A fairness criterion focuses on the distribution of benefits and costs. Sometimes, these criteria have been teased-out to highlight specific aspects of economic efficiency and fairness.

Criteria along these lines have been proposed in public finance/economics texts over the past 90 years or more.[44] They can be traced back to Adam Smith's (1776) pioneering economic work. In Australia, similar criteria have been applied in several reviews of the tax system, over the past 40 years, including the Henry Tax Review in 2010.[45] Also, they have been applied in reviews of royalty policy undertaken for state and territory governments over the same period, including the *Green Paper on Mining Royalty Policy in the Northern Territory* in 1981.[46] In addition, economic efficiency and equity were used as guiding principles in various papers prepared for the previous Commonwealth Governments on climate change policy.

[44] See Dalton (1923), Pigou (1929), Musgrave (1959), Musgrave and Musgrave (1973), Atkinson and Stiglitz (1980), Stiglitz (2000), Rosen and Gayer (2008).
[45] For example, Asprey, others (1975), Commonwealth of Australia, Treasurer (1985), Ralph, others (1998), Commonwealth of Australia, Treasurer (1998), Henry, others (2010), Commonwealth of Australia, the Treasury (2015).
[46] For example, Northern Territory of Australia (1981), Bradley (1986), Australian and New Zealand Minerals and Energy Council, Royalty Working Party (1991) and Australian Ministerial Council on Mineral and Petroleum Resources (2006).

13.1.1 Efficiency principles

The concept of economic efficiency refers to an efficient allocation of resources (human, capital, and natural resources, including land, extractable resources and the environment) at any time and over time. It includes efficient use of resources and efficient distribution of products.

An efficient allocation of resources may be impeded by market failures or policy failures. Market failures – situations in which markets fail to allocate resources efficiently – may arise because of external costs, external benefits, public good characteristics of some goods and services, asymmetric distribution of information, and existence of market power or lack of competition. Policy failure results from government intervention that worsens the allocation of resources because the method of intervention has been poorly designed to correct a perceived market failure or inequity. Policy failure might also result from intervention designed to achieve a political objective regardless of the effects of the policy measure on the efficiency of resource allocation.

Because there are numerous impediments to efficient resource allocation, achievement of the ideal of an efficient allocation of resources or economic efficiency would require multiple, consistent policy adjustments across the economy, not just a policy change to address a particular source of inefficiency. Therefore, the appropriate assessment criterion for formulation of, or a change in policy instruments is usually considered to be an improvement in the efficiency of resource allocation. This means improved capability to provide people with more of what they want (including better health and environmental outcomes) with available resources. Ideally, it involves selection of investments and policy settings that not only produce benefits in excess of costs, but also generate the largest surplus of benefits over costs.

In the case of extraction of exhaustible resources, such as a shale gas, the criterion of improving the efficiency of resource allocation is relevant not only to how and when exploration and extraction take place and how the policy regime affects those activities, but also to how the net *in situ* value of the resource (resource rent) is deployed during and after it is captured. Policy instruments need to be carefully designed to ensure that resource rent is not dissipated or destroyed during exploration and extraction, and is not wasted after it is captured.

The avoidance of unnecessarily large policy administration (compliance, monitoring and enforcement) costs is an aspect of economic efficiency. This sub-criterion has sometimes been referred to as administrative efficiency. It has also been labelled simplicity, because complexity can lead to high administration costs. Often, administrative efficiency or simplicity has been specified as a separate criterion.

13.1.2 Equity principles

Fairness or equity is an important consideration for governments in formulation of policy. The issue relates to treatment of individuals fairly relative to others. It involves highly subjective issues that have to be resolved by value judgements.

Two concepts of equity have been discussed extensively in the economics literature: the ability to pay principle and the benefit principle. These principles pre-date the foundational economic work of Adam Smith (1776), in which they were conflated. Over the past 30 years, a third principle has attained prominence: the concept of intergenerational equity.

The ability to pay principle is that costs of government interventions should be borne differently by people in accordance with differences in economic circumstances, with more being borne by better-off people (vertical equity), and similar burdens for people in similar economic circumstances (horizontal equity). The ability to pay principle has often been a dominant consideration in political discussion of policy issues.

Key issues in considering ability-to-pay in the context of health and environmental risks associated with activities and products are the distribution of the burden of hazards and the distribution of costs and benefits of policy measures designed to address them. A common concern is that low-income households often bear a disproportionate share of health and other environmental risks, and that policies to address these risks may not be progressive in distributing benefits and costs (Parry, others, 2005; Bento, 2013).

The benefit principle of equity states that entities should contribute to government in accordance with benefits received from governments or from society more generally. It is particularly relevant to consideration of fairness issues in respect of extraction natural resources and use of the environment.

The benefit principle indicates that enterprises that are allowed to extract natural resources owned by a government should be required to pay according to the net *in situ* value of the natural resource. Also, it implies that enterprises should be required to pay compensation if, through their use (or abuse) of the natural environment, they impose non-market costs, such as health and environmental costs (external costs), on others. This implication is consistent and closely associated with the *polluter-pays* principle, which states that those who impose environmental and health costs on others should be required to pay.

Intergenerational equity is an important consideration in formulation and assessment of policy regarding exploitation of natural resources. It is relevant because extraction of mineable resources and damage to the natural environment, particularly elements essential to sustain human life, reduce the stock of natural capital available to future generations, denying them opportunities to benefit from natural resources.

The concept of intergenerational equity has risen to prominence over the past 30 years in the context of concomitant emergence and growth of interest in the concept of sustainable development. The concept of sustainable development incorporates economic efficiency and equity principles discussed above. Like efficient allocation of resources at a particular time and over time, sustainable development is concerned with using natural resources efficiently – extracting them efficiently, and taking into account (risk of) damage (particularly irreparable damage) to the natural environment. Both economic efficiency and sustainable development also involve wisely using the proceeds of exploitation of natural resources. Like intergenerational equity, sustainable development is concerned with ensuring that exploitation of extractable resources and the natural environment in the short to medium term does not leave future generations worse off. Both intra-generational equity and sustainable development concepts recognise that reduction of inequality is conducive to improving and sustaining economic growth.

A recurring theme in the economic literature on policy assessment is that criteria such as those discussed above are meant to apply to policy regimes as a whole (comprising policy instruments at all levels of government), rather than to each policy instrument in isolation. A perceived inequity associated with one policy instrument may be offset by a feature of another policy instrument. An inefficiency associated with one part of the policy mix may be reduced by the settings of another part of the policy regime. It is unrealistic to expect that every policy instrument will perform perfectly with respect to all criteria. It is the performance of the whole policy package that matters, not the performance of individual policy mechanisms.[47] Nevertheless, it may be useful to assess how each policy instrument performs with respect to the criteria to ascertain how it might contribute to a package of instruments comprising a good policy regime.

The performance of a policy package can be improved by allocating different policy instruments primarily to different policy objectives or sub-objectives, by carefully selecting/designing instruments that are suited to particular targets, and by deploying at least as many instruments as targets. The process of selecting/designing instruments must allow for the effects of each instrument on all targets, not just the primary one to which it has been assigned. The policy packaging process should also include consideration of the attributes of each instrument and how they might complement features of other instruments (Tinbergen, 1952). Such an approach to policy regime design minimises trade-offs or compromises between degrees of achievement of multiple objectives.

13.2 The "Resource Curse" phenomenon

Substantial natural resource development does not lead automatically to better economic performance and greater well-being of constituents in regions and jurisdictions hosting such activity. Indeed, there is a burgeoning literature on how exploitation of natural resource wealth has too often led to underperformance of the host economy relative to its potential, and relative to economies that are not well endowed with natural resources. This phenomenon has become known as the "Resource Curse".

The concept originated with Gelb (1988) and Auty and Warhurst (1993).[48] It attracted considerable interest from economists following pioneering quantitative work by Sachs and Warner (1995) indicating that economic dependence on mineable resources was correlated with slow economic growth after allowing for structural attributes of countries. Helpful surveys of the literature have been provided in work by

[47] Geoffrey Brennan (1977) discussed these issues specifically with reference to selection/design and assessment of state and local government taxes.
[48] See also Auty (1990).

Humphreys, Sachs and Stiglitz (2007), Arezki and Gylfason (2011), van der Ploeg (2011), Frankel (2012a,b), Shaffer and Ziyadov (2012), and Venables (2016).

Most discussions of the Resource Curse have associated this affliction with developing economies. However, advanced countries with considerable mineable resources wealth are not immune. Indeed, *The Economist* magazine suggested in 1995 that Australia was affected by a "Resource Curse" (Anonymous, 1995). There is considerable circumstantial evidence that Australia has suffered "Resource Curse" symptoms as a result of mismanagement of the mining boom of 2004 to 2011.

A related phenomenon is the "Dutch Disease", which refers to effects of economic restructuring in response to development of a major mineable resources sector. Pre-existing sectors are disadvantaged because of lower export and import prices associated with nominal exchange rate appreciation, and higher costs of domestic inputs as a result of demand from the mining sector and spending of revenue derived from that sector. The higher cost structure and higher nominal exchange rate together represent a real exchange rate appreciation.

The name "Dutch Disease" was applied by *The Economist* magazine (Anonymous, 1977) following the adverse effects of discovery and exploitation of substantial gas resources in the Netherlands a few decades ago. Pioneering analysis of the phenomenon in an Australian context was undertaken by Cairnes (1859, 1873) in respect of the gold rush, and by Gregory (1976). Subsequent important early contributions to the "Dutch Disease" literature were provided by Corden and Neary (1982), Corden (1984) and Van Wijnbergen (1984). A recent useful discussion of "Dutch Disease" in Australia as a result of the 2004-2011 mining boom was presented by Corden (2012).

Mismanagement of structural adjustment in response to a mining boom or interaction of structural adjustment with external benefits of industrial activity can contribute to a "Resource Curse" problem. Indeed, these occurrences are the potential sources of economic disease, not structural adjustment *per se*. They are typically listed as "Resource Curse" mechanisms.

13.2.1 Regional resource curse issues

Until recently, the rapidly growing "Resource Curse" literature had been focussed almost entirely on effects of major mineable resource developments on national economies. Little consideration was given to the potential for "Resource Curse" issues in state and regional economies. This situation changed because of the shale gas and oil boom in the United States.

Over the last six years, economics literature has been accumulating on investigations into the existence or otherwise of "Resource Curse" effects in "local economies" in the United States.[49] Important contributions have been made by Resources for the Future (RFF), a highly regarded United States organisation that has been conducting economic research in relation to environmental and other natural resource issues since 1952. RFF has established research groups focussed on community impacts of shale gas and oil development, and shale public finance.[50]

Investigations of economic impacts of shale gas and oil development in the United States have found strong evidence of local employment gains during the development phase, and increases in incomes through wage/salary increases and private royalty arrangements. However, evidence on long-term growth and development effects is mixed and inconsistent. Several studies provided evidence of negative long-term effects or "Resource Curse" effects. Several other studies found no clear evidence of such effects. Analysis of the mixed and inconsistent results suggests that effects vary across time and locations.

An important insight of the literature relating to the presence or otherwise of regional "Resource Curse" effects is that transmission channels are similar to those for national "Resource Curse" effects. Moreover, policy settings are critical to enabling or avoiding "Resource Curse" problems in sub-national areas, just as they are nationally (Kelsey, Partridge, White, 2016).

[49] For example, see Freeman (2009), James and Aadland (2011), Brown (2014), Jacobsen and Parker (2014), Hausman and Kellogg (2015), Cust and Poelhekke (2015), Mason, Muehlenbachs and Olmstead (2015), James (2015), Kelsey, Partridge and White (2016), Weinstein, Partridge and Tsvetkova (2017), Feyrer, Mansur and Sacerdote (2017), and Allcott and Keniston (2017). A useful review has been provided by Krupnick and Echarte (2017).
[50] For example, see Raimi and Newell (2016a,b), Krupnick and Echarte (2017), Krupnick, Echarte and Meuhlenbachs (2017), and Krupnick, Echarte, Zachary and Raimi (2017).

13.2.2 Resource curse mechanisms

"Resource Curse" effects typically result from poor policies and institutions, not from resource wealth *per se*. Resource wealth that is properly managed should provide important net economic benefits. Their magnitude is dependent on relevant policy settings, as well as the quantity, quality and location of extractable resources.

There are various "Resource Curse" mechanisms that are relevant in the context of the Northern Territory and Australia. These mechanisms are discussed below.

Loss of growth-inducing external benefits

Economic restructuring in response to development of a major mineable resources sector or a prolonged surge in prices of mined commodities could have "Dutch Disease" and "Resource Curse" effects if trade-exposed sectors that are disadvantaged by real exchange rate appreciation would otherwise be sources of significant growth-inducing external benefits (van Wijnbergen, 1984; Sachs, Warner, 1995). However, this would be a matter of concern only if there are more important growth-inducing benefits associated with disadvantaged sectors than with booming sectors (Frankel, 2012a, b).

The notion that external benefits are more substantial in the case of manufacturing, than for mining and agriculture has been suggested in the economics literature from time to time. It can be traced back to Alfred Marshall (1880-1920), David Ricardo (1817) and Adam Smith (1776).

In the economics literature on "Dutch Disease", two forms of external benefits (sources of market failure) have been discussed: spillovers of information about demonstration of technology (often called learning-by-doing effects), and linkages between industries. For example, Sweder van Wijnbergen (1984) focussed on technology demonstration effects, and Jeffrey Sachs and Andrew Warner (1995) discussed linkage effects, as well as demonstration effects. Both works have been widely cited.

Technology demonstration effects external to enterprises and internal to industries were originally assumed to characterise manufacturing. However, it has been widely acknowledged that government attempts in Australia and many natural resource-rich developing countries to promote diversification into import competing manufacturing industry by erecting import tariff and quota barriers were dismal failures. More recently, some have assumed that export-orientated manufacturing is characterised by technology demonstration externalities not matched in other sectors, and on that basis they have advocated diversification from mining into such activity. It must be emphasised that these assumptions have not yet been proven empirically.

If external benefits in the form of technology-demonstration and industry-linkage effects are much greater in lagging or declining sectors, one of which is manufacturing, than in expanding sectors – mining and non-tradeable goods – there would be an economically inefficient decline in growth (Venables, 2016). However, it certainly has not been demonstrated that the external benefits generated by manufacturing are greater than those generated by expanding sectors, which include non-tradeable sectors, as well as mining and processing activities.

Anthony Scott and Peter Pearse (1992) criticised suggestions that governments in natural resource-rich countries, including developed economies like Australia and Canada, should intervene to encourage diversification into so called "high-tech" or "sophisticated" industries to overcome excessive dependence on "old economy" natural resource-based industries. Scott and Pearse pointed out that these arguments have ignored the history of technological advances in the natural resource-based industries.

Jeffrey Frankel (2012a, p. 31) reiterated criticism of the view that external benefits generated by manufacturing would be greater than external benefits from sectors engaged in mining, agricultural, and non-tradeable production:

"…….it must be pointed out that there is no reason why 'learning by (seeing others) doing' should be the exclusive preserve of manufacturing tradeables. Nontradeables can enjoy learning by (seeing others) doing. Mineral and agricultural sectors can as well. Some countries have experienced tremendous productivity growth in the oil, mineral and agricultural sectors."

It is clear that technological progress has inexorably driven down real costs of mining (including oil and gas extraction) and processing of mineable commodities over the long-term. A few examples relevant to gas include technological advances allowing extraction of petroleum from beneath deeper and deeper water, liquefaction of natural gas and transport of that product, extraction of coal seam gas, and extraction of shale gas and oil.

In addition, there has been a rapid rate of development and introduction of new technology applicable to other tradable sectors including agriculture and some service sectors. For example, backward linkages and "learning by seeing others doing" have facilitated development of a substantial mining services sector in Australia that includes provision of technologically sophisticated solutions to Australian and overseas mining activities.

There have also been important linkage and "learning by seeing others doing" effects in non-tradable sectors of the economy, including some service and construction activities. These sectors have expanded as part of the process of economic adjustment in response to a booming mining (including extraction of oil and gas) sector.

Public discussion regarding development of mineable-resource-rich economies has often produced proposals that governments should intervene to encourage diversification away from extraction activities (as observed by Frankel, 2012a,b, and Venables, 2016). Some proponents of diversification have advocated government incentives for enterprises to take advantage of backward and forward linkages with mining activities. Others have advocated incentives to establish enterprises focussed on manufacturing activities unrelated to mining, presumably because of perceived superior growth-inducing effects of those separate activities.

Venables (2016) pointed out that very few resource-rich countries had been successful in diversifying their economies through policies such as allocation of government revenue from mining to support other sectors, and domestic content requirements. A notable, but rare example was development of the Norwegian marine engineering sector.

In summary, a convincing case for government intervention to offset the economic adjustment process triggered by substantial growth in mined commodity prices and/or major new mining developments has not be found.

13.2.3 Neglect of local supply opportunities

Managers of investment and operational phases of mineable resource projects may neglect local supply opportunities. This may occur because managers have preferred suppliers as a result of previous experience in other jurisdictions. It also may occur because managers lack information on capacities of local suppliers, people, and training facilities, including capacities to adapt to the requirements of investment and operational phases of projects. In addition, local suppliers may lack information regarding the requirements of construction project managers and mine managers. Preferences for previous suppliers and lack of relevant information about locals and projects indicate the existence of information market failure.

A common policy response is specification of local content requirements. Typically they are set on an arbitrary uniform basis for all projects. This regulatory mechanism places responsibility on managers to collect information about local suppliers. It could be expected that this would be pursued just enough to meet local content requirements. That result might mean some economic local supply opportunities are missed or it might raise costs and thereby reduce realised resource rents and the amount captured by government.

An alternative approach is that government could act as an information intermediary. It could communicate with potential purchasers and suppliers about requirements and capabilities, and ensure that relevant information flows in both directions.

Local content requirements address information market failure only indirectly and in an arbitrary way, while the information intermediary option would address the information market failure directly. The former approach would impose costs on purchasers, reducing realised resource rents and potentially returns to government, depending on royalty and tax regimes. The latter approach would be funded by government, logically from resource rent captured by government in an efficient way. The former would cause deadweight losses (inefficiencies). The latter would not. In both cases, benefits should be weighed against costs.

13.3 Managing a "temporary boom"

Economic adjustments to a booming mining sector could have economic "disease" or "curse" elements if the boom is expected to be only a short- to medium-term phenomenon (Corden, 1984; Frankel, 2011, 2012a,b). Commodity-price booms typically fall into this category. Usually, they are much shorter than the post-2004-2011 boom in prices of mined commodities. Also, investment and exploration booms can be brought to an end by the collapse of commodity-price booms or by exploration failures. In addition, mining-related employment typically falls as projects transition from construction to extraction.

A temporary boom could result in a painful adjustment process that has to be reversed when commodity prices inevitably decline. Adjustment costs are then incurred to an unnecessary extent twice. This is economically inefficient, as it wastes resources. Pertinent observations by Jeffrey Frankel (2012a) are re-produced in the following box.

In addition, the macroeconomic instability associated with temporary price booms followed by busts or prolonged price declines is also likely to be detrimental to long-term economic performance (Arezki, 2011; Collier, Venables, 2011; Barnet, Ossowski, 2003; Davis, Ossowski, Daniel, Barnet, 2003).

There is a case for intervention to smooth and moderate real exchange rate changes through fiscal and monetary policy to improve the efficiency of resource allocation in the short-term and over time if losers as well as winners, although gains could be expected to outweigh losses. Gains to consumers from a high nominal exchange rate (cheaper goods and services), and gains to participants in non-trade exposed sectors would be reduced. Meanwhile, participants in all trade-exposed sectors, including the mining sector, would gain from the intervention. Also, benefits from improved economic growth would become widely available.

On the other hand, if it appeared likely that historically high mined-commodity prices and high exploration and investment activity would persist in the long-term, a policy of moderating the high exchange rate caused by a commodity-price and investment mining boom would not be economically sensible. Then, it would be appropriate to facilitate economic adjustments, not moderate them. Therefore, keeping policy options open with a flexible policy approach is important.

BOX 13.1 ECONOMIC WASTE FROM MEDIUM TERM VOLATILITY OF COMMODITY PRICES

"Cyclical shifts of factors of production (labour, capital and land) back and forth across sectors – mineral, agricultural and manufacturing, and services – may incur needless transactions costs. Frictional unemployment of labour, incomplete utilisation of the capital stock, and incomplete occupancy of housing are true deadweight costs (inefficiencies), even if they are temporary. Government policy-makers may not be better than individual economic agents at discerning whether a boom in the price for an export is temporary or permanent. But the government cannot completely ignore the issue of volatility with the logic that the private market can deal with it. When it comes to exchange rate policy or fiscal policy, governments must necessarily make judgements about the likely permanence of shocks."

SOURCE: FRANKEL (2012A), P. 27.

13.3.1 Neglect of external costs

The wellbeing of some parties in the Northern Territory could be adversely affected as a result of neglect of environmental, health and dis-amenity costs of exploration for, and exploitation of mineable resources (Davis, 2015; Krupnick, Gordon, 2015; Bartik, et al, 2017). These costs should include risks or hazards that might result in damage (Gruenspecht, Lave, 1989; Viscusi, 2007).

Such costs could contribute to a "Resource Curse" (Mason, Muehlenbachs, Olmstead, 2015). However, they have not been discussed further in this report as they are outside the scope set out in terms of reference for the assignment.

13.4 Mineral and petroleum commodities and public finances

Resources in the ground are depletable and ultimately exhaustible assets. In Australia, they are owned by state/territory governments onshore and the federal government offshore on behalf of constituents of relevant jurisdictions. These scarce resources have value in excess of the full costs of exploring for and extracting them. This net value *in situ* is often termed resource rent.

The benefit principle of equity indicates that government should capture as much of the resource rent as possible. That is what a private owner of mineable resources would seek to do. It would price the right to extract resources to capture resource rent. The economic efficiency principle indicates that policy instruments deployed to capture resource rent should be carefully designed to avoid destroying part of it by impeding incentives to realise resource rent through exploration, investment and extraction activities.

Realisation of resource rents and government revenue from capture of a substantial proportion of resource rents are not sustainable, because resource rents are derived by depleting exhaustible natural capital. Government revenue deriving from resource rent is really revenue from sale of assets. It is not sustainable like revenue from taxation linked to ongoing activities.

The unsustainability of realisation of resource rents and government revenue therefrom could be addressed by saving resource rents accruing to Australian entities, rather than consuming them. [51] Subsequently, they could be invested astutely in productivity-enhancing built and human capital. Saving and investing resource rents would be consistent with principles of inter-generational equity and efficient inter-temporal allocation of resources. In other words, it would be conducive to sustainable development from an economic perspective. This insight was originated by Solow (1973). It was subsequently developed by Hartwick (1977) and Solow (1986, 1993). The principle is widely accepted in the economics literature as indicated in a review by Barbier (2016).

13.4.1 Raising revenue

Governments that own mineable resources price the right to extract them via royalty regimes. In the Northern Territory, the Government does so via a 10 per cent ad valorem royalty based on wellhead value for oil and gas, and an 18 per cent accounting profits royalty for other mineable resources.

Resource rent that escapes capture by the Northern Territory royalty regimes becomes subject to Commonwealth Government taxes. The petroleum resource rent tax applies at a rate of 40 per cent to a base that crudely represents resource rent less royalty payments to the Territory. The Commonwealth Government's company income tax regime applies at a rate of 30 per cent to an accounting profits base that excludes royalty and petroleum resource rent tax payments. The Commonwealth Government also collects an additional portion of the resource rent through taxation of providers of capital, skilled labour, and other inputs, who have been able to capture part of the resource rent.

Ad valorem royalty regimes cannot capture a substantial amount of rent without causing substantial economic damage. Such regimes make extraction of marginal resources unprofitable and may have the same effect on resources that are not much better than marginal. If royalty rates are not kept low, they can knock out parts of resources or entire resources. They damage incentives to explore, invest and extract at the margin, thereby destroying some resource rent. However, if royalty rates are kept low to avoid such economic damage, they capture only a small proportion of resource rents realisable from exploitation of superior resources. Resource rent is then allowed to escape to other jurisdictions. There is a substantial literature on this matter, and on effects of alternative regimes, including work by Gaffney (1967), Northern Territory (1982), Willett (1985, 2002), Industry Commission (1991), Smith (1997), Lund (2009), ACIL Allen (2010), Henry, others (2010), and Boadway and Keen (2010, 2015).

An accounting profits regime, such as the Northern Territory royalty regime for mineable resources other than oil and gas, and the Commonwealth Government's company income tax regime, are superior to an ad valorem system. However, these systems still tax the cost of equity capital and they do not treat gains and losses symmetrically. Therefore, they discourage exploration and investment.

[51] Resource rents that accrue to overseas entities would not be available to replace depletable assets. To put this in perspective, about 80 per cent of the Australian mining sector is overseas owned (Connolly, Orsmond, 2011).

13.4.2 Spending revenue

Government misspending of revenue derived from a mining boom ignited by high commodity prices or major discovery may cause a genuine economic "disease" or "curse". This may result from the composition or types of spending undertaken, not just the pro-cyclicality problem discussed above.

It appears that the true "disease" experienced by the Netherlands following major discoveries and substantial exports of natural gas resulted from consumption (not saving and investment) of resulting government revenue. This took the form of high levels of social service or welfare payments that amplified economic adjustment issues, were not sustainable, and proved to be politically difficult to remove (Corden, 1984; Hart, 2010).

Determining how much should be saved and invested is not straight forward. One complication is that mineable resources can be at least partly replenished by exploration and technological advances in exploration and extraction. Additional complications working in the opposite direction are that investments in human and built capital and research are imperfect substitutes for mineable resources, and the marginal productivity of reproducible capital would tend to fall as substitution proceeds. Another issue is that only some of the resource rents remaining in private Australian hands after royalty and tax will be saved and invested in Australia, and resource rents captured by overseas entities would probably be lost to the Australian economy. There is an economic case for saving and investment of all government revenue from resource rents in capital-scarce developed countries like Australia, and particularly in relatively undeveloped locations with considerable potential, such as the Northern Territory.[52] This approach was recommended by the Productivity Commission (1998) and its predecessor, the Industry Commission (1991).

Selection of specific investments also matters. Investments that have been poorly conceived, directed towards political objectives, and/or do not pass or are not subjected to comparative social benefit-cost analyses should not been made. Government should not provide infrastructure or concessionary funding for infrastructure or other investments to developers of mining or diversification activities that are the main beneficiaries of the expenditure, without a claw-back mechanism to recover the full economic cost (including an appropriate risk-adjusted rate of capital in alternative uses). Investments should not be made by government for the purpose of impeding desirable structural adjustments.

A logical government investment in a jurisdiction that is relatively unexplored, despite favourable geology, would be expansion of funding of very early stage exploration and prompt release of the resulting information provision. There is a strong economic case for government to engage in such activity to correct two market failures: under-provision of basic geological information by the private sector because of its public good character, and asymmetric distribution of exploration information that tends to lead to wasteful pre-emptive exploration by some parties, and tends to shut out other parties and impede competition for tenements. This case has been understood for 50 years (see Gaffney, 1967; Herfindahl, 1969).

This case for government investment in exploration activity can be extended to justify a tapered subsidy scheme (from 100 per cent down to zero) for some subsequent exploration, followed by prompt release of information, because the transition of exploration information from public to private good as exploration becomes more focussed as it proceeds to later stages of assessment is not a clear-cut step. Moreover, there is a case for government investment in infrastructure and personnel to assemble, analyse, package and release information generated by government and private sector exploration activities. The nominated resource-rent capture regime would claw-back much of the value added by this government expenditure on exploration and information dissemination.

Logically, other government investment would take the form of investment in education, health, and infrastructure designed to complement and boost productivity in tradeable and non-tradeable goods and services sectors, reducing costs in those sectors. Investment could be focussed to support productivity improvements in stressed, lagging tradeable goods sectors. It could also be directed towards helping those lagging sectors indirectly by increasing productivity and constraining price rises in expanding non-

[52] In developing countries, where poverty is a major problem, it would be appropriate to allocate some of the revenues derived from resource rents to consumption spending to alleviate poverty. Particularly high rates of return on investment in education, health and infrastructure in such countries could allow release of some revenues to alleviate poverty directly, in addition to alleviating it indirectly through investments (Sachs, 2007; Collier, van der Ploeg, Spence, Venables, 2010).

tradeable sectors providing inputs to, and competing for resources with lagging sectors (Sachs, 2007; Freebairn, 2012).

The timing of government investment is as important as careful selection of specific investments. As discussed above, pro-cyclical government spending could have economic "disease" or "curse" effects. While these would be moderated as productivity-improving effects of targeted government investment come into play, "disease" or "curse" problems could occur in the interim. This suggests it would be economically appropriate to spread government investments over time in a counter-cyclical fashion.

John Freebairn (2012) suggested that revenues derived from resource rents could be invested in tax reform in a manner designed to reduce inefficiencies of the Australian tax regime as a whole. This could be undertaken along lines suggested by the Henry Tax Review (Henry, others, 2009). It should yield large productivity gains.

A common suggestion for investment of government revenue derived from resource rent is to accumulate foreign assets. This is a way of providing a stream of sustainable future revenue, while reducing economic "disease" problems, because it moderates the real exchange rate appreciation resulting from a booming mining sector. However, in the context of apparent under-investment in human capital and infrastructure in the capital-scarce Australian economy, investment solely in foreign assets seems inappropriate. Higher economic returns could be earned by investing domestically. Moreover, Australia's tax regime interferes with efficient allocation of resources. Therefore, a compromise would appear sensible, including "parking" of a high proportion of revenue derived from resource rents in liquid foreign assets during periods of booming mined-commodity prices, re-investment of some of those funds and new revenue in human capital and infrastructure on a counter-cyclical basis at other times, and investment of government revenue from resource rents in tax reform.[53]

13.5 Optimal regulation of exploration and production

Resource rent may also be misspent through poorly designed exploration tenement policies. Typical tenement regimes in Australia induce dissipation of ex ante resource rent through misallocation of resources. These regimes fall into two categories: conditional first-come-first-served systems and work programme bidding for highly conditional tenure. The mineral exploration tenement regime in the Northern Territory falls into the former category. The Northern Territory petroleum exploration regime is of the latter type.

Both systems tend to dissipate ex ante resource rent and misallocate resources because of distortion of the timing, amount and composition of exploration activity, through the effective allocation of resource rent by government to subsidise exploration that is marginal because of timing, location and technique. The existence of this policy failure in the Northern Territory context was recognised 36 years ago in the *Green Paper on Mining Royalty Policy for the Northern Territory.*

Policy failure associated with regimes with some common features was discussed in a United States context by Gaffney (1967) and Herfindahl and Kneese (1974). Similar issues with conditional first-come-first-served systems in Australia were noted by Fitzgibbons (1977). Inefficiencies associated with both systems in Australian jurisdictions have been analysed in some depth by ACIL Allen (2012), Henry and others (2010), Willett (2002, 1985), Smith (1997), and the Industry Commission (1991). The analysis has been endorsed by the Productivity Commission (2015).

Work program bidding is a mechanism for allocation of exploration tenements. It involves a formal bidding process for areas released for offers of exploration work. Each tenement is allocated to the bidder offering the exploration programme that is judged to be the best. Typically, more and earlier activity are judged to be better.

The location and timing of release of tenements for allocation by work program bidding is determined by government. Explorers are not able to apply for tenements on an *ad hoc* basis under a work program bidding system, in contrast to a conditional-first-come-first-served system.

Typically, the tenements are highly conditional, being subject to relatively short tenure (5 years), periodic relinquishment requirements (50 per cent after the initial 5 years before renewal), and performance of the

[53] A detailed discussion of saving and investment options has been presented by van der Ploeg (2014).

work programme that was bid. Capture of resources and retention of ground on a long-term basis depend on performance of the work programme and discovery of resources.

Following release of an area for work program bidding, a potential explorer seeking to capture tenure would offer no more than a work programme of size and timing that would extinguish *ex ante* resource rent. This would involve increasing and bringing forward exploration relative to the exploration programme a rational explorer would choose with secure, prolonged tenure. The earlier that an area is released for work program bidding, the more important will be the effect of bringing forward exploration, which dissipates *ex ante* resource rent through interest on premature outlays, and higher real costs of exploring earlier, rather than later. The closer that release of an area for bidding approaches the ideal time to commence exploration, the greater will be the relative importance of the tendency to increase the amount of the exploration programme offered above what is reasonably expected to be required for discovery. Then, *ex ante* resource rent is dissipated through economically excessive outlays.

Another adverse effect of work program bidding is that it would also tend to dissipate value added by government funding of very early stage exploration. This work would reduce uncertainty and consequent waste of exploration resources experienced by private sector explorers, raising ex ante resource rent from the perspective of those explorers. Subsequent work program bids would be adjusted to reflect the value added.

14 PERSPECTIVES ON POLICY ISSUES

The literature highlights the range of issues that Governments would need to consider, should the development of a shale gas industry in the Northern Territory proceed. Through the stakeholder consultation process, ACIL Allen gained further insights on the key issues that need to be considered in designing an effective policy and regulatory regime in the Northern Territory, should the development of a shale gas industry proceed. A copy of ACIL Allen's Consultation Guide in presented in Appendix B.

Through the literature review and stakeholder consultation, ACIL Allen has identified six key policy areas considered relevant to the development of a shale gas industry in the Northern Territory. In discussing each of these issues, the de-identified remarks of stakeholders have been included where they provide further context as to the issues and challenges that may arise during a development.

ACIL Allen Consulting has considered the six policy areas as they relate to three key outcomes for the Northern Territory in the event of shale gas industry development.

— Measures to **capture** the benefits
— Measures to **distribute** the benefits
— Measures to **manage** downside risks

As per its scope of works, ACIL Allen Consulting is focussing strictly on the identification of economic policy issues and initiatives that are available to the Northern Territory Government.

14.1 Managing an increase in NT Government revenue

ACIL Allen's modelling suggest the Northern Territory Government would receive between $18 million (BREEZE scenario), $34.4 million (WIND scenario) and $95 million (GALE scenario) in royalty income per annum at full scale production should a shale gas development proceed. This would represent between a 0.3 per cent and 1.4 per cent increase in the revenue base of the Northern Territory Government. In addition, the Territory will raise an estimated $2.9 million (BREEZE), $8.7 million (WIND) and $11.1 million (GALE) in payroll tax, and additional revenue associated with transfer duty, insurance duty and other State taxes which ACIL Allen has not modelled.

Within this policy area, the issues are mostly available to the Northern Territory to capture the benefits and distribute the benefits of a shale development.

In terms of capturing benefits, the Northern Territory Government already levies a 10 per cent ad valorem royalty at the well head (point of production) for all onshore petroleum production. According to NT Treasury, the royalty is calculated using a netback method, which allows operators to deduct upstream costs (principally transport) from the final sales price of gas in order to capture 10 per cent of the well head. This is in line with other Australian States and Territories, which tend to target a 10 per cent return to the community from the sale of mineral and petroleum resources.

The practice of charging the private sector a **royalty** for the sale of a non-renewable resource for extraction is well founded. Broadly, stakeholders were of the view that levying a royalty was a critical way for the Northern Territory to capture the benefits of a shale gas industry development. There was also a view presented to ACIL Allen that the royalty rate could be used as a negotiating tactic for the Government to incentivise non-production elements of the industry to move to the Northern Territory – such as a corporate head office or support function.[54]

It is also important to consider the need for a stable, certain operating environment for potential industry operators. During consultation, industry operators raised the need for a well-defined and stable taxation regime as an important consideration in their decision making as to whether a development would proceed beyond the initial exploration and appraisal phase. [55]

One particular feature of the potential for additional onshore petroleum royalties is how this may interact with Australia's system of **horizontal fiscal equalisation** (colloquially known as "GST distribution"). The Northern Territory is currently a significant beneficiary of the system, mostly on account of its identified additional expenditure needs (see Section 2.4) determined by the Commonwealth Grants Commission.

Each State's onshore petroleum royalty revenue is assessed as part of the Commonwealth Grants Commission's mining revenue assessment; onshore petroleum royalties are considered substantial enough to be assessed as an individual line of revenue. For confidentiality reasons, the Commonwealth Grants Commission does not publish the details of the onshore petroleum royalty assessment, but it does include them in the "other" mineral component. The Northern Territory has an assessed per capita revenue raising capacity in this "onshore oil and gas and other minerals" component of 9.287. This is a similar relativity as the Commission assesses the Western Australian Government in the iron ore royalty assessment (8.831), suggesting a high proportion of the Northern Territory's onshore petroleum royalties could be "equalised away" to other State and Territories in the GST distribution process.

There has also been some discussion that the Commonwealth Government may treat onshore gas revenue as "equal per capita" revenue, which would provide all States with a financial incentive to raise additional revenue from this source as it would not be subject to the GST distribution process. This is an issue worthy of further detailed examination and advice from NT Treasury[56] and the Commonwealth Grants Commission.

After raising the revenue associated with the shale gas industry, the Northern Territory Government has decisions to make regarding the way it will be treated or spent. This is primarily a distribution issue – with both geographic and intergenerational dimensions. While the pressure to spend any uplift in royalty and other revenue is likely to be strong, there are also options for the NT Government to manage the new revenue streams with an eye to intergenerational equity. There are two ways to do this: a wealth fund or a stabilisation fund.

The literature says there is a strong case for windfall royalty revenue to be treated differently. The Government is selling the right to mine a non-renewable resource, which is a one-off transaction. In this respect, mining royalties are different to taxes on income or consumption, which are perennial tax bases. Revenue raised from royalties should therefore be used to compensate society for the realisation of the value. This can be done by investing in the physical or human capital of the economy – to improve its productivity – or by warehousing the revenue in a special fund.

Traditionally, a **wealth fund** is used to accumulate revenue associated with windfall gains or with the extraction of non-renewable resources such as mineral commodities or petroleum products. The most famous example is the Government Pension Fund of Norway, which has an estimated value of just under US$1 trillion. The fund was established in 1990 as a warehouse for government revenue earned from oil company profits.[57] Most major petroleum producing nations have some sort of wealth fund for the purposes of accumulating profits or other revenue (such as royalties).

The Western Australian Government developed its own sovereign wealth fund – the *WA Future Fund* – in its 2012-13 budget as a way of warehousing some of the proceeds of the iron ore royalty boom. The WA Future Fund received an initial capital injection of $1 billion dollars between 2012-13 and 2015-16, and

[54] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017.*
[55] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017.*
[56] NT Treasury were cognisant of this risk when ACIL Allen met with personnel during its stakeholder consultation
[57] Sovereign Wealth Fund Institute. 2017. *Norway Government Pension Fund Global – Summary.* Accessed online at http://www.swfinstitute.org/

receives ongoing injections equal to one per cent of the State's royalty revenue per annum, and reinvests all of its earnings in additional capital accumulation.

The WA Future Fund is governed by an Act of Parliament, which forbids any future government to access the funds it is receiving and generation until 2031-32 (unless a Bill can pass with the concurrence of an absolute majority, of both houses of the State Parliament), at which time the State Government projects it will have a nominal value of $4.7 billion.[58] The Act states the annual interest earnings on the WA Future Fund can be used to finance the economic and social infrastructure needs of the State.

While well-intentioned, the broader settings of the State's finances are not ideal to host a wealth fund, given the State has significant public debt and high operating and cash deficits.[59] This means the State Government is effectively borrowing money to store in the fund. It is important to consider the state of public finances when making such significant, long-range decisions.

There are also a number of examples of countries which use a **sovereign wealth fund for the purposes of stabilising government finances**. These kinds of funds tend to be more short to medium term in focus than the long term nature of a wealth fund, and are used as a "banking" mechanism for countries with volatile, uncertain revenue bases. These funds tend to have strict rules around when money is to be deposited and can be withdrawn. The objective of smoothing out fluctuations in government revenue is to avoid large deficits or increased spending of short term increases in revenue.

The central government of Chile has operated a stabilisation fund under various guises since 1985, and has drawn on money stored in it during global economic crises in order to avoid large deficits or recessions in their domestic economy.[60] The rules regarding Chile's current stabilisation fund, the *Economic and Social Stabilization Fund*, are presented in Box 14.1.

BOX 14.1 CHILE COPPER STABILISATION FUND

Chile's Economic and Social Stabilization Fund (the 'ESSF') is often held up as a prime example of best practise stabilisation fund management. The ESSF received an initial seed investment of US$2.5 billion in 2007, following a decision to consolidate two sovereign wealth funds into one with simplified objective of smoothing out revenue fluctuations associated with Chile's copper industry.

The ESSF receives additional capital on an annual basis when Chile's central government budget is in a surplus position equal to or greater than one per cent of GDP – with the capital injection equal to the surplus less the amount equal to one per cent of Chile's GDP. The ESSF mostly invests in low risk government and corporate bonds, allowing it to earn a return above holding cash but also affording flexibility to allow for a quick sale if the fund needs to be accessed.

Chile's central government has an overall "balanced budget" rule, meaning the ESSF can be called upon if there is a projected central government deficit in a given year to avoid the accumulation of debt to finance the operations of government. The ESSF can also be drawn down to fund any unmet pension or social welfare liabilities at the discretion of Chile's Minister for Finance. The ESSF is consistently one of the highest rated funds by the Sovereign Wealth Fund Institute.

SOURCE: GOVERNMENT OF CHILE, NATIONAL RESOURCE GOVERNANCE INSTITUTE, ACIL ALLEN CONSULTING

The Inquiry is keenly interested in examining the notion of a "royalties for regions" fund, which could quarantine a proportion of royalties associated with the development for spending in the area where resources are extracted. Such a policy was implemented in Western Australia just as its iron ore and gas boom gathered pace in 2008-09, as a result of the negotiations associated with the formation of a new government in a hung parliament. An overview of the structure of the program is in Box 14.2.

[58] Parliament of Western Australia. 2012. *Western Australian Future Fund Act 2012*. Accessed online at http://www.parliament.wa.gov.au/
[59] CCIWA. 2012. *Examining the Issues of Sovereign Wealth Funds*. Accessed online at http://www.cciwa.com/
[60] International Monetary Fund. 2007. *Assessing Chile's Reserve Management*. Accessed online at http://www.imf.org/

BOX 14.2 WESTERN AUSTRALIA'S ROYALTIES FOR REGIONS FUND

The Royalties for Regions Fund Program is administered by the *Royalties for Regions Fund Act 2009*. The Act directs 25 per cent of annual resources royalties raised by the Western Australian Government to a special purpose account that can only be spent in areas outside of the Perth Metropolitan Area. The Act specifies the Fund is to be "over and above" the usual expenditure of government in regional areas, and it can be expended for three purposes:

1. To provide infrastructure and services in regional Western Australia
2. To develop and broaden the economic base of regional Western Australia
3. To maximise job creation and improve career opportunities in regional Western Australia

The remainder of the Program is established by administrative provisions within the Department of Primary Industries and Regional Development (formerly the Department of Regional Development). These provisions set out the strategic framework guiding spending, including the project approvals process which sees Fund applicants skip the usual WA Treasury review process.

There is a $1 billion limit placed on the end of financial year balance of the Fund, meaning in times where royalty revenue is booming, the Fund must expend close to $1 billion per annum. Prior to 2014-15, the Fund received an appropriation equal to 25 per cent of royalty revenue without a cap on the appropriation. This was changed in the 2014-15 State Budget – independent $1 billion appropriation and expenditure caps were put in place – to maintain the integrity of the program and ensure it did not become an undue drag on the State's finances.

SOURCE: ACIL ALLEN CONSULTING

The policy has been in place in Western Australia since 2008-09, quarantining 25 per cent of total royalty revenue (up to an annual amount of $1 billion) for spending on regional development projects, town beautification and social programs. There are a series of changes the Western Australian Government has made to the program in recent years (both past and current Governments) to improve the transparency, decision-making and accountability associated with it, and to shift its focus to job-creating projects rather than the provision of amenity enhancements.

Numerous reviews have also called into question the governance arrangements of the Program, noting it was not subject to the usual scrutiny of government expenditure review.[61] This was particularly true in the early years of the Program, when money was distributed to regional local government authorities with very loose accountability and little guidance on how it should be spent. The Program is now subject to a Special Inquiry.[62]

While these are important considerations, based on the development scenarios modelled by ACIL Allen Consulting it is unlikely that the revenue streams associated with the development of a shale gas industry would be of a requisite scale to warrant development of a specialist fund for the purposes of fiscal stabilisation or intergenerational equity. However, it is worth considering the benefits and costs of such an idea given it is an issue front of mind for many of the stakeholders ACIL Allen consulted.[63]

14.2 Managing an increased demand for labour

The development of the shale gas industry in the Northern Territory has the potential for substantial labour benefits in the form of job creation, skills development and workforce diversification. An increase in the demand for labour from the development of the industry can be measured by the direct labour that is hired to work on the construction and operation phases of the development, as well as the indirect employment impact from the jobs that are generated by the spending in the economy as a result of the development.

[61] WA Office of the Auditor General. 2014. *Royalties for Regions: Are the benefits being realised?* Accessed online at http://www.audit.wa.gov.au/
[62] WA Government. 2017. *Media Statement: Commission of Inquiry to Investigate financial mismanagement, 15 May 2017*. Accessed online at http://www.mediastatements.wa.gov.au/
[63] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017.*

It is estimated the employment impact of a development will average 82 FTE (BREEZE), 252 FTE (WIND) and 524 FTE (GALE), with much of this employment likely to occur in regional areas where the activities of an industry would occur.

Given the remote locations of the development sites, it is expected that a there will be a need for some of the workforce to be employed on a fly-in, fly-out employment roster as the availability of sufficient skilled labour in these areas is unlikely to be able to be sourced locally. However, depending on the location of the development sites, there could be opportunities for nearby regional job seekers to be employed on a drive-in, drive-out basis. The use of regional employment will depend on the skills sets of local job seekers and the availability of training to gain the skills required of the developments. There was a preference in consultation from local communities to maximise the use of local job seekers in order to assist in keeping the benefits of the development of the industry on country.[64]

The more remote locations of the development areas means there is often limited employment and career opportunities. With high levels of unemployment in many regional areas of the Territory, the labour opportunities presented by the development of the shale gas industry are potentially important to improving economic and social outcomes in regional and remote areas.[65]

The types of skills required to develop shale gas deposits differ between the construction and operation phases. In construction the skills set generally favour engineers, drillers, logistics personnel and labourers while engineers, geoscientists and technicians comprise the bulk of the workforce one a project is operational. This range of skill set requirements provides opportunities for job seekers in the Northern Territory, particularly for those job seekers with low skills and those wishing to develop their skills set. It also provides opportunities for trainees and apprentices.

Given the skills set and experience of the Northern Territory workforce, it has been assumed that some specialist skills may need to be sourced from elsewhere in Australia or overseas. However the majority of the workforce is expected to be sourced from within the Territory. During consultation, it was advised that local job seekers would be trained to meet the requirements of the developments. Over time, it is expected that the local employment content of the developments will increase as the skills and experience of the local workforce employed on the developments grow. [66]

There are opportunities for government to maximise the workforce benefits of shale gas development and ensure that benefits are able to be accessed by all job seekers in the Northern Territory. There is **a role for government in co-ordinating the requirements of the shale gas industry with employment and training providers**. This includes identifying the timing of developments and the skills sets required for the construction and operation phases of the developments. There is further opportunity to work with employment agencies and training providers to ensure that they match their services to the needs of the shale gas industry. This will assist in maximising local employment benefits and promoting the distribution of labour benefits to job seekers throughout the Territory.

According to potential suppliers to a shale gas industry, there is an important role for “localised” on the job training opportunities. MS Contracting, one of the major suppliers of supplies and services to the shale gas industry during its brief exploration activities in the Northern Territory, made a submission to the Inquiry and reinforced this submission during stakeholder consultation that referenced the positive outcomes of their localised training program for Indigenous persons in the regions they operate in.[67]

The Northern Territory captures the employment benefits of projects through local labour content policies such as the Indigenous participation in construction projects policy which requires contractors to develop an Indigenous Development Plan aimed at maximising the employment of Indigenous labour and businesses on construction projects. There are benefits in setting local employment targets and Indigenous employment targets as long as they do not result in a misallocation of resources. These types of targets assist in ensuring employment benefits are targeted at local job seekers.

Other programs aimed at maximising local employment and skills development through matching information flows include the NT Apprenticeships and Traineeships Database which is co-ordinated by the Northern Territory Government. The database contains details of all approved apprenticeship / traineeship

[64] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017.*
[65] ACIL Allen notes this is an issue to be covered by the Inquiry’s Social Impact consultancy.
[66] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017.*
[67] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 17 October 2017.*

qualifications in the Northern Territory and provides information on all apprenticeship/traineeship qualifications. Programs aimed at facilitating the flow of information will be important tools in ensuring positive outcomes for the workforce in the Northern Territory.

14.3 Maximising local expenditure and opportunities

Local content policy is founded on the principle of full, fair and reasonable opportunity for local businesses to secure work on large public and private sector projects. An important enabling aspect of local content policy is providing the platform for suppliers and project owners to connect, and to understand the demand for and supply of goods and services which may be required in a project.

The development of shale gas in the Northern Territory offers opportunities for local businesses through the expected high local spend.

The location of the development sites in remote areas provides a range of supply opportunities for regional businesses that provide goods and services. Opportunities are varied but examples of the types of local businesses that could be involved in the construction stage include earthmoving and civil engineering companies; trades such as electricians, plumbers and gas fitters; caterers; suppliers of fresh food and household consumables; and training providers.

In operation, there will be ongoing opportunities for local businesses to enter into long term agreements to provide goods and services to the developments. These will include those businesses that provide cleaning, maintenance, catering, grading, electrical, plumbing and other goods and services.

As discussed earlier in this report, there can be a mismatch between the expectations of developers and the capabilities and services of local suppliers which results in local businesses missing out on opportunities. **There is a role for government to ensure that there is an information flow from developers regarding available opportunities**. There is also a role to work with local businesses to ensure they properly communicate their capabilities and availability to service developments.

The Northern Territory already has a number of key initiatives in place to capture the benefits from spending by developments. These include the Building Northern Territory Industry Participation Policy, a Government procurement program requiring local content, and a partnership with the Industry Capability Network Northern Territory (ICN NT), to ensure to the Government's commitment to local participation is met.

There is benefit in setting local content targets for developers and contractors in order to maximise the capture of direct and indirect spending in the Northern Territory as long as they do not result in a misallocation of resources. There is further benefit in working with developers to promote the services of local businesses, particularly those in regional and remote areas. This would assist in distributing the benefits of the developments to businesses located throughout the Territory. **Addressing information asymmetries**, by identifying the timing of developments, and the goods and services required for the construction and operation phases of the developments is an important role for government. This would further assist local industry to access full, fair and reasonable opportunities to capture business opportunities from a new project.

There are opportunities for government to work with local businesses, particularly those in regional areas, to identify business opportunities and to match the services of regional businesses to those opportunities. The remote location of the developments offer important business opportunities for Aboriginal communities such as in the area of cleaning, catering, maintenance services, fire services and other parks and ranger services, the hire of heavy equipment such as graders, and the provision of general labour.

BOX 14.3 BUILDING NORTHERN TERRITORY INDUSTRY PARTICIPATION POLICY

Under the Building Northern Territory Industry Participation Policy, an Industry Participation Plan will be a requirement for all Northern Territory Government assisted private sector projects that have an expected value in excess of $5 million. It will also be a requirement for all Northern Territory Government tendered projects that have an expected value in excess of $5 million and for Territory Public Private Partnerships (Territory Partnerships) which will provide opportunities for all sectors in the economy to contribute to the efficient delivery of infrastructure and services.

Industry Participation Plans are intended to:

- assist project proponents and developers to maximise opportunities to utilise local suppliers, services and labour;
- improve the capacity of businesses to compete globally; and
- assist decision making in relation to Government purchasing and investment where value will be the primary consideration.

SOURCE: NT GOVERNMENT, ACIIL ALLEN CONSULTING

Many regional and remote areas in the Northern Territory are experienced with working with resources companies in the exploration, construction and operation phases of developments. By way of example, the Central Land Council **makes agreements with resources companies on behalf of traditional Aboriginal landowners** that define the outcomes for companies and Aboriginal people before activity commences. These agreements ensure that the benefits of developments flow to Aboriginal people through a commitment to employment, training, sacred site protection, environmental protection and opportunities for Aboriginal people. [68]

These types of agreements, along with a transparent and timely flow of information regarding the timing of developments and their purchase requirements will be essential to maximise the opportunities for businesses in the Northern Territory.

14.4 Industry co-existence

The issue of industry co-existence – the ability for a shale gas industry to "fit in" with the existing industry structures of the Northern Territory – was raised by most stakeholders consulted by ACIL Allen. This issue has a multitude of applications to the work of the Inquiry. The economic dimension is the extent to which a shale gas industry **may impede or distort the allocation of the factors of production**[69], particularly natural resources like land and water.

ACIL Allen's development scenarios anticipate a potential shale gas industry could disturb between 67.7 square kilometres (km^2) in the BREEZE scenario, 231.7km^2 (WIND), and 475.9km^2 in the GALE scenario.[70] This represents some 0.03 per cent of total land in the Northern Territory in the GALE scenario. ACIL Allen has accounted for the opportunity cost of this land by assuming it is made unavailable for cattle pastures. This is the primary channel of negative economic impact on the agriculture industry in the event of a shale gas development (see Section 6.2.4).

Under ACIL Allen's adopted assumptions regarding water use, the development may use between 4.2 GL (BREEZE), 11.2 GL (WIND), and 28.2 GL (GALE) of water, respectively. In annual average terms, over the 25 year project life ACIL Allen has modelled, this represents between a 0.17 GL,

[68] Central Land Council, Making agreements on Aboriginal land: Mining and development, http://www.clc.org.au/articles/cat/mining/, accessed September 2017.

[69] Classical economic theory divides the factors of production – the means of producing goods and services – into four categories: land, labour, capital and enterprise. In this instance, the capital and enterprise are to be provided by the private sector and so this has not been discussed. Labour resources are discussed in Section 14.2.

[70] These values are adopted as conservative assumptions – ie ACIL Allen has overestimated the area of disturbance so as to ensure it cannot be underestimated. It is noted producers expected approximately 100km^2 of land disturbance over the life of their "full scale" developments (400TJ/day), the majority of which is associated with transmission pipelines rather than the number of pads.

0.45 GL and 1.13 GL draw on water supplies. This is significantly less than the Australian Bureau of Statistics estimates is used by the agriculture industry in the Northern Territory (47 GL in 2015-16).[71]

Through the Inquiry, ACIL Allen has received information that suggests there are a range of options available to a shale gas development to source water – both potable and non-potable – in a manner which minimises tensions with existing users. For example, the Department of Primary Industry and Resources has identified underground aquifers with a sustainable groundwater yield of 100GL per annum or more across the four prospective shale gas basins.[72] All things being equal, this would suggest **water is unlikely to be a constraint on the development of a shale gas industry** within the current industry structure of the Northern Territory, and the prospect of a reduction in water availability for non-shale gas industry users in the aggregate is limited. In an economic sense, this means there is unlikely to be an opportunity cost borne by society flowing from the use of water by a shale gas development.

Given the above, **it is unlikely that a shale gas industry will impede on the existing allocation of natural factors of production in the Northern Territory**, in an economic sense. However, it is important for the Northern Territory Government to remain fully aware of the activities of potential shale gas operators to monitor the draw on the Territory's natural resources. This would primarily occur through regulation.

There are regulatory measures in place to manage potential land use tensions between industry and Traditional Owners, through a formalised negotiation process involving the various Aboriginal Land Councils established to govern native title in the Northern Territory. Pastoralists also have access to a process to ensure engagement with potential industry proponents, albeit it is not a formalised regulatory instrument. This issue was raised by representatives of the pastoralist industry during ACIL Allen's stakeholder consultation, noting they had advocated for a legislated right of negotiation, access and veto similar to that available to Traditional Owners. Meanwhile, the **Northern Territory Government controls the allocation of permits** for the purposes of exploration or production of petroleum products through its petroleum title system.

The somewhat complex approach to land access is driven in part by the fact that all mineral and petroleum resources are owned by the Crown, and reflects the view that minerals and petroleum are "a gift of nature" and that benefits should accrue to the community as a whole rather than to those who happen to own the surface rights to the land.[73]

In the United States, petroleum resources are owned by the person or entity which owns the land. This can be the State, but it can also be a home owner whose land sits atop a prospective shale. This has its own benefits – access to land can be a relatively simple process, with direct engagement between a prospective shale gas producer and the private land holder allowing a project to progress rapidly.[74] However, it also has costs – the State does not always realise the value of the resource, but bears some of the cost in terms of infrastructure and regulatory oversight.

ACIL Allen has commented on appropriate regulatory design in Section 14.6.

Water has been a consistent theme throughout the Inquiry. There are many dimensions, most of which are covered by elements outside of the scope of ACIL Allen's engagement. The economic dimension to water use is the opportunity cost attached to the use of water for shale gas, primarily for the purposes of creating "frack fluid" to conduct a fracture stimulation down well.

While technology is rapidly advancing, ACIL Allen has assumed there is no water recycling in its industry development scenarios. Industry operators have assumed a recycling factor of between 30 and 50 per cent of water used for fracture stimulation,[75] while industry has proposed the use of lined water "ponds" to store used fracking fluid as a means of disposing of it through evaporation.[76]

As it stands, the **Northern Territory Government does not put a price on the use of groundwater** for mining or petroleum producers. This is in contrast to other Australian jurisdictions, which charge industrial

[71] Australian Bureau of Statistics. 2017. *ABS Cat. 4618.0: Water Use on Australian Farms*. Accessed online at http://www.abs.gov.au/

[72] Department of Primary Industry and Resources NT. 2017. *Submission to Scientific Inquiry into Hydraulic Fracturing in the Northern Territory: #226*. Accessed online at http://www.frackinginquiry.nt.gov.au/

[73] Productivity Commission. 1991. *Mining and petroleum in Australia: Volume 3*. Accessed online at http://www.pc.gov.au/

[74] Resources for the Future. 2013. *US Shale Gas Development: What led to the boom? Issue brief 13-04*. Accessed online at http://www.rff.org/

[75] Santos. 2017. *Submission to Scientific Inquiry into Hydraulic Fracturing: #168*. Accessed online at http://www.frackinginquiry.nt.gov.au/

[76] Origin Energy. 2017. *Submission to Scientific Inquiry into Hydraulic Fracturing: #153*. Accessed online at http://www.frackinginquiry.nt.gov.au/

users accessing groundwater resources for industrial purposes. For example, the New South Wales Government licenses access to its surface and groundwater resources, and applies a series of tariffs based on the entitlements allocated and actual water drawn from the allocation.[77]

Implementing a water licensing and charging regime would allow the Northern Territory Government to adequately deal with any opportunity cost which may arise as a result of the use of groundwater resources by the shale gas industry. However, this would need to be balanced against the potential costs that would be incurred by industry, and whether the costs impact on the prospects of the shale gas industry's development in the Northern Territory.

Throughout its stakeholder consultation, representatives from industry, government and non-government organisations provided ACIL Allen with a **range of potential co-existence issues** that were not able to be included in the economic modelling activities in our scope of works. These are presented in the table below (Table 14.1), with the channel of impact discussed in a second column.

TABLE 14.1 INDUSTRY CO-EXISTENCE ISSUES IDENTIFIED DURING STAKEHOLDER CONSULTATION

Issue	Discussion
Increased use of major arterial roads through central Northern Territory	Stakeholders from the private sector and government raised the concerns about the potential use of major arterial roads in the Northern Territory flowing from the development of a shale gas industry. They were concerned that this may lead to an increased incidence of traffic accidents, increased congestion, and reduced usability for tourists travelling through central Australia. This may have an impact across the Northern Territory economy, although it is impossible to determine the scale without conducting substantive work to understand the current state of major arterial roads and their use. It could be ameliorated by requesting a shale gas development includes plans to upgrade the road network should traffic volumes grow large, or commitments to manage traffic flows in such a way that it does not impede other road users.
Reduced land use available for cattle farming	ACIL Allen has addressed this in its economic modelling. The transmission mechanism is a reduction in the capital of the Northern Territory's cattle industry, which reduces the ability for it to earn income by an amount equal to the share of cattle pastures disturbed by the shale gas industry.
Reduced water draw available for agricultural and other uses	ACIL Allen has addressed this in the above discussion of natural resource management. There is no price on ground water, and there are no foreseen constraints on the ability for the industry nor current users to draw.
Reputational impact of shale gas on the tourism industry	Stakeholders were concerned that the Northern Territory's "clean and green" reputation could be tarnished by the connotations of a shale gas industry development occurring in the Northern Territory. This may reduce tourism visitor spend, although it would be difficult to measure the impact, likely very small.
The Aboriginal Carbon Fund Savannah Burning Program	Aboriginal rangers in the Northern Territory conduct annual programs of savannah burning, where portions of the Territory's landscape are burned in a controlled manner to reduce fire risk. One component of this program is carbon credit farming, which occurs when burning takes place during periods of the year where the volume of greenhouse gases (methane and carbon monoxide) which escapes into the atmosphere is reduced – leading to reduced environmental impact. A stakeholder was concerned that a shale gas industry may result in a reduced availability of land for burning, which would impact on the rangers who conduct the savannah burning. This may have an impact on the employment of those involved in the savannah burning program. However as discussed, the total area of disturbance of the shale gas industry in the Northern Territory is likely to be very small.

SOURCE: ACIL ALLEN CONSULTING

[77] NSW Government Independent Pricing and Regulatory Tribunal. 2017. *Setting fees and charges*. Accessed online at http://www.water.nsw.gov.au/

14.5 Addressing potential infrastructure constraints

The development of shale gas in the Northern Territory will place additional pressure on existing and planned infrastructure in the Northern Territory including economic infrastructure, social services, social infrastructure, and civic infrastructure. It is expected that the focus will be an increase demand for road, rail and port infrastructure to transport goods and personnel to and from the development sites, in the form of constraints. There could also be additional pressure placed on social infrastructure such as health, education and civic services, particularly in regional areas where infrastructure often has limited capacity to cater for an increase in demand.

Development of infrastructure by the shale gas industry has social and economic benefits for the Northern Territory and particularly for regional areas where much of the infrastructure development is likely to occur. Well planned economic infrastructure is a key enabler for economic and social growth. The development of infrastructure in the Northern Territory is guided by the Northern Territory Infrastructure Strategy that sets out the vision and objectives for infrastructure development along with policy drivers and a framework for the development of infrastructure projects. [78] The Strategy is supported by the Northern Territory 10 Year Infrastructure Plan which details planned projects for the first two years (2017–18 and 2018–19) with proposed infrastructure projects identified in the medium (2019–20 to 2021–22) and longer (2022–23 to 2026–27) term.[79] It is important that the government is made aware of developments in the shale gas industry in order to ensure the infrastructure planning and policy framework in the Territory reflects that development.

Supporting infrastructure is a critical component of any resource venture. Given the remote locations of some resource projects, infrastructure is often provided as part of an integrated self-contained development. However, there are often significant benefits from improvements in infrastructure to other users. The development of the shale gas industry could result in upgrades to infrastructure such as roads, thereby creating efficiencies for other road users. The construction of roads in regional and remote areas can assist in providing better access to communities in these areas providing social benefits such as improved safety outcomes, and economic benefits from a more efficient logistics network, and allowing tourists and other visitors to access these areas. The development of infrastructure also allows better access to developments providing greater opportunities for all residents of the Northern Territory to share in the wealth generated by them.

Consultation found that there were perceived issues with some infrastructure that would support the development of the shale gas industry. Examples include the capacity of the Stuart Highway given the current and potential activity of the resources sector along this Highway.[80] The Northern Territory 10 Year Infrastructure Plan has identified the upgrade of the Highway as a strategic priority to assist freight and economic development. The plan also identifies multiple required road upgrades in the Territory that primarily involve the sealing of regional roads.

An often overlooked feature of the public sector's role in the provision of infrastructure is process surrounding **project selection, prioritisation and long term planning**. Infrastructure investments are often made without due regard given to the basic economic principle of opportunity cost, in that Governments have a limited ability to fund projects. In recent times, both the Australian Government and a number of State Governments have developed independent infrastructure advisory bodies, to assist in the selection, prioritisation and planning for major infrastructure in their respective jurisdictions. The Northern Territory is likely not of the requisite scale to require such a body, but it can learn – and indeed appears to have learned, given its 10 Year Infrastructure Plan – from the principles used to underpin these bodies (Box 14.4).

The Government has a key role in the development of infrastructure in the Northern Territory however with limited resources, **there is a need for private investment**. The Northern Territory 10 Year Infrastructure Plan identifies the private sector as potentially contributing funds to the development of a number of infrastructure projects relevant to the development of shale gas including roads, railways, marine/barge landings, airports, and water supply.

[78] Northern Territory Government (2017), Infrastructure Strategy, Darwin
[79] Northern Territory Government (2017), 10 Year Infrastructure Plan 2017 to 2026, Darwin
[80] ACIL Allen Consulting. 2017. *Stakeholder Consultation, 27-29 June 2017*.

BOX 14.4 THE FUNCTIONS OF INFRASTRUCTURE NSW

Infrastructure NSW (INSW) is established by the *Infrastructure NSW Act 2011*, which among other things sets out the general and specific functions of the body. These include:

— prepare and submit to the Premier a 20-year State infrastructure strategy;
— prepare and submit to the Premier 5-year infrastructure plans and other plans requested by the Premier;
— prepare and submit to the Premier sectoral State infrastructure strategy statements;
— prepare project implementation plans for major infrastructure projects;
— review and evaluate proposed major infrastructure projects by government agencies or the private sector and other proposed infrastructure projects (including recommendations for the role of Infrastructure NSW in the delivery of those projects);
— oversee and monitor the delivery of major infrastructure projects and other infrastructure projects identified in plans adopted by the Premier;
— carry out or be responsible for the delivery of a specified major infrastructure project in accordance with an order of the Premier;
— assess the risks involved in planning, funding, delivering and maintaining infrastructure, and the management of those risks;
— provide advice to the Premier on economic or regulatory impediments to the efficient delivery of specific infrastructure projects or infrastructure projects in specific sectors;
— provide advice to the Premier on appropriate funding models for infrastructure;
— co-ordinate the infrastructure funding submissions of the State and its agencies to the Commonwealth Government and to other bodies;
— carry out reviews of completed infrastructure projects at the request of the Premier; and
— provide advice on any matter relating to infrastructure that the Premier requests.

One of the critical features of INSW is any project that receives approval must have undertaken a rigorous, transparent cost-benefit analysis.

SOURCE: INFRASTRUCTURE NEW SOUTH WALES

There are also opportunities to **leverage Australian Government infrastructure funding** to assist in funding any new infrastructure that may be required.

— **The Northern Australia Infrastructure Facility** (NAIF) is a concessional loan facility established by the Australian Government to encourage and complement private sector investment in infrastructure in northern Australia. The Australian Government has made $5 billion available to approve loans between 1 July 2016 and 30 June 2021, with terms determined on a case by case basis.
— **The Building Better Regions Fund** (BBRF) is a grant-based program available to provide infrastructure or community investments in areas outside of Adelaide, Brisbane, Canberra, Melbourne, Perth and Sydney. The application for funding can be made by a Local Government Authority or not for profit organisation, but can be supported by State/Territory Governments and private sector organisations. There is just under $500 million in funding available in the program.
— **The National Water Infrastructure Fund** is available to assist public and private sector entities improve water infrastructure across Australia. Projects can build new or augment existing water infrastructure, including dams, pipelines or aquifer related projects. Projects must be sponsored by a State Government, who must be involved in the project.

These are in addition to regular programs such as national partnerships for roads and rail, local roads investments, and discretionary infrastructure investment funds made available by the Australian Government from time to time.

14.6 Approaches to industry regulation

The Productivity Commission's 2009 review into upstream petroleum regulation in Australia found the system was overly complex, contained numerous overlapping areas of compliance and statutes, and was likely harming the international competitiveness of Australia's energy sector.[81] In 2017, little appears to have change, particularly when it comes to onshore regulation (the Commonwealth Government has implemented some of the Productivity Commission's recommendations regarding consolidation of offshore petroleum regulations).

Petroleum extraction is subject to significant regulatory impost relative to other sectors, in line with the heightened safety risks and potential environmental impacts should something go wrong. During stakeholder consultation, potential industry proponents did not express a strong dissatisfaction with the current regulatory regime for petroleum extraction in the Northern Territory.[82]

The Fraser Institute's Global Petroleum Survey (2015) found **the Northern Territory was rated as the third most development-favourable jurisdiction in Australia** from a regulatory perspective, and the 34th most favourable of 126 jurisdictions surveyed by the Institute.[83] Comment on specific regulatory matters is not within ACIL Allen's scope of works, but at face value it appears the Northern Territory's existing petroleum regime serves the needs of industry well ensuring Territorians are protected.

The most substantive issue regarding industry regulation was a **perception that the Northern Territory Government may not be fully equipped to regulate a shale gas industry**. This was an issue raised by stakeholders from the private sector, government and non-government organisations.[84] Regulatory enforcement is a critical part of the way the Northern Territory Government can help provide the public with certainty industry is meeting its social license to operate. The significant land mass of the Northern Territory, and the remote location of prospective developments, make physical regulation of the industry difficult.

The functions of petroleum regulation are vested in the Department of Primary Industry and Resources' "Energy Services" group.[85] In its 2017-18 Budget, the Northern Territory Government has reduced the appropriation granted to the group from $3.9 million to $3.4 million, on account of the cessation of a one-off research funding grant. There are additional regulations which apply to the petroleum sector, such as occupational health and safety and environmental protection. Broadly speaking, the Northern Territory Government spends $37.2 million on mining and petroleum industry information services and regulation.

While the direct expenditure on petroleum-specific regulation in the Northern Territory is an increase on recent years (the Energy Services group, formerly a part of the Department of Mines and Energy, received an appropriation of $2.6 million in 2014-15 and 2015-16), **the level of funding is low compared to the cost of services of mining and petroleum regulators in other States** (Table 14.2).

The level of expenditure on services is not prima facie a measure of the level of service delivery. However the stark difference between the Northern Territory and other State and Territories suggests stakeholder concerns require this issue to be examined further. In any event, the capacity of regulators to enforce the regulation of a shale gas industry is a significant consideration for the Northern Territory Government. Given the Northern Territory's current financial challenges, there may be a need for the Northern Territory Government to examine innovative approaches to industry regulation.

Best practice principles suggest **industry should "pay its way" when it comes to industry regulation**. This is because appropriate regulations, and regulatory enforcement, is critical to industry earning a social license to operate; operators themselves are also the major beneficiary of a regulatory regime which enables the safe development of an industry. The Northern Territory Government levies a fees and charges regime for onshore petroleum exploration and production licenses, but these are relatively small in the scheme of the life of a development (for example, ACIL Allen estimates ProjectCo will spend just $3.6 million in licensing fees in the GALE scenario – 0.003 per cent of forecast revenue). There may be

[81] Productivity Commission. 2009. *Review of the regulatory burden on the upstream petroleum (oil and gas) sector, April 2009*. Accessed online at http://www.pc.gov.au/
[82] ACIL Allen Consulting. 2017. *Stakeholder Consultation: 27-29 June 2017*.
[83] Fraser Institute. 2016. *Fraser Institute Global Petroleum Survey, 2015*. Accessed online at http://www.fraserinstitute.org/
[84] ACIL Allen Consulting. 2017. *Stakeholder Consultation: 27-29 June 2017*.
[85] NT Treasury. *NT Budget 2017-18, Agency Statements*. Accessed online at http://www.budget.nt.gov.au/

scope to increase these fees and charges in order to fund any uplift in expenditure required to more adequately resource government regulators.

TABLE 14.2 COST OF ADMINISTERING AND REGULATING THE MINERAL AND PETROLEUM SECTORS, BY STATE, 2016-17, $M

State	Mining and/or petroleum information and regulation expenditure	Department/s applying regulation
Queensland	Mining and petroleum $258.5m	Department of Natural Resources and Mines Department of Energy and Water Supplies
South Australia	Mining and petroleum. Also includes some electricity regulatory services related to consumer safety $132.8m	Department of Premier and Cabinet
Western Australia	Mining and petroleum $154.6m	Department of Mines, Industry Regulation and Safety

SOURCE: ACIL ALLEN CONSULTING, BASED ON ANALYSIS OF STATE BUDGET PAPERS

APPENDICES PART ONE: ENGAGEMENT INFORMATION

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A ACIL ALLEN'S TERMS OF REFERENCE

A.1 Background to the Inquiry

On 14 September 2016 the Chief Minister of the Northern Territory, the Hon Michael Gunner MLA, announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs in the Northern Territory. At the same time, the Chief Minister announced that a *Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory* (the **Inquiry**) would be established and released draft Terms of Reference, which were open for public comment for four weeks.

On 3 December 2016 the Northern Territory Government announced the final Terms of Reference for the Inquiry and the composition of the panel that will be undertaking the Inquiry (the **Panel**).

The Inquiry was established under section 4 of the *Inquiries Act 1945* (NT) and is comprised of a judicial chair, the Hon Justice Rachel Pepper, and ten highly regarded scientists with expertise in areas ranging from hydrogeology to social science.

The Inquiry's final Terms of Reference can be read in full on the Inquiry's website (www.frackinginquiry.nt.gov.au).

On 20 February 2017 the Inquiry released a *Background and Issues Paper,* also available on the Inquiry's website, which was followed by hearings and community meetings held in March 2017 in various town centres and remote communities across the Northern Territory. The Issues Paper includes a timeline for the Inquiry, which indicates that an interim report will be released in mid-2017, a draft final report will be released during the last quarter of the year, and a final report will be released in December 2017.

The Hydraulic Fracturing Taskforce (the **Taskforce**) has been established in the Department of the Chief Minister to support the Inquiry.

A.2 Terms of Reference for the Inquiry and the economic impact theme

The Panel has divided the work of the Inquiry into the following themes: water, land, air, social impacts, economic conditions, cultural conditions, human health, land access, and the regulatory framework. This request relates to the economic theme only, however, there are overlaps with the social impact and regulatory framework themes. A sub-group of Inquiry Panel members has been allocated responsibility for each theme.

The Terms of Reference for the Inquiry require the Panel to do the following in respect of each theme:

1. determine and assess the impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the associated activities;
2. determine whether additional work or research is required to make that determination;
3. advise the level of impact or risk that is acceptable in the Northern Territory context;

4. describe methods, standards or strategies that can be used to reduce the impact and risk to acceptable levels; and
5. identify what government can do, including implementing any policy or regulatory changes, to ensure that the impacts and risks are reduced to the required levels.

The *Background and Issues Paper* includes a non-exhaustive list of the potential risks and benefits associated with the economic theme at page 22.

In accordance with the definitions in the Terms of Reference, a reference to an "unconventional reservoir" in this document is a reference to a reservoir where the rock formation is *shale*. There is currently no gas being produced from unconventional, or shale, reservoirs in the Northern Territory. The Amadeus Basin is currently producing gas from conventional reservoirs.

With regard to the third Term of Reference stated above, the level of impact or risk that is acceptable will ultimately be a matter for the decision maker under the relevant legislation (typically the Minister), however, at this stage the meaning of acceptability or acceptable levels of risk is a matter for the Panel, taking into account principles of ecological sustainable development, including the precautionary principle and intergenerational equity.

The Terms of Reference make it clear that the Panel must not only look at the impacts of hydraulic fracturing and the associated activities on economic conditions in the Northern Territory – the Panel must also consider the economic impacts of the onshore unconventional gas industry *as a whole* on the Northern Territory. This is made clear in the following extract from the Terms of Reference, which has been amended to include the relevant language only:

"*When the inquiry makes a determination… about whether or not there has been an impact or risk on … economic conditions, the inquiry will … consider the impacts and risks of the development of the onshore unconventional gas industry, including exploration activities such as seismic surveys and aerial surveys, land access and costs and benefits of the industry.*"

A.3 Steering Committee

A Steering Committee has been established to oversee the work. The Steering Committee is comprised of the Hon Justice Rachel Pepper, Dr Vaughan Beck and the Executive Director of the Hydraulic Fracturing Taskforce. The point of contact for all matters will be the Executive Director of the Hydraulic Fracturing Taskforce.

A.4 Probity Advisor

The Territory has appointed a Probity Advisor to oversee the Territory's processes in relation to the stages of this process. The Probity Advisor's role is to ensure that fairness and impartiality are observed throughout, and that the evaluation criteria stated in any related documentation are consistently applied to all submissions.

A.5 Scope of Work

The supplier must consider the following scenarios:

— **Scenario 1** or the baseline scenario, where the moratorium on hydraulic fracturing of unconventional shale gas reservoirs remains in place;

— **Scenario 2**, which involves the development of the onshore unconventional shale gas industry in the Northern Territory; and

— **Scenario 3**, which involves the development of unconventional shale gas reservoirs in the Beetaloo Sub-Basin only.

A.6 Benefits

The supplier must describe, in both quantitative and qualitative terms, the actual and potential direct and indirect economic benefits associated with each of Scenarios 1, 2 and 3 on the Northern Territory economy under the current regulatory regime.[86]

The supplier must describe, in quantitative and qualitative terms, the actual and potential direct and indirect economic benefits associated with Scenario 2 on the national economy under current regulatory, fiscal and economic settings.

For each of Scenarios 1, 2 and 3 the supplier must estimate the following:

— Gross State Product (**GSP**);
— State Final Demand (**SFD**);
— employment;
— business investment and output;
— CPI;
— population;
— wages; and
— the quantum of royalties that might be received by the Northern Territory Government under the *Petroleum Act 1984* (NT) (to avoid doubt this will include any royalties received in connection with both unconventional and conventional reservoirs).

The supplier must provide the Steering Committee with:

— in accordance with Part C, any assumptions made and an explanation of the methodology used to develop such assumptions, both of which must be approved by the Steering Committee prior to undertaking any economic modelling. The supplier must explain how reasonable and reliable the assumptions are, as well as how any potential bias has been managed, and
— a description of the similarities or differences between the assumptions made under item 7(a) above and the assumptions made in the report entitled *Economic Impact of Shale and Tight Gas Development in the NT* dated 14 July 2017 by Deloitte Access Economics.

The supplier must describe the options available to the Northern Territory Government, whether through policy or regulatory reforms or otherwise, to maximise and sustain the benefits captured by Territorians and others.[87] In this regard the supplier must:

— conduct a literature review to advise on leading practice methods for the sustainable development of onshore unconventional shale gas projects from an economic perspective, and
— provide case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful and what lessons can be learned from these experiences in the Northern Territory context.

The supplier must describe the options available to the Northern Territory Government, including regulatory or policy reforms, for how revenue from the development of onshore unconventional shale industry can be retained both jointly and separately in the regions affected by the development and the Northern Territory, in each case, without impeding investment. Consideration must be given to:

— local procurement requirements, local training programs and other mechanisms to improve local capacity as well as any 'Royalty for Regions' or similar type programs, and
— case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful and the lessons that can be learned for the Northern Territory context.

[86] Indirect benefits might include the opening up of supply chains for local businesses, innovation spin offs, opportunities to develop or support supply and maintenance industries and any other flow-on opportunities the supplier identifies.
[87] It is noted that onshore unconventional gas industry, local communities, local governments, Aboriginal stakeholders (including Aboriginal land councils and prescribed bodies corporate under the *Native Title Act 1993* (Cth)) have a significant role to play in the maximisation of economic benefits, however, the scope of the work is limited to actions that government can take.

A.7 Risks

The supplier must describe, in qualitative terms, any actual and potential adverse impacts and risks associated with Scenario 1, Scenario 2, and Scenario 3 on the Northern Territory economy under the current regulatory regime.

The supplier must consider the impacts of development on other industries in the Northern Territory, including, but without limitation, the tourism, agricultural, horticultural and pastoral, industries.

The supplier must describe the options available to the Northern Territory Government, including policy or regulatory reforms, to mitigate and manage any actual and potential impacts and risks identified above. For example, the supplier must advise what the Northern Territory Government can do to mitigate any "boom and bust" economic cycle associated with the development of any unconventional shale gas industry.

The supplier must:

— conduct a literature review to advise on leading practice methods that could be used to manage and mitigate any risks identified, and

— provide case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful, and what lessons can be learned from these experiences in the Northern Territory context.

A.8 Assumptions

No production licences have been granted under the Petroleum Act for the purpose of producing unconventional shale gas in the Northern Territory. Further exploration work, including the drilling of appraisal wells, is required to fully understand the scope of the Northern Territory's shale gas reservoirs and whether or not they are commercially recoverable.

The most prospective area for shale gas development, should the moratorium be lifted by the Government, is the Beetaloo Sub-Basin (see Attachment A). Origin Energy announced a significant discovery of unconventional shale gas in the Beetaloo Sub-Basin in February 2017, which significantly increased prior estimates of the resource.

In developing any assumptions required to undertake Part A and B, the supplier must consult with relevant stakeholders, including, but without limitation, the Departments of Treasury and Finance; Primary Industry and Resources; Trade, Business and Innovation; Chief Minister; NT Farmers; the Northern Territory Cattleman's Association; petroleum operators and titleholders in the Beetaloo Sub-Basin, Aboriginal Land Councils, and the Australian Petroleum Production and Exploration Association.

The supplier must notify the Steering Committee prior to any consultation and members of the Steering Committee may attend the consultation.

A.9 Timelines and Reporting

The work must be in the form of a written report. The report must be written in plain English. All technical terms (including economic metrics such as Gross State Product, State Final Demand, and employment multipliers) must be explained.

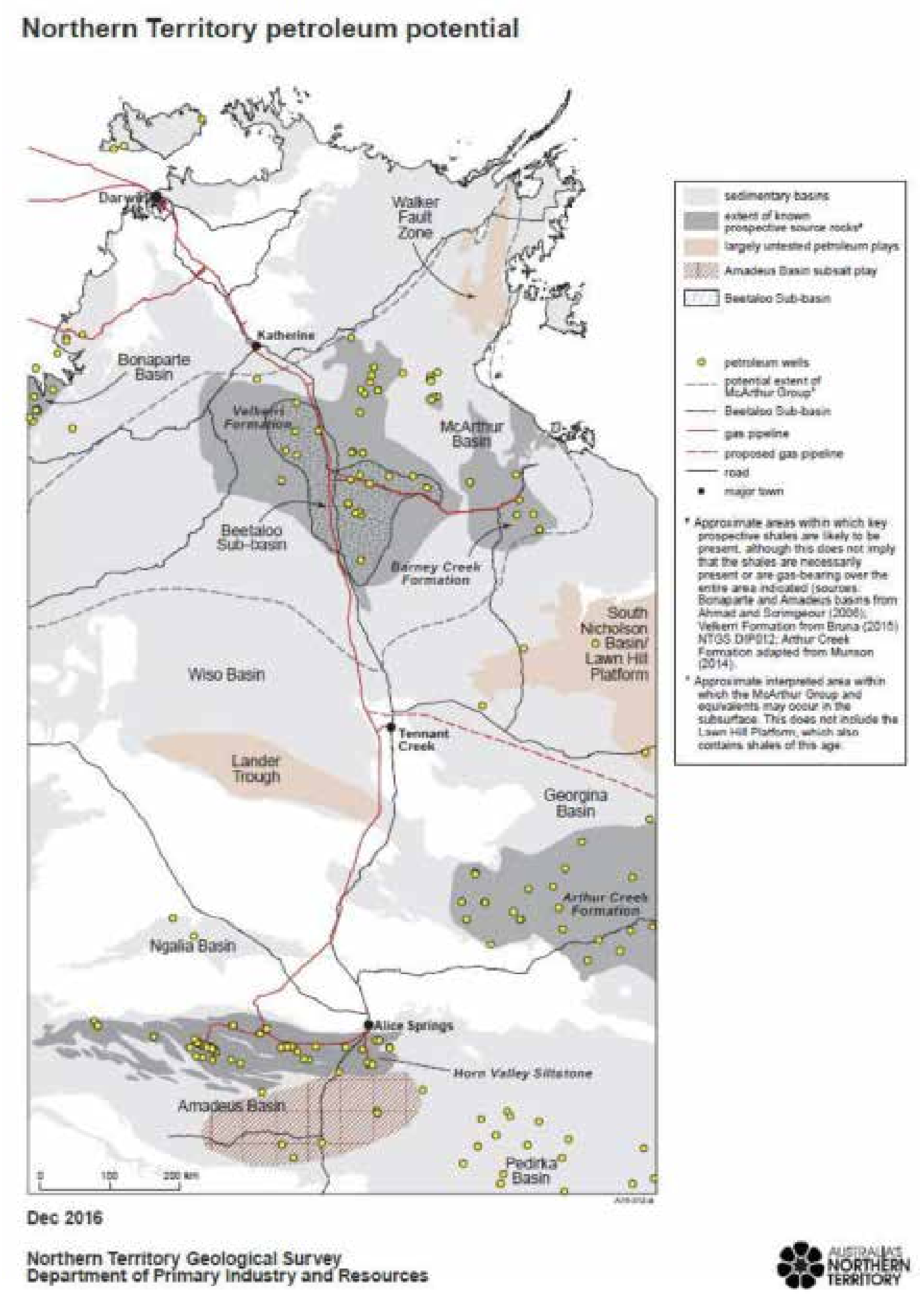
At the end of each calendar month following the award of the tender the supplier must provide the Steering Committee with a written progress report and a verbal presentation within five working days of receipt of the report.

The supplier must provide the Steering Committee with a draft final report and a verbal presentation to the Steering Committee on or prior to 18 August 2017.

A final report must be provided to the Steering Committee by 1 September 2017 and the supplier must present the final report to the Panel on a date to be determined.

The Inquiry will publish the final report on the Inquiry's website on a date to be determined.

The supplier must keep all correspondence, reports and presentations to the Steering Committee confidential, except that the supplier may make the final report publicly available after it has been published on the Inquiry's website.



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B ACIL ALLEN CONSULTATION GUIDE

The below Consultation Guide was issued to all stakeholders consulted during ACIL Allen's initial round of stakeholder consultation in the Northern Territory in June 2017. It was used to guide conversations, and assist stakeholders to provide the most relevant information for ACIL Allen's scope of works.

Background

On 3 December 2016 the Northern Territory Government announced an independent Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (the 'Inquiry'). The Inquiry is investigating the environmental, social and economic risks and impacts of hydraulic fracturing ('fracking') of onshore unconventional gas reservoirs and associated activities in the Northern Territory.

This was the result of an election commitment made by the current Northern Territory Government while in opposition. On 14 September 2016, the Northern Territory Government announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs, including the use of hydraulic fracturing for exploration, testing, and extraction. The moratorium will remain in place during the Inquiry. The Northern Territory Government's terms of reference guide the conduct of the Inquiry. These are included in Box 14.5.

BOX 14.5 TERMS OF REFERENCE: SCIENTIFIC INQUIRY INTO HYDRAULIC FRACTURING IN THE NORTHERN TERRITORY

The terms of the Inquiry are to:

4. assess the scientific evidence to determine the nature and extent of the environmental impacts and risks, including the cumulative impacts and risks, associated with hydraulic fracturing of unconventional reservoirs and the Associated Activities in the Northern Territory;
5. advise on the nature of any knowledge gaps and additional work or research that is required to make the determination in Item 1, including a program for how such work or research should be prioritised and implemented, that includes (but is not limited to);
   a) baseline surface water and groundwater studies,
   b) baseline fugitive emissions data,
   c) geological and fault line mapping, and
   d) focus areas for baseline health impact assessment,

6. for every environmental risk and impact that is identified in Item 1, advise the level of environmental impact and risk that would be considered acceptable in the Northern Territory context;
7. for every environmental risk and impact that is identified in Item 1,
   a) describe methods, standards or strategies that can be used to reduce the impact or risk; and
   b) advise whether such methods, standards or strategies can effectively and efficiently reduce the impact or risk to the levels described in Item 3;
8. identify any scientific, technical, policy or regulatory requirements or resources that are in addition to the reforms being implemented through the existing environmental reform process that are necessary to reduce environmental risks and impacts associated with the hydraulic fracturing of unconventional reservoirs to acceptable levels; and
9. identify priority areas for no go zones.

SOURCE: HYDRAULIC FRACTURING TASKFORCE

Role of ACIL Allen

ACIL Allen Consulting has been appointed by the Inquiry to assess the actual and potential direct and indirect economic benefits, risks and impacts of fracking on the Northern Territory under the current regulatory regime.

To facilitate this, ACIL Allen's scope of works gives regard to three distinct scenarios:

6. Scenario 1, or the baseline scenario, where the moratorium on hydraulic fracturing of unconventional shale gas reservoirs remains in place (the 'base case')
7. Scenario 2, which involves the development of the onshore unconventional shale gas industry in the Northern Territory (the 'unconstrained case')
8. Scenario 3, which involves the development of unconventional shale gas reservoirs in the Beetaloo Sub-Basin only.

In order to do this, ACIL Allen will complete two main tasks:

— **Conduct economic impact assessment modelling, using ACIL Allen's suite of in-house economic models**, including models of the national gas and electricity markets. To complete this task, ACIL Allen will develop credible, evidenced-based scenarios for the development of shale gas projects in the Northern Territory under a set of assumptions which are agreed by the Inquiry. The outcome of this task will be quantitative economic impact assessment results under each of the three scenarios listed above.

— **Research, analyse, articulate and discuss the potential impacts on the Northern Territory economy's other industries**, including but not limited to tourism, agriculture, horticulture and pastoral. This will centre on findings of stakeholder consultation and a review of relevant international literature and case studies. The outcome of this task will be a chapter or chapters in the final report of this engagement that outlines the economic risks and provides suggestions on policy initiatives the Inquiry may recommend to the Northern Territory Government in the Inquiry report.

ACIL Allen is undertaking consultation with key stakeholders in order to inform these two main tasks.

Stakeholder consultation process

The Inquiry has identified your organisation as an interested stakeholder that may be able to assist ACIL Allen in delivering on our scope of works.

This consultation guide provides some basic background information on the Inquiry, and the issues that ACIL Allen is seeking input from participating stakeholders. In order to guide the meeting, ACIL Allen has developed a series of questions that the project team will be asking stakeholders at their scheduled meeting.

Following the initial contact, ACIL Allen may issue additional questions via email to request data or evidence to assist in completing the above tasks.

Please note: all stakeholder consultation will be recorded (via written notes) as evidence for the Inquiry. A member of ACIL Allen's project team will take notes during consultation, and these notes will be delivered to the Inquiry to assist in the formulation of project assumptions and other elements of the engagement as required. ACIL Allen has in place a confidentiality agreement as it relates to the Inquiry and any commercial-in-confidence material provided will be treated as such.

The Northern Territory economy

The Northern Territory economy is a regional economy, which generated $23 billion in Gross State Product (GSP) in 2015-16, accounting for 1.4 per cent of Australia's Gross Domestic Product (A$1.6 trillion). Northern Territory is an emerging economic centre, with average annual rates of growth in the economy exceeding five per cent per annum over the past five years (around double the rates of growth recorded in the national economy over the same period).

Economic growth in the Northern Territory is fairly volatile due to its small size and narrow economic base. As a result, major investments can have a disproportionately large impact on overall growth. The development of the Ichthys LNG Project is already having a substantial impact on the Northern Territory economy, which most recently recorded economic growth of 15.8 per cent in 2012-13 as investment activity accelerated. However, economic growth in the Northern Territory been more measured since, with the economy growing by 2.7 per cent in 2015-16.

The largest industries in the Northern Territory are construction (17.7 per cent of GSP), mining (12.9 per cent) and public administration and safety (10.3 per cent).

The working age population in the Northern Territory is 187,000, with 134,500 person employed as at June 2016. Employment growth in the Northern Territory has been strong for a number of years, with the jobs market only recently contracting in line with a downturn in the resources sector.

Jobs growth in the Northern Territory is heavily influenced by major resource projects, with employment growth at its strongest during the construction of key projects in the Territory, with the falling levels of employment coming as the construction phase is completed.

The estimated residential population in the Northern Territory (as at June 2015) was just under 245,000, with 58 per cent of the population concentrated around the greater Darwin area. Since 2010, the estimated residential population of the Northern Territory has increased by 6 per cent, with greater Darwin growing by 11 per cent and all areas outside of greater Darwin remaining relatively unchanged (less than a 1 per cent increase).

The Northern Territory's 2017-18 Budget, released on in May 2017, projects five consecutive net operating deficits for the Territory Government, with net debt rising from $2.4 billion to $5.5 billion between 2016-17 and 2020-21. The Northern Territory non-financial public sector raised $1.9 billion in revenue from its own sources in 2016-17, and recorded total operating expenditure of $6.5 billion. The Government relies on Commonwealth Government grants to fund a large proportion of its operations.

Fracking

For the purposes of this engagement, ACIL Allen has relied upon background materials produced by the Inquiry and published on its website (www.frackinginquiry.nt.gov.au/information). A brief introduction to fracking, adapted from this information, is included below.

What is fracking?

There are two broad types of gas reserves: conventional and unconventional. Conventional gas reserves accumulate in confined areas with well-connected pore spaces in a sedimentary basin. This allows for effective drainage of reserves with well-placed vertical wells. By contrast, unconventional gas reserves accumulate in a larger area amongst more tightly bound and less porous sedimentary basins, which are typically lower in the ground. A visual representation of conventional and unconventional gas accumulations and some of the extraction techniques is provided in Figure 3.1 (overleaf).

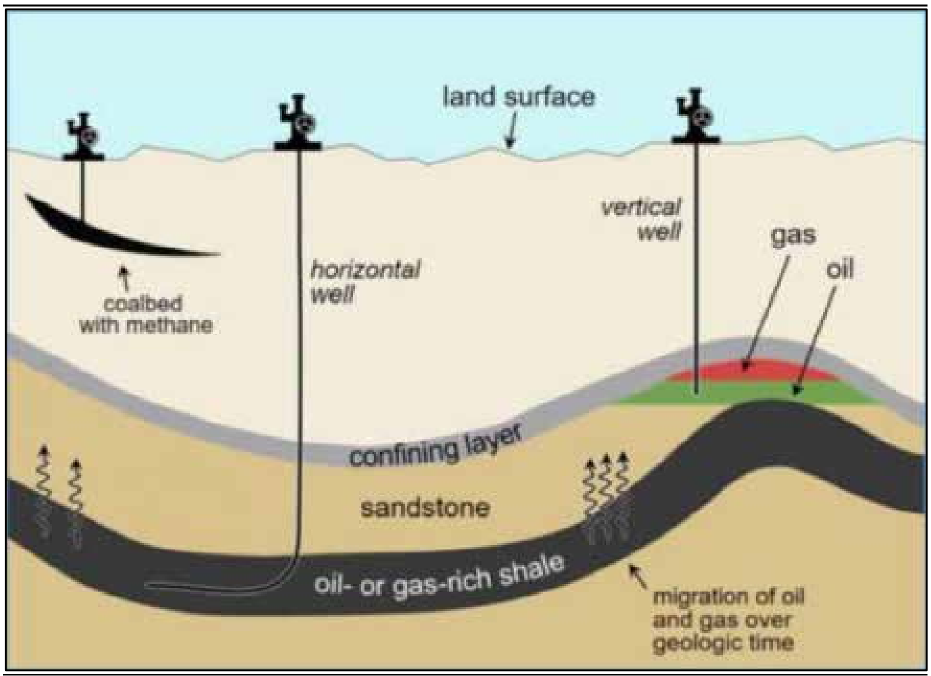
Artificial stimulation is typically required to make the gas in unconventional reservoirs flow through a well. One commonly used technique to achieve this is called hydraulic fracturing, commonly known as 'fracking'. Fracking basically involves pumping a mixture of water, sand and chemical additives ('fracking fluid') into the production well, under pressure, so that the rocks containing the gas resources crack. This allows the gas contained in the tight reservoir to flow more freely.

Shale gas versus coal seam gas (CSG)

Fracking is used to extract both coal seam gas (CSG) and shale gas. The two types of resources differ significantly.

— CSG is typically extracted from wells that are much closer to the land surface (300m – 1,000m) than shale wells (1,500m – 4,000m)
— CSG is typically much closer to the surface, and therefore closer to potable water sources such as aquifers. Shale gas is not typically located near aquifers
— CSG is most often extracted using vertical wells, while shale gas is extracted using a combination of vertical and horizontal drilling techniques
— CSG wells are typically low productivity and require a larger number of wells, where shale gas wells produce more energy per well. However, shale wells use more water per well, and operate across a larger underground footprint.
— The land surface area of CSG wells and shale gas wells is largely the same.

FIGURE 14.1 DIFFERENT TYPES OF PETROLEUM ACCUMULATIONS AND DEVELOPMENT



SOURCE: THE INQUIRY, VIA U.S. ENVIRONMENTAL PROTECTION AGENCY.

The fracking process

Shale gas is mainly methane (often with associated liquid hydrocarbons) that is trapped within clay-rich sedimentary rock at depths greater than 1,500 metres. The low permeability of the rock means that gas, either absorbed or in a free state, in the pores of the rock, is unable to flow easily.

To extract shale gas, wells are drilled anywhere from 1,500 – 4,000 metres deep through various layers of rock to access the shale. The wells are lined with various steel casings, which are cemented using fit-for-purpose cement designed to protect groundwater from contamination.

To maximise shale gas recovery a technique called horizontal drilling is used. This technique typically involves the well changing from a vertical to a horizontal direction deep underground.

Before gas can be extracted from the shale gas reservoir, hydraulic fracturing must occur. Hydraulic fracturing is a technique used to enhance the production of the gas. Hydraulic fracturing refers to the injection of fluid (comprising approximately 99.5% water and proppant (sand) and approximately 0.5% chemical additives) at high pressure into targeted sections of the layers of gas-bearing rocks. This creates localised networks of fractures that unlock gas and allow it to flow into the well and up to the surface. An average of 20 to 30 megalitres (ML) of water is used per fracked horizontal well over the life of the well.

After fracturing, the hydraulic pressure is released and most of the 'frack fluid' is pumped back out of the well. Typically gas production from the well builds up over a period of days or weeks as the frack fluid is recovered (a process known as 'well clean-up'). Much of the sand remains in the well, propping open the cracks so that gas flow is maintained (hence 'proppant').

Basically similar processes can be used to enhance gas production rates in vertical or horizontal wells in other tight reservoirs (both unconventional and conventional).

Is there any additional information relevant to an economic impact assessment that ACIL Allen Consulting should consider regarding the process of drilling, fracking, and related activities required to produce shale gas?

The investment and operating expenditure profile of a shale gas project differs significantly from a more conventional gas project, which the Northern Territory has had recent experience with in the form of the INPEX's Ichthys LNG project. A typical fracking project has a smaller upfront capital component than a conventional gas project, but may have larger ongoing capital costs associated with management and maintenance of a given level of production through development of additional wells.

To your knowledge, is this assumption regarding the capital and operating expenditure profile of a fracking operation versus a conventional gas project correct?

Do you have any information or evidence you can provide ACIL Allen regarding the capital and operating expenditure profile of a hypothetical or actual fracking operation in Australia?

Fracking in the Northern Territory

ACIL Allen is required to develop realistic, evidence-based scenarios for shale gas developments in the Northern Territory over a defined period of time. There are two development scenarios: the moratorium on activities is lifted in the Beetaloo Basin only, and the moratorium on activities in lifted across the entirety of the Northern Territory. In order to develop these scenarios, we require information on shale gas reserves and resources in the Northern Territory.

We understand from information provided to us by the Inquiry and from our initial research that the Beetaloo Basin hosts a highly prospective and large scale (one company has raised the spectre of 6.6 trillion cubic feet of resource in its license area alone) contingent gas resource. By way of contrast, the Pluto LNG project was approved on the basis of a 4.4 trillion cubic feet contingent resource. One of the scenarios ACIL Allen is required to model is the development of the Beetaloo Basin.

Do you have any information regarding the Beetaloo Basin and its prospectivity that you can share with us to assist us in developing our modelling assumptions?

ACIL Allen is also required to develop an estimate of the economic impact of the removal of a moratorium on activities across the whole land area of the Northern Territory. The information on the impact of this is largely unknown, as we understand there has been limited shale gas exploration activity outside of the Beetaloo Basin

Do you consider there is potential for the discovery and development of shale gas reserves outside of the Beetaloo Basin in the Northern Territory? Why or why not?

Is there any information about the prospectivity of shale gas outside of the Beetaloo Basin that you are able to share with ACIL Allen Consulting?

If the moratorium was lifted across the Northern Territory, are there any areas that should remain "off limits"? If so, which areas and why? If not, why not?

There are significant land holdings in the Northern Territory which are subject to long term pastoral leases, are held under native title, or both.

How would you expect a lift of the moratorium to interact with land ownership in the Northern Territory? Is it reasonable to assume as a starting point that persons or groups which hold land under pastoral lease or native title will not allow development on their land holdings, a view ACIL Allen has formed in a preliminary review of submissions made to the Inquiry?

Any potential shale gas produced from wells in the Northern Territory will require additional processing and transport to reach its end destination – be that consumption in the Northern Territory, consumption in other States, or export. This requires infrastructure over and above the development of fracking wells by project proponents.

What current infrastructure does the Northern Territory have in place to support the processing and transport of shale gas produced?

What infrastructure do you believe would be required to support the processing and transport of shale gas produced in the Northern Territory?

ACIL Allen's understanding is that shale gas operations require specialist skills from a labour perspective. It is considered unlikely that those skills exist in the Northern Territory today.

Does the Northern Territory labour market have enough capacity to absorb a potential increase in labour demand from the development of a shale gas industry? Why or why not?

There are many options for the ultimate use of shale gas produced in the Northern Territory. ACIL Allen's scope of works requires it to consider benefits, impacts and risks to the Northern Territory economy, however this will also involve consideration and analysis of the potential end use of production outside of the Northern Territory.

What are the options for consumption of shale gas produced in the Northern Territory? Where do you think shale gas produced in the Northern Territory would ultimately be consumed? Why?

Potential economic benefits of fracking to the Northern Territory economy

There are a range of potential economic benefits of shale gas production to the Northern Territory. ACIL Allen's economic model assumes there are flow on benefits to industries that supply an industry which growth disproportionately to others, via the supply of services or a reduction the cost base for those industries.

ACIL Allen wishes to hear from you what you consider to be the five most significant channels of **economic benefits** to the Northern Territory, and why.

In your view, what are the key benefits that you believe could arise in the Northern Territory economy resulting from shale gas production in the case of a lift in the moratorium on activities in the Beetaloo basin only?

In your view, what are the key benefits that you believe could arise in the Northern Territory economy resulting from shale gas production in the case of a lift in the moratorium on activities across the Northern Territory?

Potential economic risks of fracking to the Northern Territory economy

There are a range of potential economic risks/costs of shale gas production to the Northern Territory. ACIL Allen's economic model assumes a degree of "crowding out" occurs when a one industry grows disproportionately to others.

ACIL Allen wishes to hear from you what you consider to be the five most significant channels of **economic risks** (costs) to the Northern Territory, and why.

In your view, what are the risks (costs) that you believe could arise in the Northern Territory economy resulting from shale gas production in the case of a lift in the moratorium on activities in the Beetaloo Basin only?

In your view, what are the risks (costs) that you believe could arise in the Northern Territory economy resulting from shale gas production in the case of a lift in the moratorium on activities across the Northern Territory?

Potential economic policy implications of fracking in the Northern Territory

Development of fracking in the Northern Territory is likely to entail some policy challenges for the Northern Territory government. The Inquiry has requested ACIL Allen examine these, using international case studies, best practice, stakeholder views, and our firm's internal expertise in policy development, to provide some initial guidance on the policy issues and challenges that are likely to arise in the case that the moratorium on activities is lifted.

ACIL Allen is required to consider this within the context of the current regulatory regime – that is, we must discuss policy challenges within the constraints of current policies and regulations, and make suggestions to address these.

The Inquiry is cognisant of the potential for "boom-bust" cycles given the Northern Territory's recent experience with the Ichthys LNG Project, and extensive literature associated with resources industry development.

These policy issues and challenges are wide-ranging, and include:

— Human capital (labour supply, education and training, apprenticeships)
— Infrastructure (specific to fracking like pipelines, but also supporting infrastructure like roads)
— Government finances (royalties, expenditure demands)
— Local content ("Buy Local" policy)
— Land access regimes and environmental approvals

Do you have any insights on the potential policy issues which may arise in the Northern Territory in the case that the moratorium on activities is lifted?

Which policy issue(s) do you believe have the potential to create the most risk to the Northern Territory economy? Why?

Other issues

Are there any other issues you wish to raise with us related to our scope of works?

Are there any other costs, benefits or risks associated with each scenario that you would you like to raise?

About ACIL Allen

ACIL Allen Consulting is the largest independent economics and public policy consulting firm in Australia, with a specialisation in economics, policy and strategy advice. With over 60 consultants across five offices, we have an established reputation for providing sound and independent advice on economic, public policy and organisational issues for all levels of government and business. We have experience in conducting projects that involve policy, program and funding evaluations, analysis of data, development of policy options, extensive stakeholder consultations, and the preparation of clear and concise reports.

Further Enquiries

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C GASMARK MODELLING RESULTS

In this Appendix we set out the results of the modelling of the market effects of different Northern Territory shale gas development scenarios using ACIL Allen's GasMark® model of the eastern Australian and Northern Territory gas market. First, we summarise the gas production capacity and ex-field pricing assumptions under the three Northern Territory shale gas development scenarios (BREEZE: 100 TJ/d target market; WIND: 400 TJ/d target market; GALE: 1,000 TJ/d target market), and explain how the 'optimal' ex-field pricing assumptions were determined. We then present key modelling results for each of the three shale gas development scenarios in turn. For each scenario we present the modelling results for:

— modelled production performance of the Northern Territory, including total market penetration over time relative to the assumed level of shale gas production capacity and levels of gas exports from NT to eastern Australia
— levels of gas consumption in the eastern Australian and NT domestic markets, and incremental effects on domestic consumption compared to the Reference Case (no Northern Territory shale gas)
— levels of LNG production in the Northern Territory and Queensland, and incremental LNG production compared to the Reference Case
— wholesale delivered gas prices in Queensland, New South Wales, Victoria and South Australia, and the incremental effects on gas prices compared to the Reference Case.

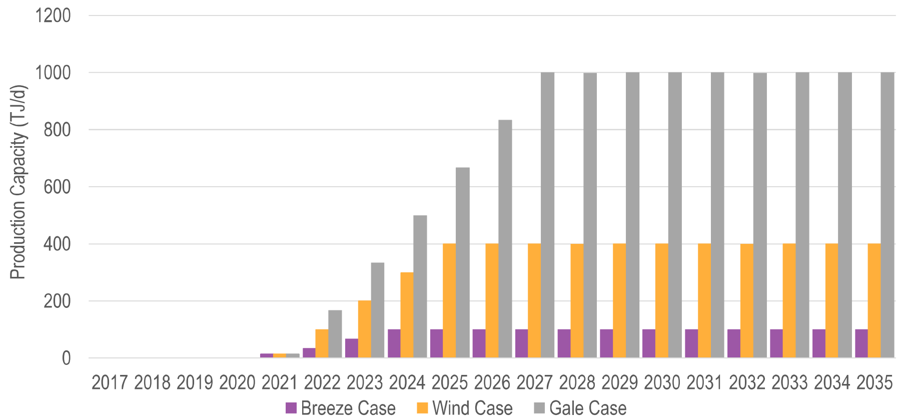
C.1 Northern Territory shale gas production and pricing assumptions

The three Northern Territory shale gas development scenarios each adopt different assumptions about the levels of shale gas production capacity that are offered into the market. The production capacity ramp-up profiles for the three cases are summarised in Figure C.1.

However, the fact that production capacity is made available or 'offered to the market' does not guarantee that all of that capacity will be taken up. If the price at which the shale gas can be offered to the market is too high, then some or all of the production capacity will remain idle. Gas users will either obtain supply from another, more competitively-prices supply source, or if this is not possible, will forego consumption because they cannot afford to buy gas at the price offered. All else being equal, it would be reasonable to expect that as the shale gas prices required to justify commercial production from the Northern Territory increase, the quantity of gas actually taken up in the market will decrease.

For the purposes of this analysis, 'optimal' ex-field pricing assumptions for each scenario were determined by using the *GasMark* model to test the volumes of gas sold across a range of ex-field pricing assumptions. Generally speaking, the volumes of gas sold fall as prices rise. Multiplying the volumes of gas sold by the price at which the gas is offered into the market allows calculation of annual gas sales revenue. The 'optimal' price path for each scenario is then the price path that

FIGURE C.1 AVAILABLE SHALE GAS PRODUCTION CAPACITY FOR THE THREE NORTHERN TERRITORY SHALE GAS DEVELOPMENT SCENARIOS



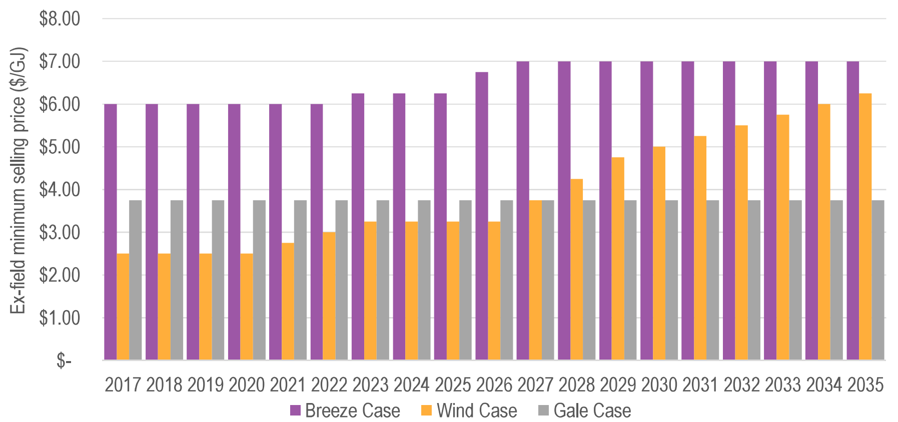
SOURCE: ACIL ALLEN GASMARK MODELLING

maximises the net present value (NPV) of modelled revenues over time. We have used a discount rate of 15 per cent (pre-tax) to calculate the NPV of revenues.

The 'optimal' prices effectively represent the maximum (capital inclusive) average cost of shale gas production that will need to be achieved if the Northern Territory producers are to earn a commercial rate of return on the targeted volumes of gas sales. If the producers are able to produce gas at a cost lower than the 'optimal' prices, they will be able to achieve rates of return above the minimum commercial threshold.

In these circumstances, producers would have no incentive to offer gas for sale at lower prices reflecting their long-run marginal costs of production because the modelling shows that they would not achieve a large enough increase in sales volumes to offset the reduction in revenue per unit of gas sold. The 'optimised ex-plant gas price assumptions for the three scenarios are shown in Figure C.2.

FIGURE C.2 'OPTIMAL' EX-PLANT PRICE ASSUMPTIONS FOR THE THREE NORTHERN TERRITORY SHALE GAS DEVELOPMENT SCENARIOS



SOURCE: ACIL ALLEN GASMARK MODELLING

C.2 Modelling results: BREEZE Case

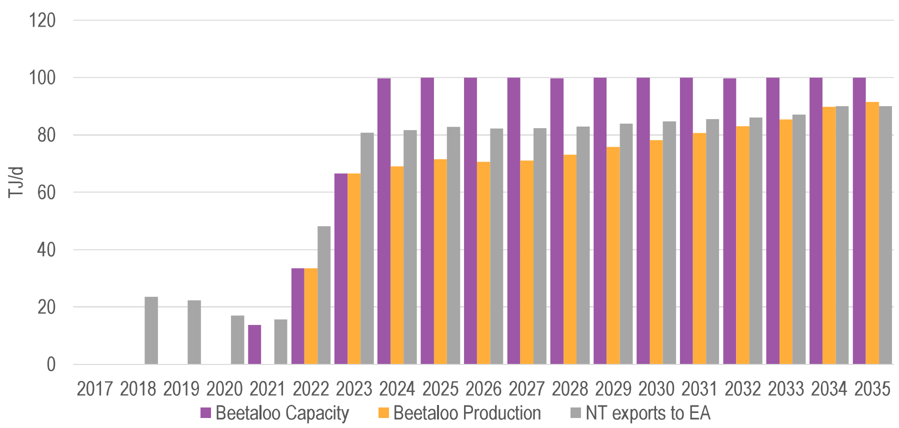
C.2.1 Northern Territory Shale Gas production performance: BREEZE Case

Figure C.3 shows the Northern Territory Shale Gas production performance under the BREEZE Case (100 TJ/d nominal production capacity). Capacity is assumed to ramp up from 2021, reaching the full 100 TJ/d nominal capacity by 2024. Actual levels of shale gas production taken up in the market increase from around 35 TJ/d in 2022 to a maximum of 92 TJ/d by the end of the modelling period.

Under the optimal pricing assumptions, the full 100 TJ/d of production capacity is not utilised during the modelling period to 2035. Higher rates of production could be achieved by discounting ex-field selling prices, but this would result in a reduction in the overall NPV of sales revenues.

Initially the total gas exports to eastern Australia (via the Jemena Northern Gas Pipeline, 'NGP') are significantly higher than the amount of Northern Territory shale gas being produced. This reflects the contribution to EA exports from Blacktip gas under the existing arrangements with PowerWater. However, the proportion of Northern Territory shale gas in exports increases over time, and by 2034 the volume of Northern Territory shale gas production reaches 90 TJ/d, equal to the assumed capacity of the NGP. Once the NGP capacity is reached, incremental production of Northern Territory shale gas is supplied into the NT market.

FIGURE C.3 NORTHERN TERRITORY SHALE GAS PRODUCTION PERFORMANCE: BREEZE CASE (100 TJ/D NOMINAL PRODUCTION CAPACITY)

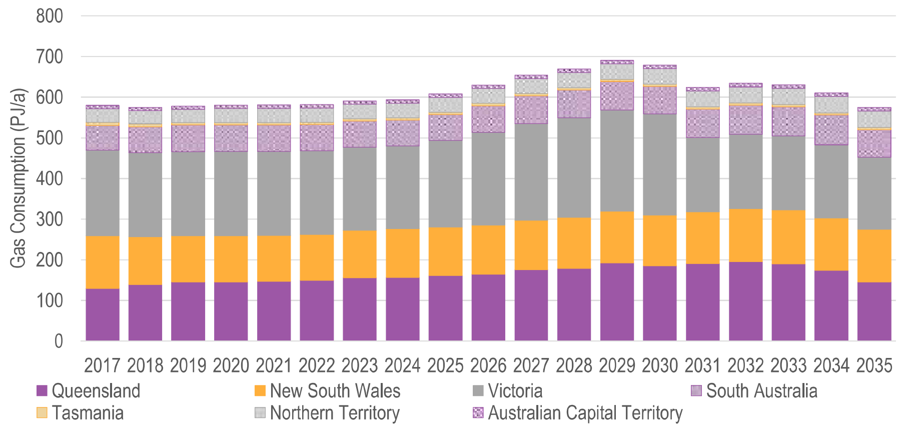


SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.2.2 Consumption volume effects: BREEZE Case

Figure C.4 shows the modelled levels of domestic gas consumption, by State/Territory, under the BREEZE Case assumptions. Domestic consumption recovers from current levels to reach almost 700 PJ/a by 2029, but then falls to less than 600 PJ/a by the end of the modelling period as a result of constrained gas supply, with new sources of supply unable to fully replace current production as reserves are depleted.

FIGURE C.4 BREEZE CASE: GAS CONSUMPTION



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

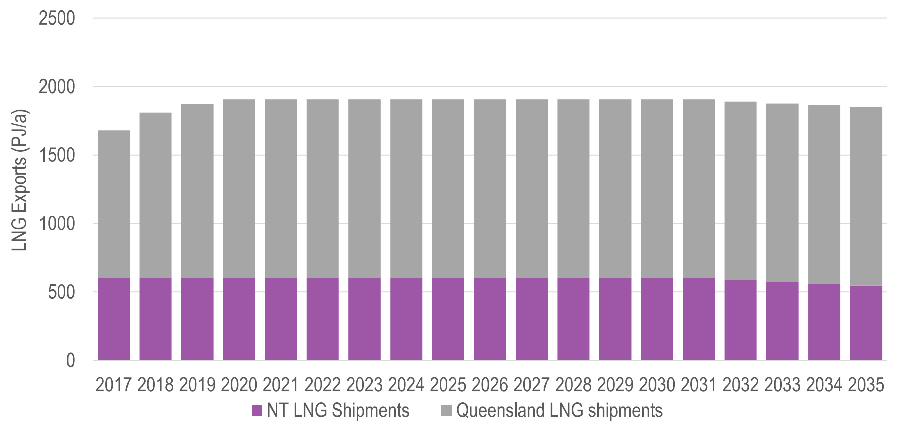
Figure C.5 shows the incremental levels of gas consumption in eastern Australia and the Northern Territory under the BREEZE Case assumptions, when compared to the Reference Case (without Northern Territory shale gas production). As shown, there is little incremental effect on consumption until 2029. Prior to that time, the NT gas exports to eastern Australia (Figure C.3 refers) are effectively substituting for high-cost local supply sources. However, from 2029 on total consumption levels increase relative to the Reference Case as the increased levels of overall gas supply reduce the amount of 'demand destruction' as the supply position from non-shale sources in both the Northern Territory and eastern Australia tightens. In most years, the largest consumption effects are felt in the Northern Territory and Queensland, but there is one year (2029) in which Victorian consumption is also given significant (indirect) support as a result of the introduction of NT shale gas into the eastern Australian market.

FIGURE C.5 BREEZE CASE: GAS CONSUMPTION DIFFERENTIAL FROM REFERENCE CASE

SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.6 shows the total levels of LNG exports from eastern Australia (NT shipments: Darwin LNG and INPEX Ichthys LNG; Queensland shipments: Gladstone LNG, Australia Pacific LNG, Queensland Curtis LNG) under the BREEZE Case assumptions. Compared to the Reference Case (no Northern Territory shale gas production) there is no change in LNG shipments from NT or Queensland under the BREEZE Case.

FIGURE C.6 LNG SHIPMENTS: BREEZE CASE (100 TJ/D NOMINAL PRODUCTION CAPACITY)



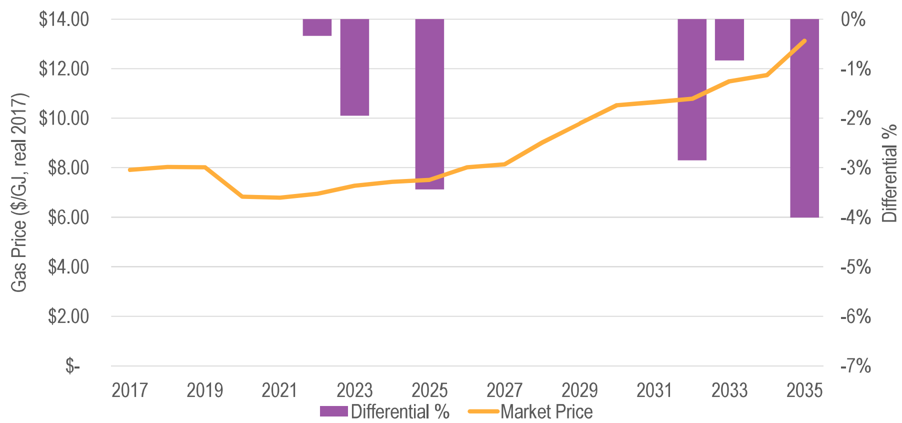
SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.2.3 Eastern Australia price effects: BREEZE Case

The increase in gas supply to eastern Australian as a result of imports of Northern Territory shale gas under the BREEZE Case assumptions results in modest, intermittent downward pressure on wholesale delivered gas prices.

Figure C.7 shows the market price at Brisbane, and the per cent price differentials from the Reference Case, under the BREEZE Case assumptions. The price effects tend to occur toward the end of the modelling period although in Queensland there are also some significant effects (up to 4 per cent reduction in price) over the period 2022 to 2025.

FIGURE C.7 BREEZE CASE: DELIVERED WHOLESALE GAS PRICES AT BRISBANE

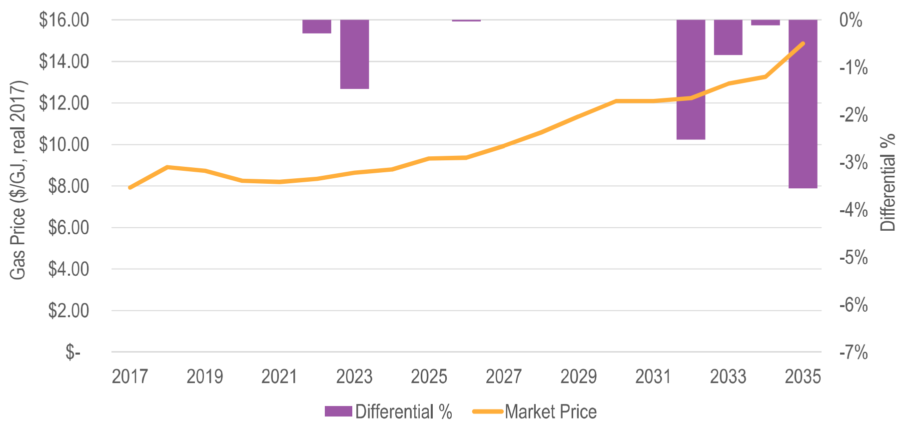


SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.8 shows the corresponding price effects in New South Wales (Sydney). Total price levels are higher in Sydney than in Brisbane (because of the added transport costs). When compared to the

Reference Case results, the early differential price impacts (2022 to 2025) are less apparent than in Queensland, but the patterns of price movement toward the end of the modelling period (2032 on) are generally similar. Levels of downward movement in gas price are somewhat lower (in percentage terms) in Sydney than in Brisbane, reflecting the increased distance from the incremental source of supply.

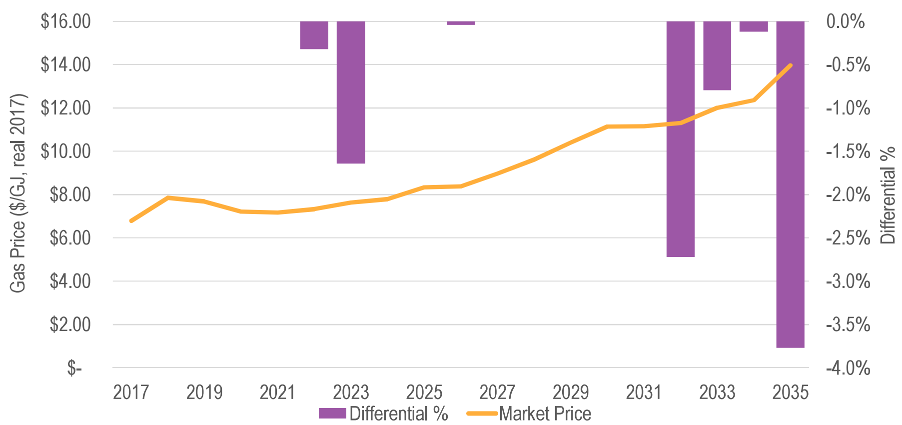
FIGURE C.8 BREEZE CASE: DELIVERED WHOLESALE GAS PRICE AT SYDNEY



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.9 shows the corresponding results for wholesale gas prices at Melbourne. Total price levels are lower than for Sydney, because of Melbourne's proximity to the major production sources in Bass Strait. In terms of differential price effects compared to the Reference Case, the results for Melbourne are very similar to Sydney.

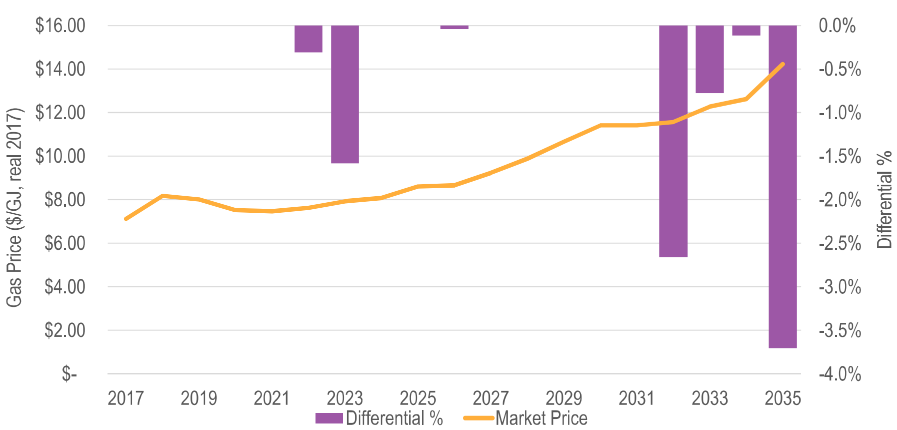
FIGURE C.9 BREEZE CASE: DELIVERED WHOLESALE GAS PRICE AT MELBOURNE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.10 shows the corresponding results for wholesale gas prices at Adelaide. Total price levels are slightly higher than for Melbourne, but show a similar pattern of movement. In terms of differential price effects compared to the Reference Case, the results for Adelaide are very similar to both Melbourne and Sydney.

FIGURE C.10 BREEZE CASE: DELIVERED WHOLESALE GAS PRICE AT ADELAIDE



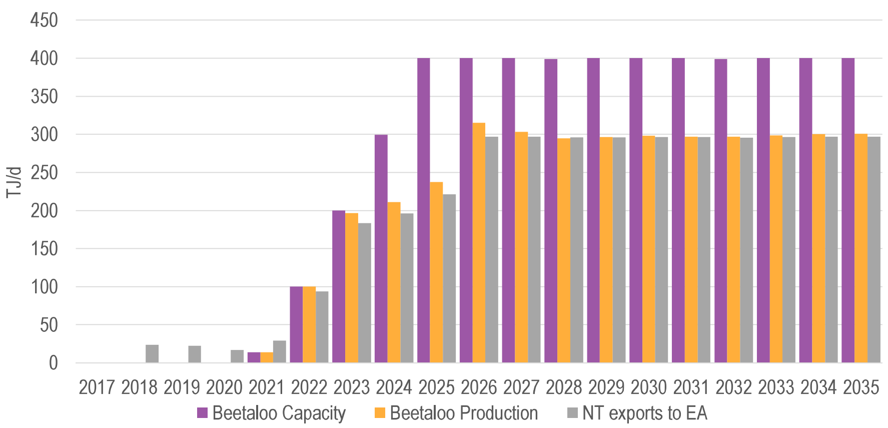
SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.3 Modelling results: WIND Case

C.3.1 Northern Territory Shale Gas production performance: WIND Case

Figure C.11 shows the Northern Territory Shale Gas production performance under the WIND Case (400 TJ/d nominal production capacity). Capacity is assumed to ramp up from 2021, reaching the full 400 TJ/d nominal capacity by 2025. Actual levels of shale gas production taken up in the market increase from 100 TJ/d in 2022 to a maximum of 315 TJ/d by 2026, then fall slightly to plateau at around 300 TJ/d through to the end of the modelling period. Under the optimal pricing assumptions, the full 400 TJ/d of production capacity is not utilised during the modelling period to 2035. Higher rates of production could be achieved by discounting ex-field selling prices, but again this would result in a reduction in the overall NPV of sales revenues. Initially the total gas exports to eastern Australia (via the Jemena Northern Gas Pipeline, 'NGP') are significantly below the amount of Northern Territory shale gas being produced, which indicates that some of the Northern Territory gas production is taken up in the Northern Territory. By 2028, the quantities of Northern Territory shale gas closely match the total volume of exports to eastern Australia.

FIGURE C.11 NORTHERN TERRITORY SHALE GAS PRODUCTION PERFORMANCE: WIND CASE (100 TJ/D NOMINAL PRODUCTION CAPACITY)

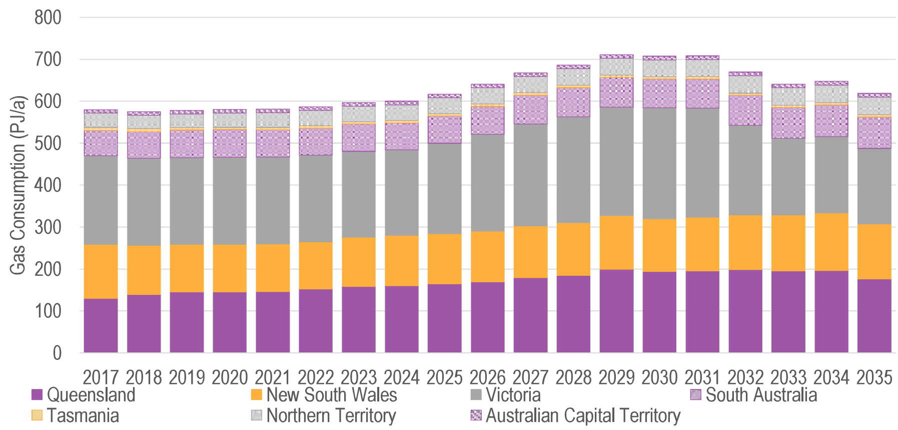


SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.3.2 Consumption volume effects: WIND Case

Figure C.12 shows the modelled levels of domestic gas consumption, by State/Territory, under the WIND Case assumptions. Domestic consumption recovers from current levels to peak at a little over 700 PJ/a by 2029, but then falls to around 615 PJ/a by the end of the modelling period as a result of constrained gas supply, with new sources of supply unable to fully replace current production as reserves are depleted.

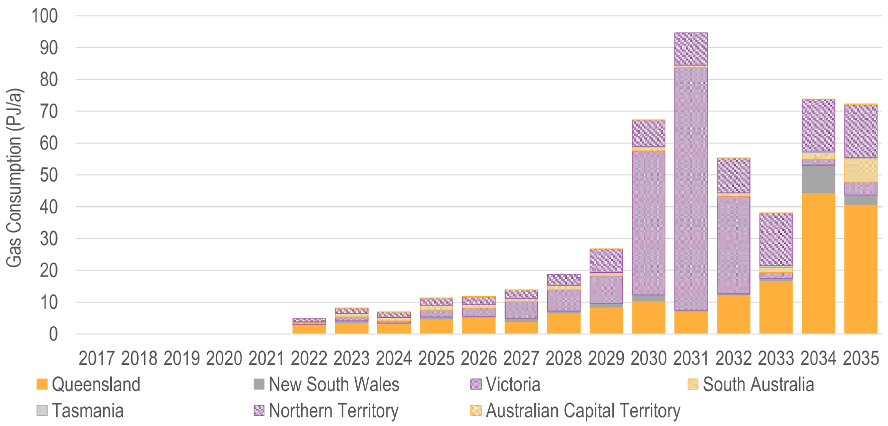
FIGURE C.12 WIND CASE: GAS CONSUMPTION



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.13 shows the incremental levels of gas consumption in eastern Australia and the Northern Territory under the WIND Case assumptions, compared to the Reference Case. The levels of incremental consumption rise slowly over the period 2022 to 2029. During this period, the NT gas exports to eastern Australia (Figure C.11 refers) are largely substituting for high-cost local supply sources. However, from 2030 on total consumption levels increase sharply relative to the Reference Case as the increased levels of overall gas supply reduce the amount of 'demand destruction' as the supply position from non-shale sources in both the Northern Territory and eastern Australia tightens. The largest consumption effects are felt in the Queensland, Victoria and the Northern Territory. Victorian consumption is impacted not as a result of physical supply from the Northern Territory but because NT supply reduces the levels of gas exported from Victoria to interstate markets – particularly New South Wales.

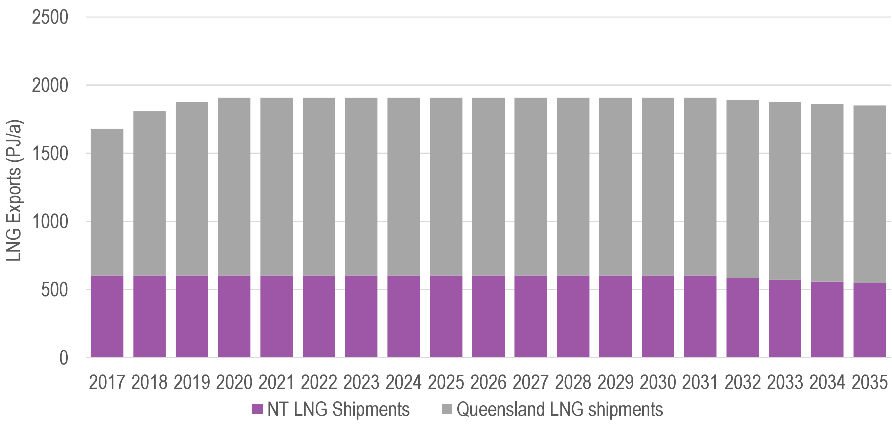
FIGURE C.13 WIND CASE: GAS CONSUMPTION DIFFERENTIAL FROM REFERENCE CASE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.14 shows the total levels of LNG exports from eastern Australia (NT shipments: Darwin LNG and INPEX Ichthys LNG; Queensland shipments: Gladstone LNG, Australia Pacific LNG, Queensland Curtis LNG) under the WIND Case assumptions. Compared to the Reference Case (no Northern Territory shale gas production) there is no change in LNG shipments from NT or Queensland under the WIND Case.

FIGURE C.14 LNG SHIPMENTS: WIND CASE (400 TJ/D NOMINAL PRODUCTION CAPACITY)



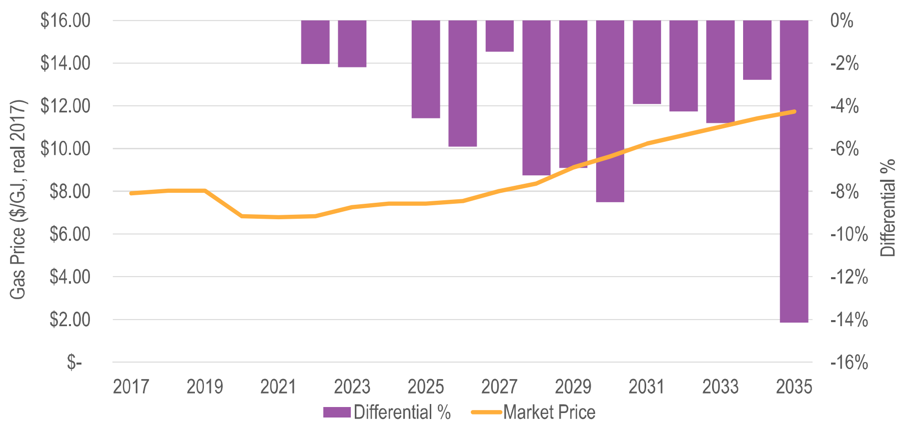
SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.3.3 Eastern Australia price effects: WIND Case

The increase in gas supply to eastern Australian as a result of imports of Northern Territory shale gas under the WIND Case assumptions results in significant and sustained downward pressure on wholesale delivered gas prices. The level of price reductions tends to increase over time as more NT gas is taken up in the eastern Australian domestic market.

Figure C.15 shows the market price at Brisbane, and the per cent price differentials from the Reference Case, under the WIND Case assumptions. The price effects tend to increase across the modelling period, averaging 5 per cent over the period 2022 to 2035, and reaching 14 per cent by the end of the modelling period. The price effects come about principally as a result of the additional supply volumes which reduce the number of periods through the year when supply becomes very tight and prices are bid up to high levels.

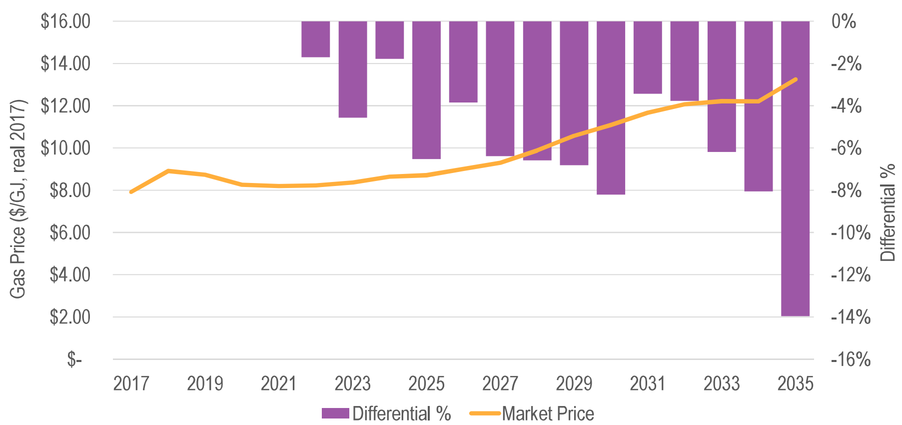
FIGURE C.15 WIND CASE: DELIVERED WHOLESALE GAS PRICES AT BRISBANE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.16 shows the corresponding price effects in New South Wales (Sydney). Total price levels are higher in Sydney than in Brisbane (because of the added transport costs). When compared to the Reference Case results, the patterns of price movement are generally similar to those observed in Queensland. The price effects tend to increase across the modelling period, averaging 6 per cent over the period 2022 to 2035, and reaching 14 per cent by the end of the modelling period.

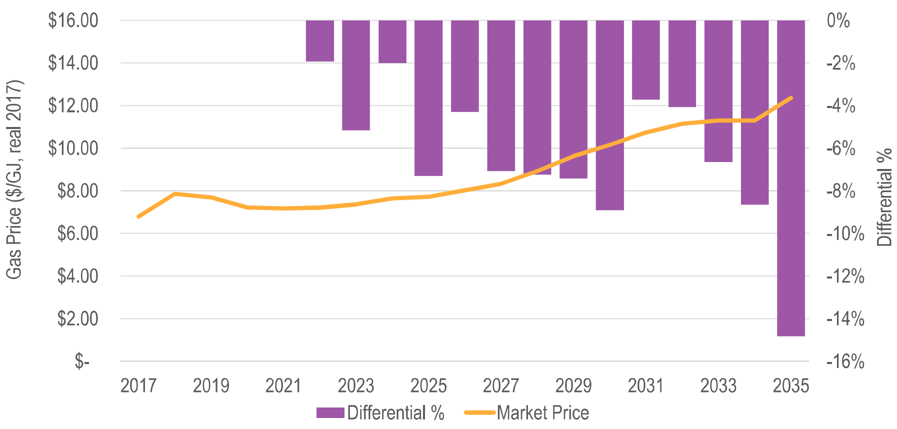
FIGURE C.16 WIND CASE: DELIVERED WHOLESALE GAS PRICE AT SYDNEY



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.17 shows the corresponding results for wholesale gas prices at Melbourne. Total price levels are lower than for Sydney, because of Melbourne's proximity to the major production sources in Bass Strait. In terms of differential price effects compared to the Reference Case, the results for Melbourne are very similar to Sydney.

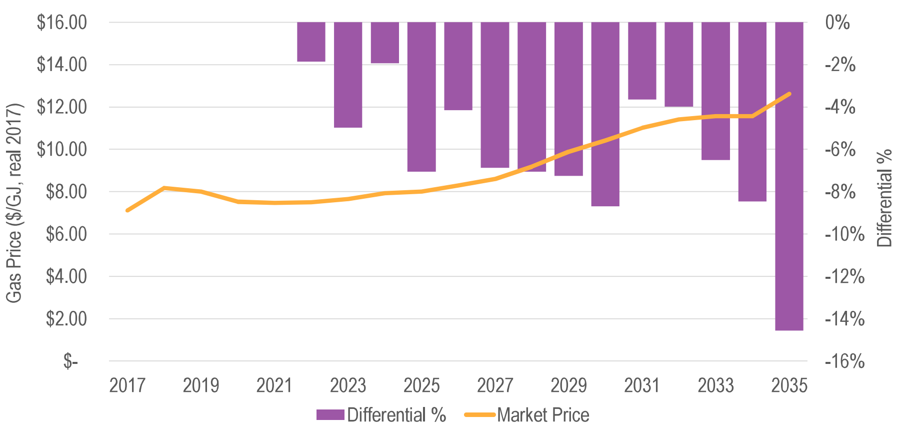
FIGURE C.17 WIND CASE: DELIVERED WHOLESALE GAS PRICE AT MELBOURNE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.18 shows the corresponding results for wholesale gas prices at Adelaide. Total price levels are slightly higher than for Melbourne, but show a similar pattern of movement. In terms of differential price effects compared to the Reference Case, the results for Adelaide are very similar to both Melbourne and Sydney.

FIGURE C.18 WIND CASE: DELIVERED WHOLESALE GAS PRICE AT ADELAIDE



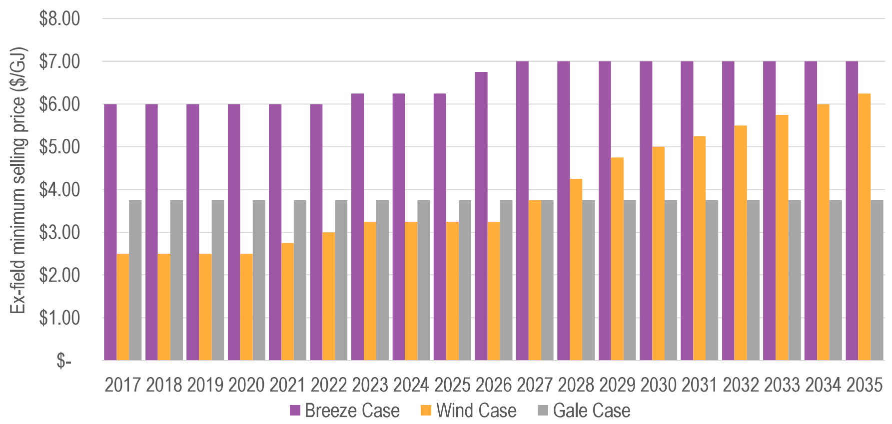
SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.4 Modelling results: GALE Case

C.4.1 Northern Territory Shale Gas production performance: GALE Case

Figure C.19 shows the Northern Territory Shale Gas production performance under the GALE Case (1,000 TJ/d nominal production capacity). Capacity is assumed to ramp up from 2021, reaching the full 1,000 TJ/d nominal capacity by 2027. Pipeline capacity augmentation allows delivery of gas to Darwin LNG as well as expanded supply to eastern Australia. Actual levels of shale gas production taken up in the market increase from 400 TJ/d in 2025 to 800 TJ/d by 2027, then continues to climb steadily. Under the optimal pricing assumptions, the full 1,000 TJ/d of production capacity is not utilised until 2034. Higher rates of production could be achieved earlier by discounting ex-field selling prices, but as for the previous cases this would result in a reduction in the overall NPV of sales revenues. From 2025 on, total gas exports to eastern Australia (via the Jemena Northern Gas Pipeline, 'NGP') are significantly below the amount of Northern Territory shale gas being produced, which indicates that a substantial amount of the Northern Territory gas production is taken up in the Northern Territory. By the end of the modelling period, the quantities of Northern Territory shale gas being produced exceed the total volume of exports to eastern Australia by some 315 TJ/d.

FIGURE C.19 NORTHERN TERRITORY SHALE GAS PRODUCTION PERFORMANCE: GALE CASE (1000 TJ/D NOMINAL PRODUCTION CAPACITY)

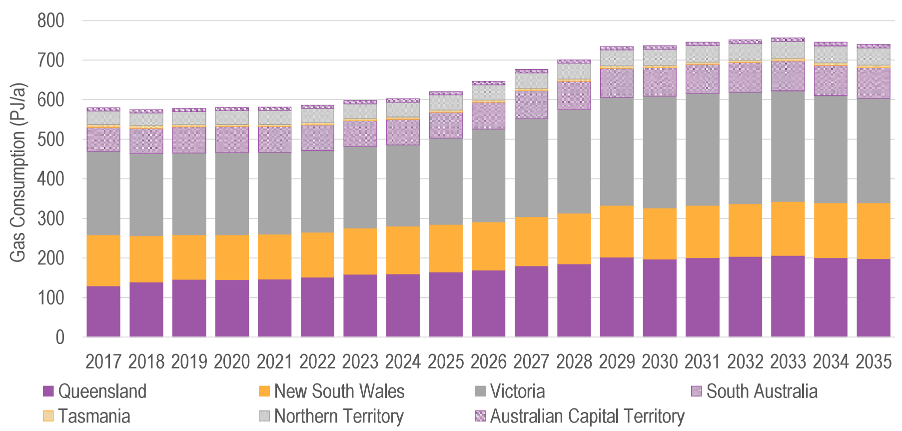


SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.4.2 Consumption volume effects: GALE Case

Figure C.20 shows the modelled levels of domestic gas consumption, by State/Territory, under the GALE Case assumptions. Domestic consumption recovers from current levels to peak at a little over 750 PJ/a in 2033, but then falls to 740 PJ/a by the end of the modelling period as gas supply constraints start to be felt, with new sources of supply unable to fully replace current production as reserves are depleted.

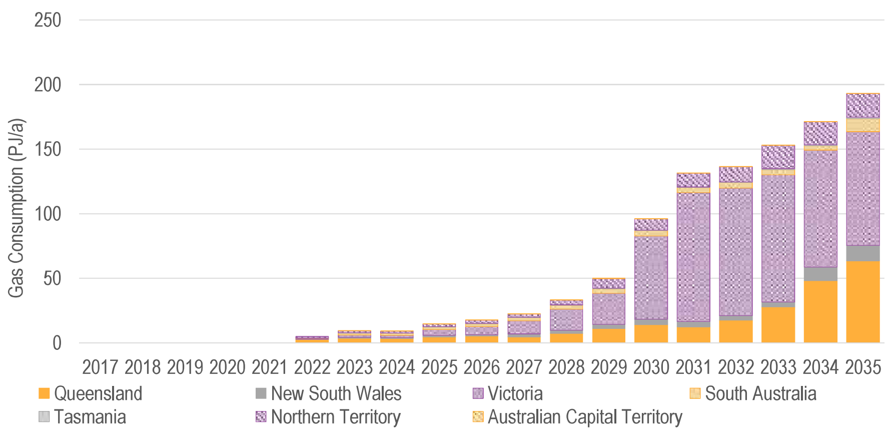
FIGURE C.20 GALE CASE: GAS CONSUMPTION



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.21 shows the incremental levels of gas consumption in eastern Australia and the Northern Territory under the GALE Case assumptions, compared to the Reference Case. The levels of incremental consumption rise slowly over the period 2022 to 2029, reaching a total incremental consumption level of about 50 PJ/a. However, from 2030 on total consumption levels increase sharply relative to the Reference Case as the increased levels of overall gas supply reduce the amount of 'demand destruction' as the supply position from non-shale sources in both the Northern Territory and eastern Australia tightens. By the end of the modelling period in 2035, the total incremental supply stands at almost 200 PJ/a. The largest consumption effects are felt in the Victorian, Queensland, and Northern Territory markets. Victorian consumption is impacted not as a result of physical supply from the Northern Territory but because NT supply reduces the levels of gas exported from Victoria to interstate markets – particularly New South Wales.

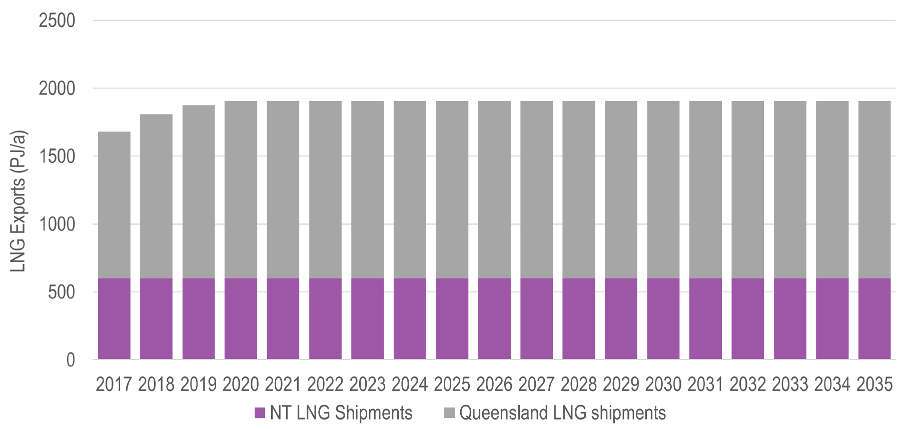
FIGURE C.21 GALE CASE: GAS CONSUMPTION DIFFERENTIAL FROM REFERENCE CASE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.22 shows the total levels of LNG exports from eastern Australia (NT shipments: Darwin LNG and INPEX Ichthys LNG; Queensland shipments: Gladstone LNG, Australia Pacific LNG, Queensland Curtis LNG) under the GALE Case assumptions. Compared to the Reference Case (no Northern Territory shale gas production) there is no change in LNG shipments from NT or Queensland under the WIND Case.

FIGURE C.22 LNG SHIPMENTS: GALE CASE (100 TJ/D NOMINAL PRODUCTION CAPACITY)



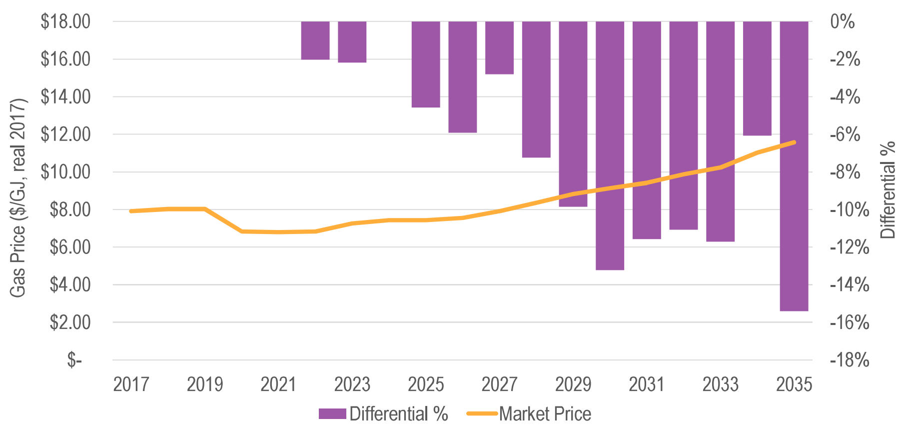
SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

C.4.3 Eastern Australia price effects: GALE Case

The increase in gas supply to eastern Australian as a result of imports of Northern Territory shale gas under the GALE Case assumptions results in significant and sustained downward pressure on wholesale delivered gas prices. The level of price reductions tends to increase over time as more NT gas is taken up in the eastern Australian domestic market.

Figure C.23 shows the market price at Brisbane, and the per cent price differentials from the Reference Case, under the GALE Case assumptions. The price effects tend to increase across the modelling period, averaging 7 per cent over the period 2022 to 2035, and reaching 15 per cent by the end of the modelling period. The price effects come about principally as a result of the additional supply volumes which reduce the number of periods through the year when supply becomes very tight and prices are bid up to high levels.

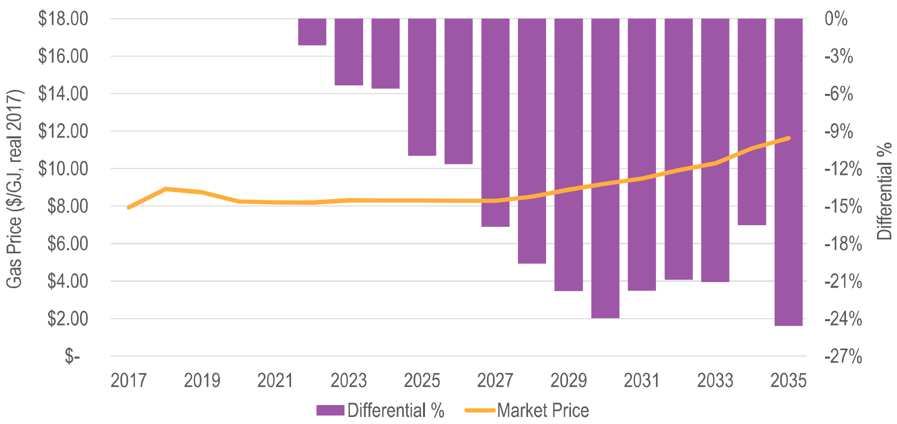
FIGURE C.23 GALE CASE: DELIVERED WHOLESALE GAS PRICES AT BRISBANE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.24 shows the corresponding price effects in New South Wales (Sydney). Total price levels are higher in Sydney than in Brisbane (because of the added transport costs). When compared to the Reference Case results, the patterns of price movement are generally similar to those observed in Queensland, but are considerably stronger. The price effects tend to increase across the modelling period, averaging 16 per cent over the period 2022 to 2035, and reaching 25 per cent by the end of the modelling period.

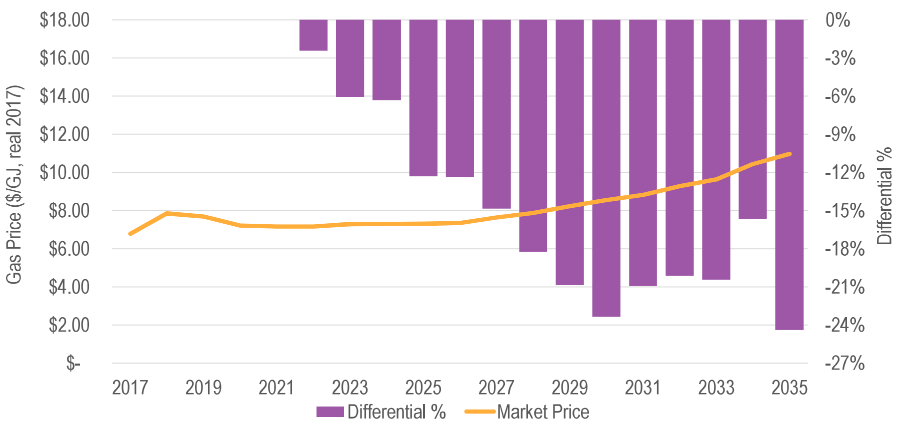
FIGURE C.24 GALE CASE: DELIVERED WHOLESALE GAS PRICE AT SYDNEY



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.25 shows the corresponding results for wholesale gas prices at Melbourne. Total price levels are lower than for Sydney, because of Melbourne's proximity to the major production sources in Bass Strait. In terms of differential price effects compared to the Reference Case, the results for Melbourne are very similar to Sydney.

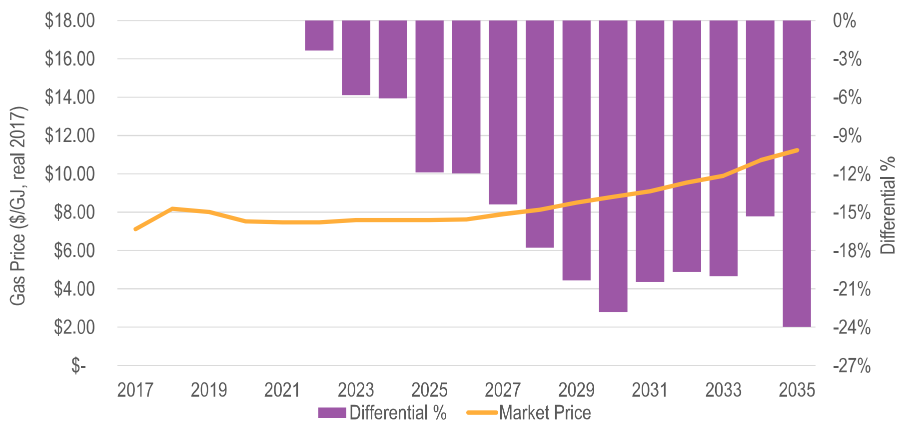
FIGURE C.25 GALE CASE: DELIVERED WHOLESALE GAS PRICE AT MELBOURNE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

Figure C.26 shows the corresponding results for wholesale gas prices at Adelaide. Total price levels are slightly higher than for Melbourne, but show a similar pattern of movement. In terms of differential price effects compared to the Reference Case, the results for Adelaide are very similar to both Melbourne and Sydney.

FIGURE C.26 GALE CASE: DELIVERED WHOLESALE GAS PRICE AT ADELAIDE



SOURCE: ACIL ALLEN CONSULTING, GASMARK MODELLING

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APPENDICES PART TWO: ABOUT ACIL ALLEN'S MODELS

E

TASMAN GLOBAL

ACIL Allen's CGE model *Tasman Global* is a powerful tool for undertaking economic impact analysis at the regional, state, national and global level.

There are various types of economic models and modelling techniques. Many of these are based on partial equilibrium analysis that usually considers a single market. However, in economic analysis, linkages between markets and how these linkages develop and change over time can be critical. *Tasman Global* has been developed to meet this need.

Tasman Global is a large-scale CGE model which is designed to account for all sectors within an economy and all economies across the world. ACIL Allen uses this modelling platform to undertake industry, project, scenario and policy analyses. The model is able to analyse issues at the industry, global, national, state and regional levels and to determine the impacts of various economic changes on production, consumption and trade at the macroeconomic and industry levels.

A Dynamic Model

Tasman Global is a model that estimates relationships between variables at different points in time. This is in contrast to comparative static models, which compare two equilibriums (one before a policy change and one following). A dynamic model such as *Tasman Global* is beneficial when analysing issues where both the timing of and the adjustment path that economies follow are relevant in the analysis.

The Database

A key advantage of *Tasman Global* is the level of detail in the database underpinning the model. The database we will use for this project is derived from the Global Trade Analysis Project (GTAP) database (version 8.1). This database is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among regions for all GTAP commodities.

The GTAP model was constructed at the Centre for Global Trade Analysis at Purdue University in the United States. It is the most up-to-date, detailed database of its type in the world.

Tasman Global builds on the GTAP model's equation structure and database by adding the following important features:

- dynamics (including detailed population and labour market dynamics)
- detailed technology representation within key industries (such as electricity generation and iron and steel production)
- disaggregation of a range of major commodities including iron ore, bauxite, alumina, primary aluminium, brown coal, black coal and LNG
- the ability to repatriate labour and capital income
- a detailed emissions accounting abatement framework

- explicit representation of the states and territories of Australia
- the capacity to explicitly represent multiple regions within states and territories of Australia

Nominally the *Tasman Global* database divides the world economy into 141 regions (133 international regions plus the 8 states and territories of Australia) although in reality the regions are frequently disaggregated further. ACIL Allen regularly models Australian projects or policies at the regional level.

The *Tasman Global* database also contains a wealth of sectoral detail currently identifying up to 70 industries (Table 1). The foundation of this information is the input-output tables that underpin the database. The input-output tables account for the distribution of industry production to satisfy industry and final demands. Industry demands, so-called intermediate usage, are the demands from each industry for inputs.

For example, electricity is an input into the production of communications. In other words, the communications industry uses electricity as an intermediate input. Final demands are those made by households, governments, investors and foreigners (export demand). These final demands, as the name suggests, represent the demand for finished goods and services. To continue the example, electricity is used by households – their consumption of electricity is a final demand.

Each sector in the economy is typically assumed to produce one commodity, although in *Tasman Global*, the electricity, transport and iron and steel sectors are modelled using a 'technology bundle' approach. With this approach, different known production methods are used to generate a homogeneous output for the 'technology bundle' industry. For example, electricity can be generated using brown coal, black coal, petroleum, base load gas, peak load gas, nuclear, hydro, geothermal, biomass, wind, solar or other renewable based technologies – each of which have their own cost structure.

The other key feature of the database is that the cost structure of each industry is also represented in detail. Each industry purchases intermediate inputs (from domestic and imported sources) primary factors (labour, capital, land and natural resources) as well as paying taxes or receiving subsidies.

Factors of Production

Capital, land, labour and natural resources are the four primary factors of production. The capital stock in each region (country or group of countries) accumulates through investment (less depreciation) in each period. Land is used only in agriculture industries and is fixed in each region. *Tasman Global* explicitly models natural resource inputs as a sector specific factor of production in resource based sectors (coal mining, oil and gas extraction, other mining, forestry and fishing).

Population Growth and Labour Supply

Population growth is an important determinant of economic growth through the supply of labour and the demand for final goods and services. Population growth for the 112 international regions and for the 8 states and territories of Australia represented in the *Tasman Global* database is projected using ACIL Allen's in-house demographic model. The demographic model projects how the population in each region grows and how age and gender composition changes over time and is an important tool for determining the changes in regional labour supply and total population over the projection period.

For each of the 120 regions in *Tasman Global*, the model projects the changes in age-specific birth, mortality and net migration rates by gender for 101 age cohorts (0-99 and 100+). The demographic model also projects changes in participation rates by gender by age for each region, and, when combined with the age and gender composition of the population, endogenously projects the future supply of labour in each region. Changes in life expectancy are a function of income per person as well as assumed technical progress on lowering mortality rates for a given income (for example, reducing malaria-related mortality through better medicines, education, governance, etc.). Participation rates are a function of life expectancy as well as expected changes in higher education rates, fertility rates and changes in the workforce as a share of the total population.

Labour supply is derived from the combination of the projected regional population by age by gender and the projected regional participation rates by age by gender. Over the projection period labour supply in most developed economies is projected to grow slower than total population as a result of ageing population effects.

For the Australian states and territories, the projected aggregate labour supply from ACIL Allen's demographics module is used as the base level potential workforce for the detailed Australian labour market module, which is described in the next section.

SECTORS IN THE *TASMAN GLOBAL* DATABASE

	Sector		Sector
1	Paddy rice	36	Paper products, publishing
2	Wheat	37	Diesel (incl. nonconventional diesel)
3	Cereal grains nec	38	Other petroleum, coal products
4	Vegetables, fruit, nuts	39	Chemical, rubber, plastic products
5	Oil seeds	40	Iron ore
6	Sugar cane, sugar beef	41	Bauxite
7	Plant- based fibres	42	Mineral products nec
8	Crops nec	43	Ferrous metals
9	Bovine cattle, sheep, goats, horses	44	Alumina
10	Animal products nec	45	Primary aluminium
11	Raw milk	46	Metals nec
12	Wool, silk worm cocoons	47	Metal products
13	Forestry	48	Motor vehicle and parts
14	Fishing	49	Transport equipment nec
15	Brown coal	50	Electronic equipment
16	Black coal	51	Machinery and equipment nec
17	Oil	52	Manufactures nec
18	Liquefied natural gas (LNG)	53	Electricity generation
19	Other natural gas	54	Electricity transmission and distribution
20	Minerals nec	55	Gas manufacture, distribution
21	Bovine meat products	56	Water
22	Meat products nec	57	Construction
23	Vegetables oils and fats	58	Trade
24	Dairy products	59	Road transport
25	Processed rice	60	Rail and pipeline transport
26	Sugar	61	Water transport
27	Food products nec	62	Air transport
28	Wine	63	Transport nec
29	Beer	64	Communication
30	Spirits and RTDs	65	Financial services nec
31	Other beverages and tobacco products	66	Insurance
32	Textiles	67	Business services nec
33	Wearing apparel	68	Recreational and other services
34	Leather products	69	Public Administration, Defence, Education, Health
35	Wood products	70	Dwellings

Note: nec = not elsewhere classified.

The Australian Labour Market

Tasman Global has a detailed representation of the Australian labour market which has been designed to capture:

- different occupations
- changes to participation rates (or average hours worked) due to changes in real wages
- changes to unemployment rates due to changes in labour demand

- limited substitution between occupations by the firms demanding labour and by the individuals supplying labour
- limited labour mobility between states and regions within each state.

Tasman Global recognises 97 different occupations within Australia – although the exact number of occupations depends on the aggregation. The firms who hire labour are provided with some limited scope to change between these 97 labour types as the relative real wage between them changes. Similarly, the individuals supplying labour have a limited ability to change occupations in response to the changing relative real wage between occupations. Finally, as the real wage for a given occupation rises in one state relative to other states, workers are given some ability to respond by shifting their location. The model produces results at the 97 3-digit ANZSCO (Australian New Zealand Standard Classification of Occupations) level.

The labour market structure of *Tasman Global* is thus designed to capture the reality of labour markets in Australia, where supply and demand at the occupational level do adjust, but within limits.

Labour supply in *Tasman Global* is presented as a three stage process:

- labour makes itself available to the workforce based on movements in the real wage and the unemployment rate;
- labour chooses between occupations in a state based on relative real wages within the state; and
- labour of a given occupation chooses in which state to locate based on movements in the relative real wage for that occupation between states.

By default, *Tasman Global*, like all CGE models, assumes that markets clear. Therefore, overall, supply and demand for different occupations will equate (as is the case in other markets in the model).

F

GASMARK

GasMark Global (GMG) is a generic gas modelling platform developed by ACIL Allen. GMG has the flexibility to represent the unique characteristics of gas markets across the globe, including both pipeline gas and LNG. Its potential applications cover a broad scope — from global LNG trade, through to intra-country and regional market analysis. *GasMark Global Australia* (GMG Australia) is an Australian version of the model which focuses specifically on the Australian market (including both Eastern Australian and Western Australian modules), but which has the capacity to interface with international LNG markets.

The model can be specified to run at daily, monthly, quarterly or annual resolution over periods up to 30 years.

F.1 Settlement

At its core, GMG Australia is a partial spatial equilibrium model. The market is represented by a collection of spatially related nodal objects (supply sources, demand points, LNG liquefaction and receiving facilities), connected via a network of pipeline or LNG shipping elements (in a similar fashion to 'arks' within a network model).

The equilibrium solution of the model is found through application of linear programming techniques which seek to maximise the sum of producer and consumer surplus across the entire market simultaneously. The objective function of this solution, which is well established in economic theory[88], consists of three terms:

— the integral of the demand price function over demand; minus
— the integral of the supply price function over supply; minus
— the sum of the transportation, conversion and storage costs.

The solution results in an economically efficient system where lower cost sources of supply are utilised before more expensive sources and end-users who have higher willingness to pay are served before those who are less willing to pay. Through the process of maximising producer and consumer surplus, transportation costs are minimised and spatial arbitrage opportunities are eliminated. Each market is cleared with a single competitive price.

The figure below seeks to explain diagrammatically a simplified example of the optimisation process. The two charts at the top of the figure below show simple linear demand and supply functions for a particular market. The charts in the middle of the figure below show the integrals of these demand and supply functions, which represent the areas under the demand and supply curves. These are equivalent to the consumer and producer surpluses at each price point along the curve. The figure on the bottom left shows the summation of the consumer and producer surplus, with a maximum clearly evident at a quantity of 900

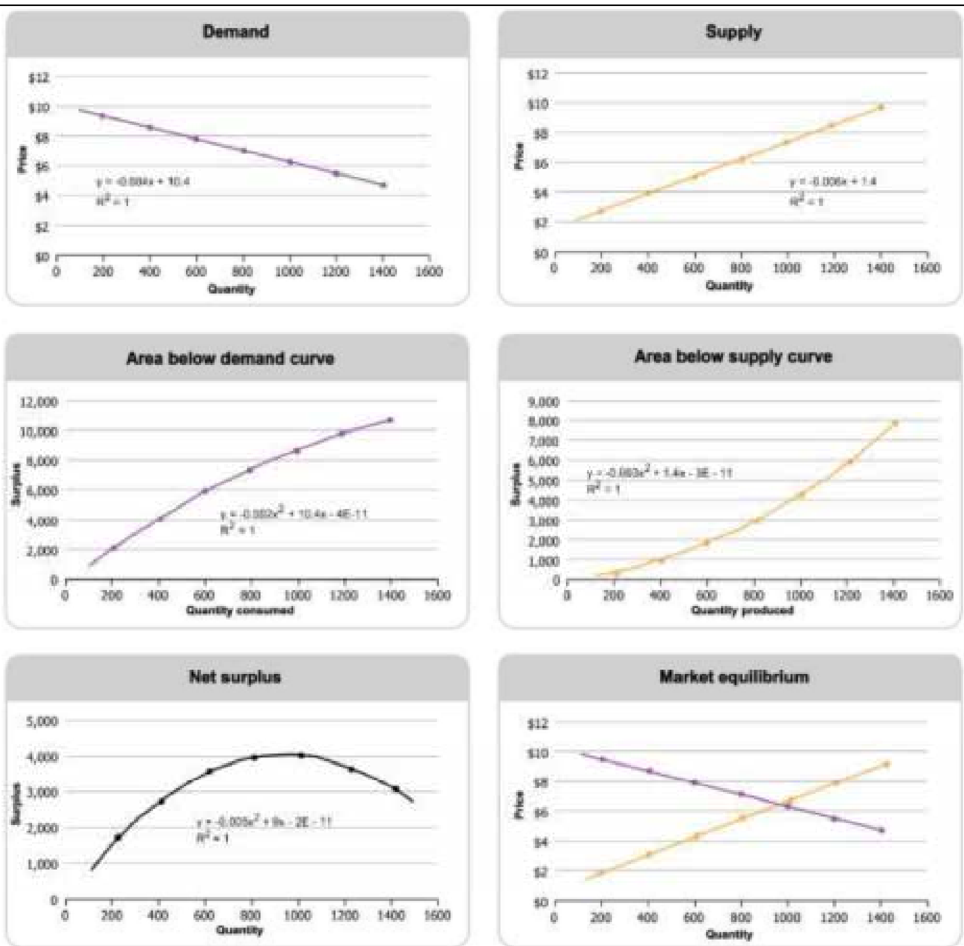
[88] The theoretical framework for the market solution used in GMG is attributed to Nobel Prize winning economist Paul Samuelson.

units. This is equivalent to the equilibrium quantity when demand and supply curves are overlayed as shown in the bottom right figure.

The distinguishing characteristic of spatial price equilibrium models lies in their recognition of the importance of space and transportation costs associated with transporting a commodity from a supply source to a demand centre. Since gas markets are interlinked by a complex series of transportation paths (pipelines, shipping paths) with distinct pricing structures (fixed, zonal or distance based), GMG Australia also includes a detailed network model with these features.

Spatial price equilibrium models have been used to study problems in a number of fields including agriculture, energy markets, mineral economics, as well as in finance. These perfectly competitive partial equilibrium models assume that there are many producers and consumers involved in the production and consumption, respectively, of one or more commodities and that as a result the market settles in an economically efficient fashion. Similar approaches are used within gas market models across the world.

SIMPLIFIED EXAMPLE OF MARKET EQUILIBRIUM AND SETTLEMENT PROCESS



SOURCE: ACIL ALLEN CONSULTING

F.2 Data inputs

The user can establish the level of detail by defining a set of supply regions, customers, demand regions, pipelines and LNG facilities. These sets of basic entities in the model can be very detailed or aggregated as best suits the objectives of the user. A ‘pipeline’ could represent an actual pipeline or a pipeline corridor between a supply and a demand region. A supplier could be a whole gas production basin aggregating the output of many individual fields, or could be a specific producer in a smaller region. Similarly a demand point could be a single industrial user or an aggregation of small consumers such as the residential and commercial users typically serviced by energy utility companies.

The inputs to GMG Australia can be categorised as follows:

— **Existing and potential new sources of gas supply**: these are characterised by assumptions about available reserves, production rates, production decline characteristics, and minimum price expectations of the producer. These price expectations may be based on long-run marginal costs of production or on market expectations, including producer’s understandings of substitute prices.
— **Existing and potential new gas demand**: demand may relate to a specific load such as a power station, or fertiliser plant. Alternatively it may relate to a group or aggregation of customers, such as the residential or commercial utility load in a particular region or location. Loads are defined in terms of their location, annual and daily gas demand including daily demand profiles, and price tolerance.
— **Existing, new and expanded transmission pipeline capacity**: pipelines are represented in terms of their geographic location, physical capacity (which may vary over time), flow characteristics (uni-directional or bi-directional) and tariffs.
— **Existing and potential new LNG facilities**: LNG facilities include liquefaction plants, regasification (receiving) terminals and assumptions regarding shipping costs and routes. LNG facilities play a similar role to pipelines in that they link supply sources with demand. LNG plants and terminals are defined at the plant level and require assumptions with regard to annual throughput capacity and tariffs for conversion.

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ABOUT ACIL ALLEN CONSULTING

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WE PROVIDE SENIOR ADVISORY SERVICES THAT BRING UNPARALLELED STRATEGIC THINKING AND REAL WORLD EXPERIENCE TO BEAR ON PROBLEM SOLVING AND STRATEGY FORMULATION.

Appendix 18 Scope of services for economic impact modelling

Scope of Services

Background to the Inquiry

On 14 September 2016 the Chief Minister of the Northern Territory, the Hon Michael Gunner MLA, announced a moratorium on hydraulic fracturing of onshore unconventional reservoirs in the Northern Territory. At the same time, the Chief Minister announced that a *Scientific Inquiry into Hydraulic Fracturing of Onshore Unconventional Reservoirs in the Northern Territory* (the **Inquiry**) would be established and released draft Terms of Reference, which were open for public comment for four weeks.

On 3 December 2016 the Northern Territory Government announced the final Terms of Reference for the Inquiry and the composition of the panel that will be undertaking the Inquiry (the **Panel**).

The Inquiry was established under section 4 of the Inquiries Act 1945 (NT) and is comprised of a judicial chair, the Hon Justice Rachel Pepper, and ten highly regarded scientists with expertise in areas ranging from hydrogeology to social science.

The Inquiry's final Terms of Reference can be read in full on the Inquiry's website (www.frackinginquiry.nt.gov.au).

On 20 February 2017 the Inquiry released a Background and Issues Paper, also available on the Inquiry's website, which was followed by hearings and community meetings held in March 2017 in various town centres and remote communities across the Northern Territory. The Issues Paper includes a timeline for the Inquiry, which indicates that an interim report will be released in mid-2017, a draft final report will be released during the last quarter of the year, and a final report will be released in December 2017.

The Hydraulic Fracturing Taskforce (the **Taskforce**) has been established in the Department of the Chief Minister to support the Inquiry.

Terms of Reference for the Inquiry and the economic impact theme

The Panel has divided the work of the Inquiry into the following themes: water, land, air, social impacts, economic conditions, cultural conditions, human health, land access, and the regulatory framework. This request relates to the economic theme only, however, there are overlaps with the social impact and regulatory framework themes. A sub-group of Inquiry Panel members has been allocated responsibility for each theme.

The Terms of Reference for the Inquiry require the Panel to do the following in respect of each theme:

- determine and assess the impacts and risks associated with hydraulic fracturing of unconventional reservoirs and the associated activities;
- determine whether additional work or research is required to make that determination;
- advise the level of impact or risk that is acceptable in the Northern Territory context;
- describe methods, standards or strategies that can be used to reduce the impact and risk to acceptable levels; and
- identify what government can do, including implementing any policy or regulatory changes, to ensure that the impacts and risks are reduced to the required levels.

The *Background and Issues Paper* includes a non-exhaustive list of the potential risks and benefits associated with the economic theme at page 22.

In accordance with the definitions in the Terms of Reference, a reference to an "unconventional reservoir" in this document is a reference to a reservoir where the rock formation is *shale*. There is currently no gas being produced from unconventional, or shale, reservoirs in the Northern Territory. The Amadeus Basin is currently producing gas from conventional reservoirs.

With regard to the third Term of Reference stated above, the level of impact or risk that is acceptable will ultimately be a matter for the decision maker under the relevant legislation (typically the Minister), however, at this stage the meaning of acceptability or acceptable levels of risk is a matter for the Panel, taking into account principles of ecological sustainable development, including the precautionary principle and intergenerational equity.

The Terms of Reference make it clear that the Panel must not only look at the impacts of hydraulic fracturing and the associated activities on economic conditions in the Northern Territory – the Panel must also consider the economic impacts of the onshore unconventional gas industry as a whole on the Northern Territory. This is made clear in the following extract from the Terms of Reference, which has been amended to include the relevant language only:

> *"When the inquiry makes a determination… about whether or not there has been an impact or risk on … economic conditions, the inquiry will … consider the impacts and risks of the development of the onshore unconventional gas industry, including exploration activities such as seismic surveys and aerial surveys, land access and costs and benefits of the industry."*

Steering Committee

A Steering Committee has been established to oversee the work. The Steering Committee is comprised of the Hon Justice Rachel Pepper, Dr Vaughan Beck and the Executive Director of the Hydraulic Fracturing Taskforce. The point of contact for all matters will be the Executive Director of the Hydraulic Fracturing Taskforce.

Probity Advisor

The Territory has appointed a Probity Advisor to oversee the Territory's processes in relation to the stages of this process. The Probity Advisor's role is to ensure that fairness and impartiality are observed throughout, and that the evaluation criteria stated in any related documentation are consistently applied to all submissions.

Scope of Work

The supplier must consider the following scenarios:

- **Scenario 1** or the baseline scenario, where the moratorium on hydraulic fracturing of unconventional shale gas reservoirs remains in place;
- **Scenario 2**, which involves the development of the onshore unconventional shale gas industry in the Northern Territory; and
- **Scenario 3,** which involves the development of unconventional shale gas reservoirs in the Beetaloo sub-basin only.

Benefits

The supplier must describe, in both quantitative and qualitative terms, the actual and potential direct and indirect economic benefits associated with each of Scenarios 1, 2 and 3 on the Northern Territory economy under the current regulatory regime.[1]

The supplier must describe, in quantitative and qualitative terms, the actual and potential direct and indirect economic benefits associated with Scenario 2 on the national economy under current regulatory, fiscal and economic settings.

For each of Scenarios 1, 2 and 3 the supplier must estimate the following:

- Gross State Product (**GSP**);
- State Final Demand (**SFD**);
- employment;
- business investment and output;
- CPI;
- population;
- wages; and
- the quantum of royalties that might be received by the Northern Territory Government under the *Petroleum Act 1984* (NT) (to avoid doubt this will include any royalties received in connection with both unconventional and conventional reservoirs).

1 Indirect benefits might include the opening up of supply chains for local businesses, innovation spin offs, opportunities to develop or support supply and maintenance industries and any other flow-on opportunities the supplier identifies.

The supplier must provide the Steering Committee with:

- in accordance with Part C, any assumptions made and an explanation of the methodology used to develop such assumptions, both of which must be approved by the Steering Committee prior to undertaking any economic modelling. The supplier must explain how reasonable and reliable the assumptions are, as well as how any potential bias has been managed, and
- a description of the similarities or differences between the assumptions made under item 7(a) above and the assumptions made in the report entitled Economic Impact of Shale and Tight Gas Development in the Northern Territory dated 14 July 2017 by Deloitte Access Economics.

The supplier must describe the options available to the Northern Territory Government, whether through policy or regulatory reforms or otherwise, to maximise and sustain the benefits captured by Territorians and others.[2] In this regard the supplier must:

- conduct a literature review to advise on leading practice methods for the sustainable development of onshore unconventional shale gas projects from an economic perspective, and
- provide case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful and what lessons can be learned from these experiences in the Northern Territory context.

The supplier must describe the options available to the Northern Territory Government, including regulatory or policy reforms, for how revenue from the development of onshore unconventional shale industry can be retained both jointly and separately in the regions affected by the development and the Northern Territory, in each case, without impeding investment. Consideration must be given to:

- local procurement requirements, local training programs and other mechanisms to improve local capacity as well as any ‘Royalty for Regions’ or similar type programs, and
- case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful and the lessons that can be learned for the Northern Territory context.

Risks

The supplier must describe, in qualitative terms, any actual and potential adverse impacts and risks associated with Scenario 1, Scenario 2, and Scenario 3 on the Northern Territory economy under the current regulatory regime.

The supplier must consider the impacts of development on other industries in the Northern Territory, including, but without limitation, the tourism, agricultural, horticultural and pastoral, industries.

The supplier must describe the options available to the Northern Territory Government, including policy or regulatory reforms, to mitigate and manage any actual and potential impacts and risks identified above. For example, the supplier must advise what the Northern Territory Government can do to mitigate any “boom and bust” economic cycle associated with the development of any unconventional shale gas industry.

The supplier must:

- conduct a literature review to advise on leading practice methods that could be used to manage and mitigate any risks identified, and
- provide case studies and examples from comparable jurisdictions, including domestic and overseas jurisdictions, where such options have been successful and unsuccessful, and what lessons can be learned from these experiences in the Northern Territory context.

2 It is noted that onshore unconventional gas industry, local communities, local governments, Aboriginal stakeholders (including Aboriginal land councils and prescribed bodies corporate under the *Native Title Act 1993* (Cth)) have a significant role to play in the maximisation of economic benefits, however, the scope of the work is limited to actions that government can take.

Assumptions

No production licences have been granted under the Petroleum Act for the purpose of producing unconventional shale gas in the Northern Territory. Further exploration work, including the drilling of appraisal wells, is required to fully understand the scope of the Northern Territory's shale gas reservoirs and whether or not they are commercially recoverable.

The most prospective area for shale gas development, should the moratorium be lifted by the Government, is the Beetaloo sub-basin (see Attachment A). Origin Energy announced a significant discovery of unconventional shale gas in the Beetaloo sub-basin in February 2017, which significantly increased prior estimates of the resource.

In developing any assumptions required to undertake Part A and B, the supplier must consult with relevant stakeholders, including, but without limitation, the Departments of Treasury and Finance; Primary Industry and Resources; Trade, Business and Innovation; Chief Minister; Northern Territory Farmers; the Northern Territory Cattlemen's Association; petroleum operators and titleholders in the Beetaloo sub-basin, Aboriginal Land Councils, and the Australian Petroleum Production and Exploration Association.

The supplier must notify the Steering Committee prior to any consultation and members of the Steering Committee may attend the consultation.

Timelines and Reporting

The work must be in the form of a written report. The report must be written in plain English. All technical terms (including economic metrics such as Gross State Product, State Final Demand, and employment multipliers) must be explained.

At the end of each calendar month following the award of the tender the supplier must provide the Steering Committee with a written progress report and a verbal presentation within five working days of receipt of the report.

The supplier must provide the Steering Committee with a draft final report and a verbal presentation to the Steering Committee on or prior to 18 August 2017.

A final report must be provided to the Steering Committee by 1 September 2017 and the supplier must present the final report to the Panel on a date to be determined.

The Inquiry will publish the final report on the Inquiry's website on a date to be determined.

The supplier must keep all correspondence, reports and presentations to the Steering Committee confidential, except that the supplier may make the final report publicly available after it has been published on the Inquiry's website.

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